Measuring Competitive Advantage and its Effects

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The Sport Industry

- In general competition leads to innovation and innovation leads to economic growth.
- From the perspective of individual firms, though, profits tend to rise when competition is eliminated.
- The professional sports industry is the exception.
  - interest in sports depend crucially on the uncertainty of outcome
  - When a professional sports team eliminates competition, the team runs the risk to eliminate the primary source of revenue.
- To understand the relation between competition and profits in the sport industry we introduce the measure of "competitive balance "

Competitive Balance

- Competitive balance measures the level of competition in the games of any given league.
- If teams are equal in ability, we can expect a fully balanced competition.
- We shall discuss different measures of competitive balance

The Noll-Scully Measure

- Noll and Scully consider sports in which there are no draws and therefore there are only two possible outcomes of a game for a team: win or loss.
- Competitive Balance is measured by the standard deviation of winning percentage divided by the idealized standard deviation (the standard deviation of the winning percentage when all teams are equal and have 0.5 probability of winning a game).

$$
\begin{aligned}
CB^{NS} &= \frac{\sigma^{WP}}{\sigma^{ID}} \\
WP_i &= \frac{W_i}{N} \\
\sigma^{ID} &= \frac{0.5}{\sqrt{N}}
\end{aligned}
$$

Understanding the Noll-Scully Measure

- To understand the idealized standard deviation, derive the number of wins in a season for a team that has a 0.5 probability of winning a game. W_i features a Bernoulli distribution

$$W_i \sim Ber\left(np, np(1-p)\right)$$

- This applies to all teams as they are equal
- The win percentage is defined as $WP_i = \frac{W_i}{N}$ and so $\sigma^{ID} = \frac{0.5}{\sqrt{N}}$.

Understanding the Noll-Scully Measure

- Think now of a single game an idealized league, the distribution is now binomial with outcomes 0 and 1.

$$
\begin{aligned}
E(x) &= 0 * 0.5 + 1 * 0.5 = 0.5 \\
Var(x) &= 0.5(1 - 0.5)^2 + 0.5(0 - 0.5)^2 = 0.25 \\
Var(W) &= N * 0.25, \sigma(W) = \sqrt{N} * 0.5 \\
\sigma(\frac{W_i}{N}) &= \frac{0.5}{\sqrt{N}}
\end{aligned}
$$

A sport with draws

- If tie is a possibility the Noll-scully measure cannot be applied. Hoddock and Cain(2006) propose the following alternative
- Compute the average probability of a tie using a long sample of seasons. In the case of UK football they obtain 0.25.
- In an idealized league redistribute equally the remaining 0.75 probability mass between win and loss.
- Concentrate on the number of points rather than on wins

A sport with draws

- Think again of a single game in an idealized league:

$$
\begin{aligned}
E(p) &= 0 * 0.375 + 1 * 0.25 + 2 * 0.375 = 1 \\
Var(p) &= 0.375(0-1)^2 + 0.25(1-1)^2 + 0.375(2-1)^2 = 0.75 \\
Var(TP^{id}) &= N * 0.75, \sigma(TP) = \sqrt{N * 0.75}
\end{aligned}
$$

- $CB^{NS} = \frac{\sigma^{TP}}{\sigma^{ITPD}}$

CR Concentration Measure

- the Noll-Scully measure does not capture the dominance of the "top teams"
- The CR concentration measure (Koning(2000)) allows a comparison between the performance of the top five team in a league and the rest
- it is constructed as the ratio of the actual points cumulated in a season by the top 5 teams to the maximum number of points they can cumulate
- the same formula applies to leagues featuring games with two and three outcomes

CR Concentration Measure

$$\frac{\sum_{i=1}^{5} P_{it}}{5W(2N-5-1)}$$

- where W is the number of points attributed to a win and N is the number of games

Herfindahl Index

- index original developed to analyzew inequality in the firms of any given industry
- standardized sum of the squared market shares of all firms, in case of sports market shares are measured by the share of points made by a team in a season

$$H_t = \frac{100}{n} \sum_{i=1}^{n} s_{it}^2$$

- standardization makes the index independent from the number of teams gives a value of 100 to the index for a perfectly balanced league

European Football

FIGURE 3
Seasonal Development: Average Match Attendance and
Competitive Balance in the English Premier League 1963/64 - 2005/06

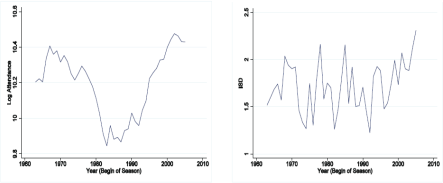
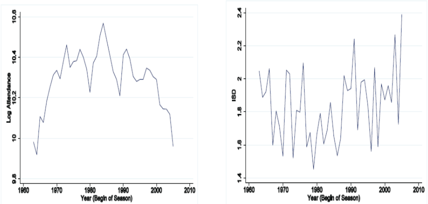


FIGURE 5
Seasonal Development: Average Match Attendance and
Competitive Balance in the Italian Serie A 1963/64 - 2005/06



Szimansky(2009)

- If some teams can count on a larger or more devoted fan bases, than the sucess of these teams will increase social welfare
- The central question is if the market will deliver the social optimum or if regulatary intervention is required

A small model

- Sport competition made of two teams,one of which generates an higher fan utility than the other
- fan utility depend on wins, which in turns are generated by the relative amount of talent

$$
\begin{aligned}
U_1 &= \mu_1 w_1 = \mu_1 \frac{t_1}{t_1 + t_2} \\
U_2 &= \mu_2 w_2 = \mu_2 \frac{t_2}{t_1 + t_2}
\end{aligned}
$$

A small model

- A share of the fans is made by uncommitted agents motivated only by an atractive show
- the utility of the "couch potatoes" is maximized under perfect competitive balance. So social welfare can be written as

$$U = \mu_1 w_1 + \mu_2 w_2 + w_1 w_2$$

A small model

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$$U = \mu_1 w_1 + \mu_2 w_2 + \theta w_1 w_2$$

Maximizing Social Welfare

Social optimum is obtained by maximizing total utility with respect to win percentage

$$U = \mu_1 w_1 + \mu_2 (1 - w_1) + \theta w_1 (1 - w_1)$$

$$\frac{\partial U}{\partial w_1} = \mu_1 - \mu_2 + \theta - 2\theta w_1 = 0$$

$$w_1^* = \frac{1}{2} + \frac{\mu_1 - \mu_2}{2\theta}$$

Maximizing Team Profit

Team optimum is obtained by maximized profits with respect to (costly talent)

$$\Pi_i = \varphi_i \mu_i \frac{t_i}{t_1 + t_2} - c t_i$$

$$\begin{aligned} \frac{\partial \Pi_i}{\partial t_i} &= \frac{\varphi_i \mu_i}{t_1 + t_2} - \frac{t_i}{(t_1 + t_2)^2} - c = 0 \\ \frac{\varphi_1 \mu_1}{\varphi_2 \mu_2} &= \frac{t_1}{t_2} \end{aligned}$$

- perfect competive baklance might not be the social optimum and in general the market does not reach the social optimum.

J.Ellenberg(2015) "How Not to be Wrong. The Hidden Maths in Everyday Life"

- A. Wald and the Statistical Research Group (SRG) where faced with a problem
  - to prevent planes from being shot down by enemy fighters your armor them.
  - but armour makes the plane heavier ...
  - armoring the planes too much is a problem and armoring them too little is a problem
- which is the optimum level of armoring ?

The Data

When American planes came back from engagements over Europe, they were covered with bullet holes. Here are the data

Section of the Plane	Bullet Holes per sq. f.
Engine	1.11
Fuselage	1.73
Fuel System	1.55
Rest of the plane	1.8

Econometrics is about using the data to make decisions. So in the light of the data where do you put the armoring ?

A.Wald choice

The armor, said Wald, does not go where the bullet holes are. It goes were the bullet holes are not: THE ENGINES

The Effects of Hospitalization

Group	Sample Size	Mean health status	Std. Error
Hospital	7774	2.79	0.014
No Hospital	90049	2.07	0.003

The difference in the means is 0.71, a large and highly significant contrast in favor of the *non-hospitalized*, with a t-statistic of 58.9.

Selection Bias

Think of Hospital treatmes as defined by a bunary random variable : $D_i = [0, 1]$. The outcome of interest is the health status of an indivdual Y_i.

potential outcome =$\begin{Bmatrix} Y_{1i} \;\; \mathit{if} \;\; D_i = 1 \\ Y_{0i} \;\; \mathit{if} \;\; D_i = 0 \end{Bmatrix}$

$$Y_i = Y_{0i} + (Y_{1i} - Y_{0i}) D_i$$

Selection Bias

$$\underbrace{E[Y_i|D_i=1]-E[Y_i|D_i=0]}_{\text{Observed difference in average health}} = \underbrace{E[Y_{1i}|D_i=1]-E[Y_{0i}|D_i=1]}_{\text{average treatment effect on the treated}}$$

$$+\underbrace{E[Y_{0i}|D_i=1]-E[Y_{0i}|D_i=0]}_{\text{selection bias}}$$

The selection bias is the difference in the average status of health between those who were hospitalized and those who were not.
The classical solution to the selection bias is to introduce treatment randomly.

Selection Bias in Regression

$$
\begin{aligned}
Y_i &= Y_{0i} + (Y_{1i} - Y_{0i}) D_i \\
Y_{0i} &= \alpha + \eta_i, (Y_{1i} - Y_{0i}) = \beta \\
Y_i &= \alpha + \beta D_i + \eta_i
\end{aligned}
$$

where D_i is correlated with η_i

find a set of instruments X_i, such that

$$\begin{aligned}
E(\eta_i \mid P_i, X_i) &= E(\eta_i \mid X_i) \\
E(\eta_i \mid X_i) &= \gamma X_i \\
Y_i &= \alpha + \beta D_i + \gamma X_i + e_i
\end{aligned}$$

and in the last model there is no correlation among regressors and residuals

There are many determinants of attendance

$$ATT_i = \beta_0 + \beta_1 CB_i + \gamma' X_i + u_i$$

if one runs a regression between ATT_i and CB_i only, the omitted variable problems can cause carrelation between residuals and the "treatment of interest" i.e. competitive

Possible solution (Szymanski 2001) find two sets of data in which competitive balance is different but all other relevant factors are the same.

$$\begin{aligned} ATT_{1,i} &= \beta_0 + \beta_1 CB_{1,i} + \gamma' X_i + u_{1i} \\ ATT_{2,i} &= \beta_0 + \beta_1 CB_{2,i} + \gamma' X_i + u_{2i} \\ ATT_{1,i} - ATT_{2,i} &= \beta_1 \left(CB_{1,i} - CB_{2,i} \right) + e_i \end{aligned}$$

A quasi natural experiment

- Compare matches between the same teams in the FA cup and in the leaugue. Under the null that the FA feature less competitive balance than the league (by its nature) and that this gap has been increasing over time
- Consider one thousand same division FA-CUP matches
- 64 teams enter the third round ofthe cup of which 44 are from the top two divisions. Maximum share of the match played from the third round on fromthetop two is 84 % (106 out of 126 appearances) while the theretcal minimum is 44% (56 appearances)

A quasi natural experiment: a first look at the data

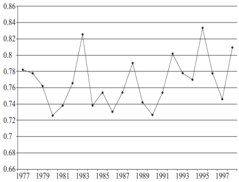

Fig. 3. *Share of Division 1 & 2 Teams in all FA Cup Matches Played from the Third Round Onwards*

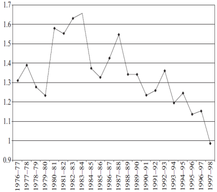

Fig. 4. *FA/League Attendance Ratio*

Top division clubs dominate the competition with evidence of increasing dominance: the proportion of cases in which a lower division team has won an FA match has decreased overtime

A quasi natural experiment

Table 2

Attendance Regressions 1982/3–1997/8 Seasons

	OLS whole sample	Tobit whole sample	OLS excluding first division
Constant	28,323	27,774	12,867
	(23.095)	(38.317)	(13.814)
2^{nd} division	−11,442	−11,181	
	(−19.592)	(−18.416)	
3^{rd} division	−17,525	−17,012	−6,452.5
	(−35.905)	(−41.573)	(−15.001)
4^{th} division	−20,043	−19,373	−8,402
	(−40.134)	(−48.418)	(−19.973)
Sum of team league positions	−262.38	−174.58	−138.34
	(−12.73)	(−12.812)	(−7.852)
Match played on Sunday	1,690.8	1,609.4	913.31
	(1.712)	(1.949)	(1.104)
Season month	129.73	−201.89	253.44
	(1.301)	(−3.149)	(3.397)
Replay	−1,145.1	−1,080.2	458.53
	(−1.812)	(−2.536)	(0.758)
FA Cup match 1983–86	3,617.5	3,519.9	1,998.8
	(4.322)	(6.706)	(2.815)
FA Cup match 1987–90	3,456.3	3,283.3	1,989.3
	(4.255)	(7.408)	(3.777)
FA Cup match 1991–94	912.61	926.63	543.19
	(1.410)	(1.803)	(1.302)
FA Cup match 1995–98	−138.29	−179.21	279.83
	(−0.166)	(−0.35)	(0.449)
Observations	1,286	1,286	772
R^2	0.637		0.479
Log L	−13,856	−12,713	−7,766

Heteroscedastic consistent t-statistics in parentheses. Time dummies included but not reported. Tobit coefficients are marginal effects.

A quasi natural experiment

"...The experiment appears to confirm the standard hypothesis about the impact of income inequality and competitve balance on the attractiveness of sporting competition ..."