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Rockerbie, Duane and Easton, Stephen

University of Lethbridge, Simon Fraser University

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RISK DIVERSIFICATION FROM REVENUE SHARING IN A PROFESSIONAL SPORTS LEAGUE: MEASURING WELFARE GAINS

Duane W. Rockerbie

Department of Economics, University of Lethbridge

rockerbie@uleth.ca

Stephen T. Easton

Department of Economics, Simon Fraser University

easton@sfu.ca

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ABSTRACT

Revenue sharing is a common league policy in professional sports leagues. Several motivations for revenue sharing have been explored in the literature, including supporting small market teams, affecting league parity, suppressing player salaries and improving team profitability. We investigate a different motivation. Risk-averse team owners may be able to increase league welfare by using revenue sharing to reduce the variance and affect the skewness of the league distribution of team local revenues. We first determine the extent to which revenue sharing affects these moments in theory, then we attempt to quantify the effects on league welfare for Major League Baseball. Our results suggest that revenue sharing had significant welfare gains, obtained at little cost, that enhance the positive effects noted by other studies. (JEL: Z28)

I. INTRODUCTION

Many papers in the sports economics literature have studied the effects of different types of revenue sharing systems on league outcomes. The majority have focused on the effects on league parity using both theoretical models (Kesenne (2015, 2000), Miller (2007), Rockerbie (2009), Szymanski (2004) and Vrooman (2009) are examples), and empirical evidence (Maxcy (2009)). Others have focused on the effects on player salaries (Hill and Jolly (2015)), while others have focused on team profitability (Easton and Rockerbie (2005), Kesenne (2007)). These papers assume that the motivation for a league to adopt revenue sharing is to encourage financial stability and minimize the credible threats of rival leagues. Financial stability is an often used term that is addressed only indirectly by creating links between parity and profitability to financial stability. Our purpose in this paper is to investigate the effects of revenue sharing on financial stability more directly by considering its effects on the league distribution of local revenues and the potential benefits (and costs) they generate for league welfare. Specifically we show that a straight pool revenue sharing system reduces the variance and skewness of the league revenue distribution in a systematic but non-linear fashion. We then quantify the welfare gains to a league by assuming a risk-averse league commissioner whose objective is to improve league welfare. Our results using data for Major League Baseball (MLB) suggest that these welfare gains can be significant and provide a motivation for revenue sharing that have not seen explored in the literature.

A growing literature has considered how trade-induced economic growth has resulted in greater income inequality (Dixit and Norman (1986), Goldberg and Pavcnik (2007)) and how an income tax system can redistribute income to enhance the potential gains from free trade and integration.

Revenue sharing has traditionally been used as a tax-like method to redistribute revenues from rich to poor teams in professional sports leagues. We focus on sharing of local revenues in this paper. However sharing of marketing, media and television revenues has become a standard practice as well. The National League of MLB adopted gate revenue sharing in 1876 and the American League in 1903 (fixed dollar amounts per home ticket sold)[1]. The National Hockey League (NHL) adopted a limited gate revenue sharing plan in 1925 (3.5% of home gate receipts)[2] and the National Football League (NFL) a much more extensive gate sharing plan in 1960 (40% of home gate receipts).[3] Early in their histories, leagues often adopted revenue sharing often during periods of rapid expansion that created a large imbalance in league revenues. Maintaining the financial stability of the league was important to insure that teams had opponents to play games against and to stave off the threat of rival leagues.[4] Today's revenue sharing plans are complex and extensive and are agreed to with the players in their collective bargaining agreements. Virtually all local revenues are shared to some extent, including local television network and cable revenues.

Theoretical models have focused mainly on the effects on parity and team profitability in levels. However, it is uncertain how a movement towards or away from parity in winning percentages affects the stability of league revenues. We consider the effects of revenue sharing on the league

[1] See Surdham (2007).
[2] See Ross (2015).
[3] See Surdham (2007).
[4] The NHL welcomed the Boston Bruins, New York Americans and Pittsburgh Pirates in 1925 and approved new franchises in Chicago and Detroit in 1926. The addition of these large American cities to the much smaller four Canadian cities already in the NHL created a bidding war for professional players that put the smaller franchises at a considerable financial disadvantage. The NFL had just survived the threat of the now defunct All-American Football Conference (AAFC) by absorbing three AAFC teams in 1950. The new American Football League (AFL) began operations in 1960 as a direct competitor to the long-established NFL.

distribution of team revenues in terms of its second (variance) and third (skewness) moments. Reducing its variance has obvious benefits with a risk-averse league commissioner, but reducing its skewness does not have as obvious benefits. Reducing skewness implies a more equitable (equal) distribution of team revenues – a desirable result for a league composed of socialist owners. But team owners are capitalists who prefer more to less and their commissioner is chosen to represent their financial interests. As we show, a league with a majority of teams above the average team revenue (negative skewness) is preferred to the opposite. While not the worst outcome, equality of team revenues is less preferred to negatively skewed revenues – a seemingly odd result, but one that is perfectly consistent with improving welfare.

II. WELFARE AND REVENUES

To motivate the consideration of league welfare from revenue sharing, we assume that team owners are risk-averse and maximize their utility from profit. This differs from the standard sports league model that assumes that risk-neutral team owners maximize profit. Consumers are often thought of as being risk averse when facing a gamble that affects their income or wealth. In the simplest case, a representative team owner faces uncertain revenue from season to season that takes on only two outcomes, high or low. These uncertain revenues arise from the inherent uncertainty of team performance due to injuries or changes in the performance of competing teams. While team owners do not have the choice of accepting a certainty equivalent amount of revenue, they may prefer league policies that reduce the variance of team revenues and raise their utility. Krautmann (2017) finds evidence to suggest that team owners demonstrate risk aversion by paying a premium to MLB players who demonstrate consistent performance. Maxcy (2004) suggests that team owners reward consistent players with longer term contracts. Consistent player performance could translate into consistent team revenues, suggesting that team owners value consistent revenues.

Our sports league is composed of n teams. Each team owner contributes a share (1-α) of its local revenue into a straight pool which is then divided evenly among the team owners at the end of each playing season. Local revenues are obtained primarily from ticket sales but also contain other local revenues that increase with the performance of the team. We ignore other types of revenue that are not typically dependent upon team performance. To focus on welfare consequences of revenue sharing, we do not explicitly model the determination of the profit-maximizing revenue for each team in order, although we acknowledge that revenue sharing can affect the optimal choice of talent and thus team revenue (references).

Revenue for team i after revenue sharing (where an "A" distinguishes revenue after sharing) is given by

$$R_i^A = \alpha R_i + (1-\alpha)\sum R_j/n = \alpha R_i + (1-\alpha)\bar{R} \qquad (1)$$

In (1), $\bar{R} = \sum_{j=1}^{n} R_j/n$, the team average local revenue for the league before revenue sharing.[5] We assume that revenue sharing does not affect team owner incentives to acquire talent and earn revenue. Effectively this means that for any team i, $R_i \neq R_i(\alpha, w_i)$, where w_i is winning

[5] It is easy to show that the average local revenue is unchanged by revenue sharing. Using (1), $\bar{R}^A = \sum R_j^A/n = \left(\sum \alpha R_j + \sum(1-\alpha)\bar{R}\right)/n = \alpha\bar{R} + (1-\alpha)\bar{R} = \bar{R}$.

percentage. If we think of revenue sharing as a constant tax rate on revenue, it is easy to show that team owners will simply maximize team revenue and then pay the revenue sharing tax, regardless of the value of the tax rate.

Since that the survival of other teams is necessary to carry on a business, we assume that each team owner cares about the economic health of the league. To this end, owners elect a league Commissioner by a simple majority vote who acts as a responsible agent for the owners. Utility for the Commissioner is representative of the joint utility of the owners and is calculated as a constant relative risk aversion utility function of the form[6]

$$U = R^{1-\theta}/1 - \theta \qquad (2)$$

The θ term is the coefficient of relative risk aversion and R is total league local revenue. Our measure of welfare differs from those found in the sports economics literature. Fort and Quirk (2010a, 2010b) use the sum of consumer and producer surpluses to compare welfare at different levels of league parity. Dietl and Lang (2008) show that revenue sharing increases consumer surplus and team profits. In the first instance, revenue sharing affects the league distribution of revenues and we focus our analysis on any welfare effects that results. To estimate league

[6] The CRRA utility function is a popular choice in models of consumption and real business cycles for two reasons: risk aversion is invariant to the level of consumption, income and wealth; utility is stationary, that is, moving the same consumption path forward one or more periods does not change the preference ordering. See Lucas (1987).

welfare, we take a Taylor series expansion of (2) expanded around the mean of league revenue, limited to the first four terms.[7]

$$U_1 = R^{1-\theta}/1-\theta + \bar{R}^{-\theta}(R-\bar{R}) - \frac{\theta}{2}\bar{R}^{-\theta-1}(R-\bar{R})^2 + \frac{\theta(\theta-1)}{6}\bar{R}^{-\theta-2}(R-\bar{R})^3 \quad (3)$$

Before revenue sharing, league revenue can deviate from its mean due to shocks that we specify as $R = \bar{R} + e$ without specifying the nature of these shocks, but assuming that $E(e) = 0$ and $Var(e) = \sigma^2$. Obviously these league shocks are a summation of the shocks to individual team revenues in a manner, that for simplicity, we do not specify. The mean league revenue is unchanged after revenue sharing hence the second term in (3) vanishes after taking the expected value, however the variance and skewness of league revenue after revenue sharing, denoted $E\left(R_i^A - \bar{R}\right)^2 = \sigma_A^2 = \frac{1}{n}\sum\left(R_i^A - \bar{R}\right)^2$ and $E\left(R_i^A - \bar{R}\right)^3 = Z_A^3 = \frac{1}{n}\sum\left(R_i^A - \bar{R}\right)^3$ respectively, may not be.[8]

$$E(U_1) = R^{1-\theta}/1-\theta - \frac{\theta}{2}\bar{R}^{-(1+\theta)}\sigma_A^2 + \frac{\theta(\theta-1)}{6}\bar{R}^{-(2+\theta)}Z_A^3 \quad (4)$$

[7] Lucas (1987) used the same expansion method to evaluate the welfare gain from consumption smoothing. He did not expand to the fourth term in (3) since he did not have the data necessary to compute the necessary moments of the distribution of U.S. consumption.
[8] Note that Z_A^3 is not the coefficient of skewness, defined as $n^{-1}\sum((R_i^A - \bar{R})/\sigma_A)^3 = (n\sigma_A^3)^{-1}Z_A^3$, however we refer to it as a measure of skewness in the rest of the paper.

Risk aversion suggests that greater variability in team revenues (σ_A^2) reduces utility. Risk averse team owners seek to reduce the variability in revenues by diversifying their revenue "portfolios" and revenue sharing provides a mechanism to do this, although we do not pursue this team-specific portfolio effect.[9] Rather we assume that the Commissioner is concerned with the variance and skewness of the distribution of team revenues around the team average.

The effect of skewness on utility depends upon the degree of relative risk aversion. If the Commissioner is somewhat risk averse, it is likely that $\theta > 1$ and negative skewness in revenues ($Z_A^3 > 0$) will increase utility.[10] Negative skewness can imply many teams with revenues above the league average or a few teams with very large revenues above the league average. This increases utility for the league, in the first case at the expense of a few teams well below the league average. Unfortunately we cannot distinguish between the first and second cases based only on negative skewness. What we can say is that any movement towards negative skewness is preferred, defeating the argument that the best result is equality of team revenues. Negative skewness indicates that there is more league revenue above the average than below, but not necessarily more teams with revenue above the league average.

[9] Revenue sharing in the form assumed in this paper allows team owners to diversify their revenue portfolios by essentially investing in the economic health of other teams. Two requirements are necessary for team owners to benefit from a portfolio effect. First, team revenues should display some sort of cyclical behavior; second, and related to the first requirement, a majority of teams should display a negative covariance with revenues of other teams or the league average revenue. Most professional sports teams have periods of strong revenue growth followed by periods of revenue stagnation or decline. The cyclical nature of winning percentages and a possible cause of this has been explored by Easton and Rockerbie (2010) and Rockerbie and Easton (2014). Revenues are at least partially determined by success on the field, however the cyclical nature of team revenues has not been deeply explored in the literature. The majority of team owners that vote in favor of revenue sharing might do so if they perceive benefitting from the portfolio effect, implying their local revenue displays a negative covariance with the local revenues of other teams.

[10] In the special case of $\theta = 1$, we have a log utility function and skewness does not affect utility by inspection of (4).

It is important not to confuse skewness in revenues with a lack of revenue equity that some might associate with lower welfare. In our model, the Commissioner wishes to see the majority of teams doing well on the revenue side. How revenue sharing affects skewness specifically is addressed in a later section, however any improvement in revenue equity, as measured by a movement to a more symmetric league revenue distribution from negative skewness, will lower league welfare.

Revenue sharing and the variance of team revenues

To calculate the variance of team revenues after revenue sharing, one might be tempted to use the simple rule of variances that $Var\ aX = a^2 Var\ X$ since part of local revenue after sharing is just αR_i, but this would ignore the payment received from the revenue sharing pool. The variance of team revenues around the league average after revenue sharing is not as obvious as the simple rule, but not hard to derive.

$$\sigma_A^2 = E\left(R_j^A - \bar{R}\right)^2 = \frac{1}{n}\sum_{j=1}^{n}\left(R_j^A - \bar{R}\right)^2 \qquad (5)$$

Consider the bracketed term only for team i and insert (1).

$$\left(R_i^A - \bar{R}\right)^2 = (\alpha R_i + (1-\alpha)\bar{R} - \bar{R})^2 = \left(\alpha(R_i - \bar{R})\right)^2 = \alpha^2(R_i - \bar{R})^2 \qquad (6)$$

Each of the n teams will have the same expression as (6) with the terms inside the bracket using values for the individual team. Summing over the n teams gives

$$\sigma_A^2 = \frac{1}{n}\sum_{j=1}^{n}\left(R_j^A - \bar{R}\right)^2 = \alpha^2 \frac{1}{n}\sum_{j=1}^{n}\left(R_j - \bar{R}\right)^2 = \alpha^2\sigma^2 \qquad (7)$$

The reduction in the variance of league revenues after revenue sharing is proportional to α^2. If we think of the variance of local revenues as a measure of risk, revenue sharing reduces this risk by a factor of $0.69^2 = 0.4761$ in MLB (as per the 2016 CBA), a significant reduction.

Risk averse team owners will value the reduction in risk that revenue sharing delivers. But by how much? The relevant part of (4) is $-\frac{\theta}{2}\bar{R}^{-(1+\theta)}\sigma_A^2$. Consider a one-shot adoption of revenue sharing that reduces $\alpha = 1$ to $\alpha = 0.69$. Expressing the increase in utility relative to marginal utility (evaluated at the team average local revenue) gives the increase in dollars per unit of utility. Next dividing by the average local revenue for the league expresses the welfare change as a percentage of average league revenue.

$$\frac{\Delta U/U\prime}{\bar{R}} = -(\theta/\overline{2R}^2)\sigma^2(0.69^2 - 1) = (\theta/\overline{2R}^2)0.5239\sigma^2 > 0 \qquad (8)$$

The larger the variance in league local revenues before revenue sharing, the larger the welfare gains from revenue sharing, and the larger is the average local revenue of the league, the smaller are the welfare gains from revenue sharing. Leagues composed of very wealthy teams playing in large markets may stand little to gain in welfare by instituting revenue sharing.

Revenue sharing and the skewness of team revenues

Skewness is also important to the Commissioner when considering league welfare. Negative skewness provides higher welfare since many teams are above the league average local revenue. Skewness after revenue sharing is defined as

$$Z_A^3 = E\left(R_j^A - \bar{R}\right)^3 = \frac{1}{n}\sum_{j=1}^{n}\left(R_j^A - \bar{R}\right)^3 \tag{9}$$

Using the same method used to derive the variance, the skewness in local revenues is given by

$$Z_A^3 = \alpha^3 Z^3 \tag{10}$$

The reduction in skewness of the league revenue distribution that revenue sharing delivers is proportional to α^3. For MLB, this is $0.69^3 = 0.3285$, again a significant reduction, but in this case, a reduction in welfare for the league if the league revenue distribution is negatively skewed.

How much will the Commissioner value the reduction in skewness with greater revenue sharing? The relevant part of (4) is $\frac{\theta(\theta-1)}{6}\bar{R}^{-(2+\theta)}Z_A^3$. Again expressing the increase in utility relative to marginal utility and then as a percentage of average league revenue gives the increase in welfare for the Commissioner by increasing revenue sharing.

$$\frac{\Delta U/U\prime}{\bar{R}} = \frac{\theta(\theta-1)}{6\bar{R}^3}Z^3(0.69^3-1) = -\frac{\theta(\theta-1)}{6\bar{R}^3}0.6715Z^3 < 0 \qquad (11)$$

The comparative static result in (11) assumes that $Z^3 > 0$, but if in fact $Z^3 < 0$, then (11) is positive.

III. OVERALL WELFARE GAINS FROM REVENUE SHARING

Revenue sharing increases league welfare by reducing the variance of local revenues around the league average, but lowers welfare by transferring revenue from teams above the league average to teams below the league average, reducing any negative skewness. The net change in league welfare is the sum of (10) and (11).

$$Net\ \frac{\Delta U/U\prime}{\bar{R}} = (\theta(\theta-1)(\alpha^3-1)Z^3 - 3\theta\bar{R}(\alpha^2-1)\sigma^2)/6\bar{R}^3 \qquad (12)$$

The measurement of the welfare gain in (12) requires accurate data concerning the distribution of team revenues to be meaningful. Professional sports leagues do not make these data publicly available. We require local revenues before revenue sharing for every team in a professional sports league. MLB released accurate data for the 1995 through 2001 seasons in a supplement to its Blue Ribbon report (MLB 2001). Team local revenues before revenue sharing are reported in Table 27 of the report.[11] Unfortunately MLB did not use the straight-pool revenue sharing plan that we assumed in deriving equations (7) and (10) in any of these seasons. The long-standing gate sharing plan was used in both the NL and the AL in the 1995 season. The 1996-2001 seasons saw MLB experimenting with different hybrid plans in each season. It was not until the 2002 season that MLB adopted the simple straight-pool revenue sharing plan that required each team to contribute 34% of its local revenue to the pool, with the pool then split up evenly among all 30 teams. The 2007 CBA saw the contribution rate drop to 31% with no other changes. Two revenue sharing pools were created in the 2012 CBA: a basic pool that is no different from the 2002 plan and a supplemental pool (approximately 14% contribution rate) where payments from the pool were made based on the estimated sizes of the local television markets.

The Blue Ribbon report provided a unique glimpse into the financial numbers for MLB.[12] As much as we would like to use data from the report, we cannot for two reasons. First, as already noted, the derivations of equations (7) and (10) that determine the properties of straight-pool

[11] Local revenue consists of gate receipts, local television, radio and cable rights fees, ballpark concessions, local advertising, sponsorship and publications, parking, suite rentals and postseason and spring training revenues. Local revenues are the largest single component of most clubs' total annual revenues.

[12] Financial statements for MLB clubs are sometimes leaked by the press or presented voluntarily by MLB clubs, but only sporadically. See Rod Fort's website for limited data for the Seattle Mariners, Milwaukee Brewers and Cleveland Indians (https://sites.google.com/site/rodswebpages/codes). More recent data for the Los Angeles Angels, Florida Marlins and Pittsburgh Pirates can be found at http://deadspin.com/5615096/mlb-confidential-the-financial-documents-baseball-doesnt-want-you-to-see-part-1.

revenue sharing on the variance and skewness of the league revenue distribution do not hold for the forms of revenue sharing used in the 1995-2001 seasons. Second, team owners form expectations of the amount of revenue to be contributed to the revenue sharing pool when making their talent acquisitions, setting ticket prices and other financial decisions. The pre-revenue sharing local revenue figures incorporate these decisions. Using local revenue data for different revenue sharing plans is not consistent with team owner expectations.

Forbes magazine publishes estimates of gate revenue before revenue sharing for MLB beginning in 1990. We have chosen the 2002-2011 MLB seasons since the straight-pool revenue sharing plan was used in each season. Forbes reports estimates of gate revenue, other revenue, and total revenue.[13] Other revenue includes all other sources of local revenue (parking, concessions, marketing, local media and so on) as well as the net revenue sharing payment received and the share of the national broadcast revenue. To evaluate equation (12), we require total local revenue *before* revenue sharing. We first subtract the share of the national television broadcast revenue from the reported total local revenue[14]. All of the remaining local revenue is shared and is reported net of any revenue sharing payment. We calculate local revenue before sharing using the formula $R_1 = (R_1^A - (1 - a)\bar{R})/\alpha$ using the values $\alpha = 0.66$ and $\alpha = 0.69$ for the 2002-06 and 2007-11 periods respectively. Finally, we divided by the national consumer price index (2002 = 100) to convert to real local revenues.[15]

[13] The data are conveniently located at Rod Fort's website, https://sites.google.com/site/rodswebpages/codes.
[14] Each team received approximately $18.6 million in each of the 2002 through 2006 seasons and $23.7 million in each of the 2007 through 2011 seasons. https://sites.google.com/site/rodswebpages/codes.
[15] http://www.usinflationcalculator.com/

In our Table 1, we estimate the welfare gains to MLB in 2002-11 seasons after hypothetically adopting the straight-pool revenue sharing plan adopted in 2002 in a one-shot fashion. We use the parameter values $\alpha = 0.66$ (2002-06), $\alpha = 0.69$ (2002-11)and $\theta = 2$. Our choice of value for θ is survey evidence found in and Mehra and Prescott (1985), however we also used values between 1 and 3 with little change in the results. The welfare gain due to the decrease in the variance of team revenues ranged from 6.3% to 13.7%, averaging 9.4% of the average team revenue, *over and above what the welfare change would have been without revenue sharing*.. The welfare losses due to moving to positive skewness were modest, ranging from -1.5% to -7.7%, averaging -3.1%. The local revenue distributions were slightly negatively skewed in these seasons. Revenue sharing results in a transfer of revenue to those teams below the league average revenue, resulting in a more symmetric revenue distribution and reducing welfare in (4). This effect was evident in all of the 2002-11 seasons. Figures 1 and 2 are histograms of the standardized values of team local revenues for the 2002 and 2011 seasons. In 2002, 11 out of 28 teams (39.3%) experienced pre-revenue sharing local revenue above the league average. By 2011, this increased to 13 out of 30 teams (43.3%). The top local revenue team was the New York Yankees in both seasons. The Yankees pre-revenue sharing local revenue was 5.12 standard deviations above the average in 2002, increasing to 6.57 standard deviations in 2011, despite the league standard deviation being virtually unchanged between the two seasons.[16] The increase in negative skewness would have increased league welfare without revenue sharing, however with revenue sharing, league welfare decreased from the resulting decrease in negative skewness.

[16] The Montreal Expos move to Washington for the 2005 season reduced the standard deviation of pre-revenue sharing local revenues from \$62.4 million to \$55.6 million and increased the average from \$156.1 million to \$165.7 million. This one move may have had a larger effect on league welfare than the revenue sharing plan.

The last row of Table 1 presents the welfare gain or loss from revenue sharing in Dollars. The present value of these gains or losses is $86.0 million in 2002 using a 3% discount rate or $89.4 million using a 2% discount rate.[17] Almost all of this net welfare gain arises from the decrease in the variance of team revenues that revenue sharing delivers.[18] The net welfare gain could have been much larger if the league local revenue distribution did not become increasingly negatively skewed over the seven seasons, from a skewness coefficient value of 0.935 in 2002 to 2.448 in the 2011 season. Ignoring the skewness effect on the league revenue distribution, the present value of the net welfare gain only due to the reduction in the variance is $126.8 million in 2002.

IV. CONCLUSIONS

We have demonstrated significant welfare gains to MLB from the straight pool revenue sharing system adopted in the 2002 CBA. However, our measures of welfare gain could be understated for several reasons. It could be that team owners are more risk-averse than we have assumed, implying that our values for θ are too small, but this seems unlikely. At the league level, stability of revenues could enhance the ability of a league commissioner to negotiate lucrative rights packages for television, internet, merchandising and so on. In the past, revenue sharing has also been a useful policy to prevent the formation of rival leagues by making the existing league attractive to cities that wish to join. At the team level, revenue sharing reduces the variance of local revenues and hence reduces risk. This could have two beneficial effects for team owners.

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[17] The average real interest rate (reported by the World Bank) was 3% for the U.S. over the 2002-2011 period.

[18] It is interesting to note that it is not the case that higher risk aversion always increases the welfare gain from revenue sharing. This can be seen through inspection of the numerator of (12). Our welfare gain in (12) reached a peak of $86.1 million at $\theta = 2.1$ and a 3% discount rate.

Lower risk can reduce the capital costs of new facilities for teams that wish to finance a portion or all of new facilities. Local governments might be more willing to pick up a portion of the construction costs when they know the team is on a stable financial footing and unlikely to leave for greener pastures once construction is finished. More importantly for team owners, low financial risk enhances the market value of the team when potential buyers are risk-averse. For many team owners, the financial rewards are the greatest when the team is sold.

Given that revenue sharing costs little to implement, it would seem to be advantageous for a professional sports league to adopt it. In fact, further welfare gains could be had by utilizing a progressive revenue tax. However the wealthiest teams could oppose revenue sharing since the system penalizes on-field success and financial smarts. MLB has used a progressive competitive balance tax since the 1996 CBA. Teams pay a tax rate of 22.5% of the payroll overage if their payrolls exceed the payroll threshold set in the most current CBA ($195 million for the 2017 season) if they are first-time offenders. The tax rate increases to 30% for second-time offenders, 40% for third-time offenders and 50% for four or more offenses. It is estimated that the New York Yankees paid $304 million in tax over the 2002-16 seasons.[19] Even though the tax system is progressive in some sense, the tax revenue is not redistributed to any of the MLB teams, hence the tax system lacks the redistributive effects of revenue sharing. Neither revenue sharing nor the competitive balance tax are ideal systems in a league welfare sense.

[19] Orinick, S. Competitive balance tax. http://www.stevetheump.com/luxury_tax.htm. Accessed on 02/08/2017.

Mirlees (1971) demonstrated that an optimal income tax system still features a progressive income tax rate, even after accounting for the negative work-incentive effects of the tax, although his criteria of welfare differed from ours in that he focused on utility from consumption for individual workers. It would be useful to explore whether the same result holds for the use of revenue sharing in a professional sports league using our measure of league welfare. However it would necessitating specifying how the progressive revenue sharing tax affects the talent decisions of team owners, which is, stating what the function $R_i = R_i(\alpha, w_i)$ looks like.[20] We leave that problem for future research.

[20] Marburger (1997) considers the effect of a progressive competitive balance tax on owner incentives and equilibrium outcomes, but does not consider a progressive revenue sharing tax.

TABLE 1

Welfare gains to MLB, 2002-11 seasons. ($\alpha = 0.66$ (2002-06), $\alpha = 0.69$ (2007-11), $\theta = 2$)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
$\bar{R}$ ($ millions)	141.75	146.91	156.09	165.72	169.04	151.20	153.54	144.53	161.02	162.19
σ^2	4382.2	3354.1	3889.8	3086.0	3450.8	3346.9	4032.3	5070.2	4423.2	4559.0
Z^3	271146	317344	326126	250310	300939	294511	540408	984473	755352	753520
Welfare gain from variance[1]	0.123	0.088	0.090	0.063	0.068	0.083	0.097	0.137	0.096	0.098
Welfare gain from skewness[1]	-0.023	-0.024	-0.020	-0.013	-0.015	-0.020	-0.035	-0.077	-0.043	-0.042
Total welfare gain[1]	0.1005	0.0639	0.0697	0.0504	0.0534	0.0624	0.0611	0.0595	0.0533	0.0559
Total welfare gain in $ millions	14.24	9.39	10.89	8.35	9.02	9.43	9.38	8.61	8.58	9.06

[1] As a percentage (x100) of the average team local revenue.

FIGURE 1

Pre-revenue sharing local revenues in MLB, 2002.

(Average = $141.8 million)

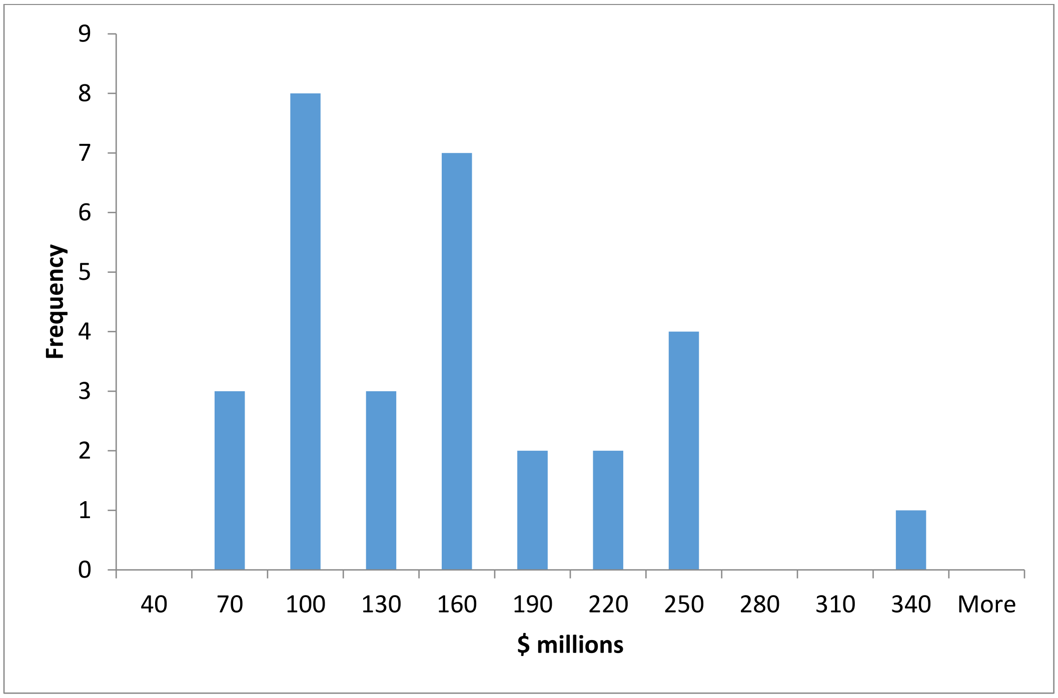
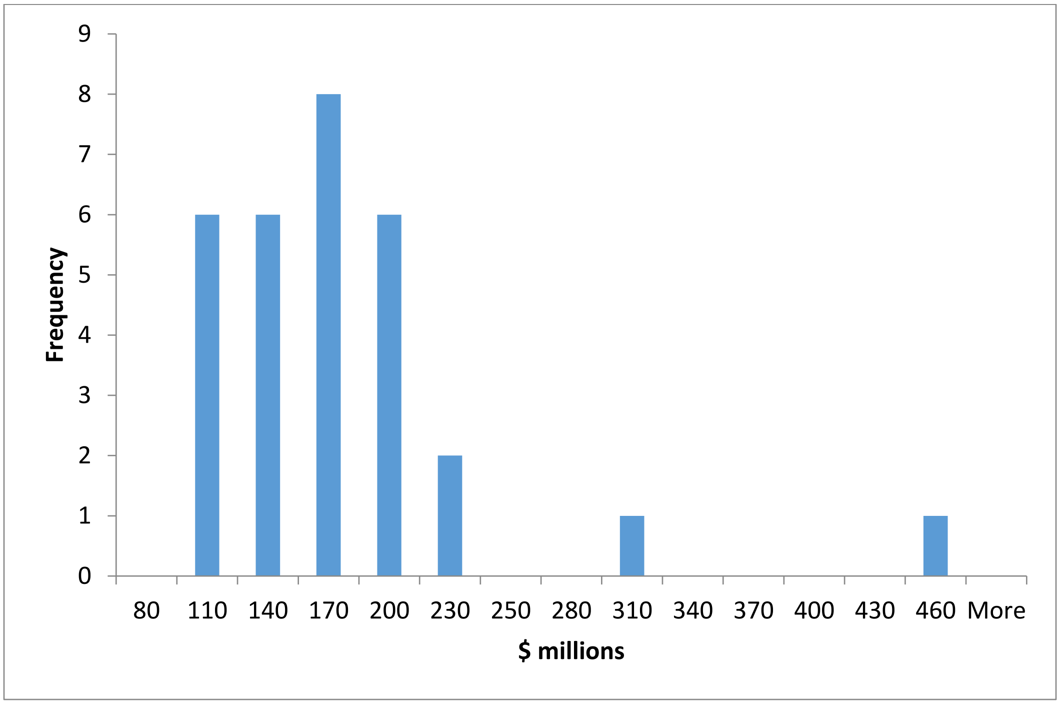


FIGURE 2

Pre-revenue sharing local revenues in MLB, 2011.

(Average = $162.2 million)



References

Dixit, A. and V. Norman. “Gains from Trade without Lump-sum Compensation”. *Journal of International Economics*, 21(1-2), 1985, 111-22.

Easton, S. and D. Rockerbie. “Revenue Sharing, Conjectures and Scarce Talent in a Sports League Model”. *Journal of Sports Economics*, 6(4), 2005, 359-378.

________________________. “The Ebbs and Flows of the Game: Multiple Equilibria in a Sports League Model”. *Journal of Sports Economics*, 11(2), 2010, 172-85.

Fort, R. and J. Quirk. “Optimal Competitive Balance in Single-game Ticket Sports Leagues”. *Journal of Sports Economics*, 11(6), 2010a, 587-601.

_________________. “Optimal Competitive Balance in a Season Ticket League”. *Economic Inquiry*, 49(2), 2010b, 464-73.

Goldberg, P. and N. Pavcnik. “Distributional Effects of Globilization in Developing Countries”. *Journal of Economic Literature*, 45(1), 2007, 39-82.

Hill, J. and R. Jolly. “Revenue Sharing and Player Salaries in Major League Baseball”. *Journal of Sports Economics*, 2015, doi: 10.1177/1527002515609660.

Kesenne, S. “Revenue Sharing and Competitive Balance in Professional Team Sports”. *Journal of Sports Economics*, 1(1), 2000, 56–65.

_________. “Revenue Sharing and Owner Profits in Professional Sports Models”. *Journal of Sports Economics*, 8(5), 2007, 519-529.

_________. “Revenue Sharing and Absolute League Quality, Talent Investment and Talent Allocation”. *Scottish Journal of Political Economy*, 62(1), 2015, 51-58.

Krautmann, A. “Risk-averse Team Owners and Player’s Salaries in Major League Baseball”. *Journal of Sports Economics*, 18(1), 2017, 19-33.

Levin, R., Mitchell, G. Volcker, P., Will, G. *The Report of the Independent Members of the Commissioner’s Blue Ribbon Panel on Baseball Economics*. Major League Baseball, July 2001.

Lucas, R. *Models of Business Cycles*. Oxford: Blackwell Publishers, 1987.

Major League Baseball. *Updated Supplement to the Report of the Independent Members of the Commissioner’s Blue Ribbon Panel on Baseball Economics.* December 2001. http://roadsidephotos.sabr.org/baseball/BRpanelupd.doc

Marburger, D. “Gate Revenue Sharing and Luxury Taxes in Professional Sports”. *Contemporary Economic Policy*, 15, 1997, 114-23.

Maxcy, J. “Motivating Long-term Employment Contracts: Risk Management in Major League Baseball. *Managerial and Decision Economics*, 25(2), 2004, 109-20.

_________. “Progressive Revenue Sharing in Major League Baseball: The Effect on Player Transfers and Talent Distribution. *Review of Industrial Organization*, 35(3), 2009, 275-97.

Mehra, R. and E. Prescott. “The Equity Premium: A puzzle”. *Journal of Monetary Economics*, 15, 1985, 145-61.

Miller, P. "Revenue Sharing in Sports Leagues: The Effects on Talent Distribution and Competitive Balance". *Journal of Sports Economics*, 8(1), 2007, 62–82.

Mirlees, J. "An Exploration in the Theory of Optimal Income Taxation". *Review of Economic Studies*, 38(2), 1971, 175-208.

Rockerbie, D. "Free Agent Auctions and Revenue Sharing: A Simple Exposition". *Journal of Sport Management*, 23(1), 2009, 87-98.

Rockerbie, D. and S. Easton. *The Run to the Pennant: A Multiple Equilibria Approach to Professional Sports Leagues*. New York: Springer-Verlag, 2014.

Ross, J. *Joining the Clubs: The Business of the National Hockey League to 1945*. Syracuse, NY: Syracuse University Press, 2015.

Szymanski, S. "Professional Team Sports are only a Game: The Walrasian Fixed-supply Conjecture Model, Contest-Nash Equilibrium, and the Invariance Principle". *Journal of Sports Economics*, 5(2), 2004, 111-26.

Surdham, D. "A Tale of Two Gate-sharing Plans: The National Football League and the National League, 1952-56". *Southern Economic Journal*, 73(4), 2007, 931-46.

Vrooman, J. "Theory of the Perfect Game: Competitive Balance in Monopoly Sports Leagues". *Review of Industrial Organization*, 34, 2009, 5-44.