The Invariance Proposition in Baseball: New Evidence

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Abstract: This paper considers the change in revenue sharing in Major League Baseball that occurred prior to the 2007 season and its effects on parity via its effects on marginal revenues. Based on the results from a empirical specification for team revenue, we find evidence that the reduction in revenue sharing increased marginal revenue by approximately the same amount for both small and large market clubs despite other differences in how small and large market club revenues are determined. The upshot of this result is that the modest change in revenue sharing had little to no effect on league parity in the three seasons following its implementation. The well-known invariance proposition in the economics of sport literature that predicts this result appears to hold.

Key words: baseball, revenue sharing, parity

1. INTRODUCTION

The invariance proposition is debatably the most fundamental result to arise from the economics of professional sport literature. As originally formulated by Rottenberg (1956), the invariance proposition states that the ultimate distribution of player talent among teams in a league is identical regardless of whether players (free agency) or owners (reserve clause) own the property rights to player talent. The proposition assumes that cash sales of players is allowed. Since cash sales are uncommon now in North American professional sports leagues and the reserve clause has long since fallen, the invariance proposition has assumed a different form, that revenue sharing has no effect on league parity. This can be shown to be a natural outcome of the original form of the invariance proposition as demonstrated in Fort and Quirk (2005) with a closed supply of talent.

The economics of professional sports literature has many theoretical studies that explore the effects of revenue sharing on league parity in a two-team or N-team professional sports league. The theoretical results on parity can be neatly divided into whether the club owner is a profit-maximizer or win-maximizer (with a non-negative profit constraint) and whether the stock of league talent is open (Cournot-Nash talent conjecture) or closed. The distinction has tended to divide economists between North America (profit-maximization) and Europe (win-maximization) with no resolution.

European scholars frequently make the assumption that owners are win-maximizers that face a non-negative profit constraint which leads to a different set of results regarding the invariance proposition. This assumption has found recent empirical support in Garcia-del-Barrio and Szymanski (2009) for European football leagues but the lack of accurate financial data makes testing difficult. Empirical evidence for profit-maximization in North American faces the same problems with few only a few empirical efforts including Stewart et al (1992) and Rockerbie (2011) for the National Hockey League.

Theoretical work on the invariance proposition has been much more forthcoming. Kesenne (2004, 2005) demonstrates that revenue sharing worsens parity with profit-maximizing owners and improves parity with win-maximizing owners when the supply of talent is open. Vrooman (2007) provides an elegant paper that summarizes the results of the debate. Revenue sharing in a league composed of profit-maximizing owners reduces competitive balance when the stock of talent is open and leaves competitive balance unaffected when the stock of talent is closed. With win-maximizing owners, revenue sharing reduces competitive balance regardless of whether the stock of talent is open or closed. Of course, Vrooman's (2007) results depend somewhat on the form of his revenue function and the contest success function he used, although his choices seem reasonable.

Winfree and Fort (2011) address the apparent inconsistency raised initially by Szymanski (2004) regarding the role of a closed stock of league talent in a one-shot static game. Sports leagues are typically modeled as a one-shot game in which case the Cournot-Nash talent conjecture is the only consistent conjecture while the closed talent supply assumption imposes a competitive conjecture.[1] Winfree and Fort (2011) offer a solution to the inconsistency by arguing that sports clubs maximize profit by choosing an optimal budget to purchase talent, rather than just choosing an optimal stock of talent. Club owners can then possess Cournot-Nash conjectures in choosing a budget, yet face a league talent constraint. The upshot is that this richer one-shot league model predicts the invariance proposition will hold regardless of open or closed talent supply in a profit-maximizing framework.

The empirical effects of revenue sharing on league parity have been studied much more sparsely in the literature, probably due to a lack of reliable revenue data. Estimating the marginal revenue product (MRP) of talent for a club is a necessary step in the analysis and there is a growing literature in this area with Scully (1974, 1989), Zimbalist (1992), MacDonald and Reynolds (1994), Krautmann (1999), Leeds and Kowalewski (2001) as good examples. Most of these studies estimate marginal revenue (MR) functions for clubs in order to determine whether a player is paid his MRP, but they do not consider the effects of changes in revenue sharing on MR.

Solow and Krautmann (2007), hereafter referred to as SK, do estimate the effects on revenue sharing on parity by estimating MR functions for each club in major league baseball (MLB). This was made possible by the release of club revenue data in the Blue Ribbon Panel report (Levin et al (2000)) originally convened by MLB Commissioner Bud Selig. Skidmore-Hess and Cox (2002) have questioned the reliability of this data (and we comment on this later in this paper. After estimating MR functions for MLB clubs, SK conclude that the expanded 1996 revenue sharing agreement did not affect league parity despite significantly reducing MR for each club, but did lower player salaries significantly. These results are consistent with the so-called invariance proposition that can be found in some theoretical models.

Our purpose in this paper is to provide additional evidence on the effects of revenue sharing using a different sample period and methodology than that used by SK. We use a sample period in which there exists a much more clear change in the revenue sharing agreement than the sample period used by SK, allowing for estimation results that are easier to interpret. Our results suggest that the changes to the revenue sharing prior to the 2007 season had no effect on league parity, suggesting that the invariance proposition is alive and well in North America. In the next section, we provide a brief overview of the different revenue sharing arrangements that have existed in MLB since 1995. In the third section we determine the effects of revenue sharing on a representative club using a standard profit-maximizing equilibrium approach that is prevalent in the literature. The fourth section specifies the empirical model and provides estimation results. The last section provides concluding remarks.

II. REVENUE SHARING AND PARITY IN MLB SINCE 1995

The common argument leagues use to justify revenue sharing is that the system redistributes revenues to small market clubs that could not otherwise survive. This insures the financial viability of the league in the absence of any poor business decisions by its owners. Although revenue sharing can be used as a vehicle to increase league profits (Easton and Rockerbie (2005)), this explanation of revenue sharing is generally not disputed by economists, although Maxcy (2009) found that low revenue clubs divest themselves of talent when revenue sharing more extensively. As noted in Rockerbie (2009), the effects of revenue sharing on league parity, player salaries and the distribution of talent depend greatly on the nature of the revenue sharing agreement. To estimate the effects of revenue sharing, one needs revenue data for clubs before and after revenue sharing, or before and after revenue sharing became more or less extensive.

Prior to 1996, MLB utilized an 80-20 gate sharing split between home and visiting clubs in the American League (Surdham (2007)). Thus the revenues kept by home clubs and taken away by visiting clubs depended to some degree on the league schedule. The National League used revenue sharing must less extensively than the American League with the visiting club receiving only about $0.50 per ticket sold, working out to roughly a 95-5 gate revenue split. From 1996 through 2001, all MLB clubs contributed a percentage of local revenues (gate, concession, parking and so on) to a league pool to be divided among all the clubs using a variety of different plans. This percentage was subsequently increased to 34% prior to the 2003 season and then reduced to 31% for the 2007 season.[2]

We believe that estimating the effect of enhanced revenue sharing on league parity and player salaries will require more revenue data than that used by SK. MLB actually used two different pooled revenue sharing systems over the 1996-2001 seasons (Levin et al. (2000), p. 38, Dosh (2010)). A *straight-pool plan* specified that seasons each club contribute 39% of its local revenue to a central pool to be divided equally between all clubs. A *split-pool plan* specified that each club contribute only 20% of local revenue to a central pool with 75% of the pooled revenue returned to each club using equal shares and the remaining 25% to be distributed unevenly to those club's whose revenue fell below the league average. Net receipts or contributions were then calculated for each club and each club was assigned the plan that gave it the most net benefit. To complicate matters further, each club paid or received less than the net amount determined. Under this *hybrid plan*, the percentages were 60% in 1996 and 1997, 80% in 1998, 85% in 1999 and 100% for the 2000 and 2001 seasons.

By the 2002 season, MLB returned to the straight-pool plan with a 34% contribution rate on the justification that clubs close to the average league revenue paid higher marginal tax rates on local revenue than clubs well above the average league revenue. The contribution was reduced to 31% for the 2007 through 2010 seasons. Regardless, the use of two different revenue sharing systems with different contribution percentages makes it very difficult to isolate the effects of changes in the contribution rate as many clubs paid and received different effective rates. Again it is not clear how league parity and player salaries will respond theoretically under the two different systems, so it is difficult to interpret any econometric results that attempt to divide the sample into two separate periods. The only sample periods that utilized the same revenue sharing system but different contribution rates are the 2002-06 seasons (34%) and the seasons after 2006 (31%). It is not clear if the small decrease in the contribution rate will allow for an accurate estimation of the effect on marginal revenues and parity.

The standard deviation of winning percentages is a common measure of parity that is simple to calculate and interpret, but not without its critics (Eckard (2001)). Nevertheless we calculate this measure of parity in Table 1 for the 1995 to 2009 seasons. Parity appeared to worsen from 1995 to 2003 but improve after 2003. It is difficult to associate this parity behaviour with changes in the revenue sharing arrangement over the same period, hence little can be gained from a casual look at the data, particularly when considering the 2007 reduction in revenue sharing.

III. THE IMMEDIATE EFFECT OF REVENUE SHARING ON MARGINAL REVENUE

We consider how the MR curve shifts with greater revenue sharing in an N team model. After revenue sharing, team revenue is given by

$$R_i^A = \alpha R_1 + \left((1-\alpha)/N\right)R_1 + \left((1-\alpha)/N\right)\sum R_j \qquad (1)$$

where the j subscript represents every other team in the league besides team 1. Marginal revenue for team 1 after revenue sharing is given by

$$MR_1^A = [((N-1)\alpha + 1)/N]MR_1 - [(1-\alpha)/N]\sum MR_j \qquad (2)$$

Suppose revenue sharing increases so that α decreases from α_1 to α_2. The percentage change in the marginal revenue is computed as

$$MR_1^A \partial / MR_1^A \partial\alpha = (1/MR_1^A)[((N-1)/N)MR_1 + (\sum MR_j/N)] \qquad (3)$$

If the league is in equilibrium before and after the increase in revenue sharing, it is not difficult to show by inserting (2) into (3) and simplifying that a decrease in the revenue sharing contribution rate (α) from 34% to 31% will shift the marginal revenue schedule for each club upwards by 8.755% in a 30 team league. Finding a value close to this result in the empirical model gives some confirmation that the empirical results are reliable. The shift is greater the larger is the number of clubs in the league for a given value of α. As revenue sharing is reduced, α approaches 1 and the upward shift in marginal revenue diminishes in value asymptotically, for a given number of clubs.

IV. AN EMPIRICAL MODEL

Very little reliable financial data exists for MLB clubs outside of the 1995-2001 period covered in the Blue Ribbon Report and certainly not enough to construct a pooled time-series cross-section dataset sufficient to estimate revenue functions.[3] The only alternative source is the revenue series constructed annually by Forbes magazine (and more distantly Financial World magazine) that reaches back to 1990. These numbers are educated estimates of actual total revenues that include revenue sharing. Some scholars and pundits have questioned the accuracy of the Forbes data (Beamer (2007)) which can only be judged when measured against actual revenue data provided by MLB assuming of course that the data provided by MLB is accurate and honest. Figure 1 plots total revenue data from the 1996, 1997, 1999 and 2001 seasons taken from the Blue Ribbon Report against estimates of total revenue computed by Forbes for the same years (data for the 1998 season is not available from Forbes). A simple least squares regression model using the MLB data as the dependent variable reports an R-squared of 0.931 and a slope 0.997 that is statistically significant at 99% confidence and a statistically insignificant intercept. The standard error of the regression is $10.2 million or 12.7% of the sample mean total revenue reported by MLB but if the two largest revenue observations are dropped from the sample, the standard error falls to 10.7%. This standard error is not large in comparison to the average errors reported by Fort (2010) for MLB payrolls reported by different sources that had values between 11.6% and 16.3%. Yet payroll data is frequently used by economists with little regard for its inherent error.[4] If one needs a complete revenue dataset for the seasons that utilized the same straight-pool revenue sharing plan, the Forbes data is all there is.

We estimate revenue functions using the same empirical specification as SK over the 2002 through 2009 seasons. The dependent variable is revenue per game for the ith team for season t (REV_{it}/G_{it}) since the total revenue data reported by Forbes includes revenue for playoff games. We simply ignore the fact that a playoff game generates more revenue than a regular season game, as do SK. The independent variables include winning percentage for the current season and winning percentage for the previous season (W_{it} and W_{it-1}), as well as a quadratic current winning percentage variable (W_{it}^2), local area population (POP_{it}), per capital income for the local area (INC_{it}), the presence of a new stadium in year t represented by a dummy variable ($NEWSTDM_{it}$) and a dummy variable to control for the presence of two MLB teams in the same city or in close proximity ($TWOTEAM_{it}$).[5] The national consumer price index (1998 = 100) was used to deflate the revenue and income data. Finally a dummy variable D_t was included that took on the value one in the 2007, 2008 and 2009 seasons to reflect the reduction in revenue sharing. With *smaller* revenue sharing adopted in the 2007 season, the model predicts that $\delta_3 > 0$. The model we estimate is given by

$$\frac{REV_{it}}{CPI_{it}G_{it}} = \alpha + \beta_1 W_{it} + \beta_2 W_{it}^2 + \beta_3 W_{it} \bullet W_{it-1} + \beta_4 W_{it} \bullet POP_{it} + \beta_5 W_{it} \bullet \frac{INC_{it}}{CPI_{it} POP_{it}} + \\ + \delta_1 W_{it} \bullet TWOTEAM_{it} + \delta_2 W_{it} \bullet NEWSTDM_{it} + \delta_3 W_{it} \bullet D_t + \varepsilon_{it} \tag{4}$$

Marginal revenue varies over a clubs winning percentage, hence it's derivative is straightforward.

$$MR_{it} = \beta_1 + 2\beta_2 W_{it} + \beta_3 W_{it-1} + \beta_4 POP_{it} + \beta_5 \frac{INC_{it}}{CPI_{it} POP_{it}} + \delta_1 TWOTEAM_{it} + \delta_2 NEWSTDM_{it} + \delta_3 D_t \tag{5}$$

The main coefficient of interest here is δ_3 that estimates the shift in the marginal revenue function when the revenue sharing contribution was reduced from 34% to 31% in 2007. In order to compare the shift in MR across clubs of different market sizes, we split the sample into two samples using the median level of real income in each MLB city[6]. If differences in these shifts are detected across the two groups, we may be able to make some comments regarding changes in parity. We also subtracted the national television revenue from the Forbes revenue numbers on the basis that the 2007 season also saw the adoption of a new, more lucrative national television contract (FOX and TBS) for MLB, rising from $16 million per season per club prior to 2007 to $28 million per season per club. Segmenting the market sizes by metropolitan population made very little difference to estimates, so we do not present those results.

V. ESTIMATION RESULTS

Computing the effects of a change in revenue sharing requires estimation of (4) over the 2002 through 2009 seasons. Total revenues were taken from Forbes due to the lack of original MLB data over the entire sample period. Personal income and population data for metropolitan statistical areas were taken from the Bureau of Economic Analysis. The consumer price index data for each MLB city (2001 = 100) was taken from the Bureau of Labor Statistics. A complete list of data sources is available in the appendix. Equation (4) was estimated including fixed effects and using cross-section weights (GLS) to correct the coefficient standard errors for heteroskedasticity. Toronto and Montreal were excluded from the sample due to the unavailability of personal income population data for every year in the sample. The results[7] for each sample appear in Table 2. The models explain real total revenue per game reasonably well with adjusted R^2's of 0.938 and 0.877 for the higher and low real income samples respectively. A Wald test rejected the null hypothesis that the two regression models (one for each income group) had identical coefficients at a very high level of confidence. Population was found to be an important factor in determining club revenues for the low income areas only. Interpreting the coefficient is a little tricky. An increase in the metropolitan population of 1000 people increases real marginal revenue per game by about $1.95 and increases total real revenue per game by $97.50 for a club with a 0.500 winning percentage. Over the course of a season, total revenue increases by $7897.50 (81 home games), so marginal and total revenues are not very responsive to population increases within each income group.

Per capita real income was also an important determinant of club revenue for both income groups, but more so for the high income group. This could be due to the fact that per capita real incomes are closely clustered in the lower income areas, whereas they show a great degree of variation in the higher income areas. The presence of a new stadium was also an important determinant on club revenue for both high and low income areas, but again more so for high income areas where a new stadium contributed almost $39 million over a season for a club with a 0.500 winning percentage. The presence of two clubs operating in the same city significantly reduced club revenues in high income areas.[8] This result is consistent with the result found in Winfree et al (2004).

Winning percentage is an important determinant of revenue for the high income group, but not the low income group. This could be a figment of the sample period as the winning percentages for the clubs in the low income group showed little variation, whereas a great deal of variation was observed for clubs in the high income group. The winning percentage from the previous season has a significant effect on current revenue for the low income group, probably due to the effect on season's ticket sales, advertising and local television contracts, and so on that are determined in the off-seasons.

The coefficient of the dummy variable D_t gives an estimate of the shift in the marginal revenue with the adoption of the new contribution rate in 2007. Since the contribution rate fell from 34% to 31%, the model predicts a positive coefficient and this was the case for both the lower income and higher income areas. The level of significance was very high at 99.8% in each case. When taken as a percentage of the intercept (coefficient for W_{it}) for the high income group, the shift in the marginal revenue line is about 7.95%. This is close to the 8.71% shift that the theoretical model predicts with 14 teams in each of the large and small market sample. To evaluate parity effects, it is only the absolute shift in the marginal revenues between lower income and higher income areas that is relevant. The coefficients are close in value, in fact, the null hypothesis that they are the same value could not be rejected at 95% confidence on the basis of a Wald test.[9]

If we accept the result that parity was unaffected as a result of the 2007 change to the revenue sharing agreement, the 7.95% increase in marginal revenue for all clubs (since they must be in equilibrium both before and after the change in revenue sharing) suggests that salaries could have increased by a similar amount given that MLB has no constraints on salaries other than the rather ineffective competitive balance tax that sets an annual maximum threshold for team payrolls (of which only a few clubs pay). Determining whether salaries increased as a result of less revenue sharing requires that a salary regression be estimated that holds constant various player productivity variables and other factors that might determine a players marginal product. We leave that for future research.

VI. CONCLUDING REMARKS

Despite using a different methodological approach, the qualitative results in this paper agree with the results of SK, namely that revenue sharing has little to no effect on league parity in MLB. Marginal revenues for low real income and high real income clubs shift by the same positive amount given a decrease in the degree of revenue sharing from 34% to 31% that occurred prior to the 2007 season. In fact the shifts in marginal revenues are close to those predicted by an 28-club league model. We found these results to be quite robust to changes in measurement and the choice of variables. One might conclude that these results call into question prior theoretical results that suggest that revenue sharing does affect parity and the invariance proposition does not hold, however the results here only hold for MLB and for a small change in revenue sharing. It would be too big a stretch to assume the same result for parity for a much larger change in revenue sharing, or even abandoning it altogether.

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FOOTNOTES

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[1]See Bresnahan (1981) for the seminal paper that began this discussion.

[2]A good review of how these different revenue sharing plans worked is Dosh (2010).

[3]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. 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. An update to the Blue Ribbon was produced in 2001 that provided additional data for the 2000 and 2001 seasons.

[4]There are too many references to list completely. A good list is contained in Wiseman and Chatterjee (2003).

[5]Based on the Bureau of Economic Analysis definitions of metropolitan statistical areas, these cities included Anaheim, Chicago, Los Angeles, New York, Oakland and San Francisco. Winfree et al. (2004) find a significant negative effect on attendance for both teams when two teams operate in close proximity.

[6]Clubs above the median real income included Anaheim, Baltimore, Boston, Chicago, Florida (Miami), Houston, Los Angeles, New York, Oakland, Philadelphia, San Francisco and Texas (Dallas). Oakland and San Francisco are included in the same metropolitan statistical area by the Bureau of Economic Analysis, as are Anaheim and Los Angeles.

[7]The weighted average real ticket price for each club (obtained from www.teammarketing.com was included as an independent variable , however a Hausmann test could not reject the hypothesis that the ticket price was endogenous. The ticket price variable was found to be statistically insignificant after utilizing two-stage least squares with the local unemployment rate added as an additional instrument.

[8]San Francisco, Oakland, Los Angeles and Anaheim appeared in the lower income areas, while New York and Chicago appeared in the higher income areas.

[9]The results are very similar if population is used as the measure of market size to divide the sample.

Table 1

Standard deviation of winning percentages in MLB

	National League	American League
1995	0.0615	0.0802
1996	0.0567	0.0712
1997	0.0606	0.0639
1998	0.0871	0.0781
1999	0.0783	0.0780
2000	0.0681	0.0560
2001	0.0829	0.0800
2002	0.0841	0.1092
2003	0.0726	0.1010
2004	0.0695	0.0955
2005	0.0607	0.0805
2006	0.0508	0.0768
2007	0.0492	0.0691
2008	0.0747	0.0562
2009	0.0610	0.0771

Table 2

GLS estimates of revenue equation (4), 2002 through 2009 MLB seasons

Coefficient	Real income < 50th percentile	Real income >= 50th percentile
Constant	706333.9*	-131798.8
W_{it}	6965.61	42201.50**
W_{it}^2	-234.80**	-746.84*
$W_{it}\ W_{it-1}$	151.91*	35.97
$W_{it} \cdot POP_{it}/1000$	1.95**	0.51
$W_{it} \cdot INCOME_{it}$	6.13*	9.58*
$W_{it}\ TWOTEAM_{it}$		-1502730*
$W_{it}\ NEWSTDM_{it}$	5451.21*	9552.10*
$W_{it}\ D_t$	3159.03*	3359.79*
Adjusted R^2	0.877	0.938
N	112	112

** Indicates statistical significance at 90% confidence. * indicates statistical significance at 95% confidence.

Figure 1

Forbe's estimates of MLB club revenues versus club revenues provided by MLB

(1996, 1997, 1999, 2001 seasons)