Applied Economics, 2004, **36**, 2453–2460

Another look at competition: a regime-switching aproach

MARTIN B. SCHMIDT* and DAVID J. BERRI†

Department of Economics, The College of William and Mary, PO Box 8795, Williamsburg, VA 23187-8795, USA and †*Department of Economics, California State University—Bakersfield, 9001 Stockdale Highway, Bakersfield, CA 93311, USA*

Measuring the level of competition in an industry is an empirical task with a lengthy history. Many of the traditional measures offer a snapshot of the industry, where the distribution of market share is examined at a given point in time. The purpose of this inquiry is to utilize a regime-switching model which highlights the importance of intra-industry movement. The empirical results suggest that even in an environment where the distribution of market share is improving, an industry can still be persistently dominated by the same collection of leading firms.

I. INTRODUCTION

Historically the level of competition within an industry has been examined via a variety of static measures, such as the n-firm concentration ratio, the Herfindahl-Hirschman Index, and the Rothschild Index. Each of these measures offers a snap-shot of an industry where one can see how market shares are distributed at a given point in time. If enough snapshots are taken, one can see whether the distribution of market-share is narrowing or expanding across time. In terms of the overall level of competition, a narrowing over time is generally associated with an improvement in the industry's competitive environment.

What these aggregate measures fail to capture is the degree of intra-industry movement. It is possible to observe an industry where the industry experiences a decrease in aggregate concentration rates and yet the identity of the leading firms remains constant across time. While one may still argue that competition in the industry is improving, it is not entirely clear why this industry should be rated more competitive than an industry with a more inequitable distribution but which has greater intra-industry adjustments.

In order to more closely examine the degree of intra-industry movement, the present paper incorporates the regime-switching model of, among others, Hamilton (1989). The regime-switching approach allows the researcher to examine both the level and probability of movement within an industry. Specifically, one may examine how likely individual firms are to move from one state, perhaps a high revenue generating state, to another state, perhaps a low revenue generating state. In terms of the competitive environment, one may argue that high transitional probabilities reflect significant movement among firms and therefore higher degrees of competition.

We apply the regime-switching model to a specific industry – Major League Baseball (MLB). The MLB industry is attractive due to the fact that there exists defined measures of competition and an abundance of data.[1] In particular we examine the distribution of winning percentage across the MLB industry. The focus on winning percentage revolves around the objective of industry participants. In general, the stated objective of industry participants is winning. Economists, however, often suspect the true motive is profit maximization. Studies have shown,

* Corresponding author. E-mail: mbschm@wm.edu

[1] It is true that competition in sports is fundamentally different than competition in non-sports industries. In non-sports industries, the elimination of competition will enhance the profitability of an individual firm. As noted by Rottenberg (1956) and El-Hodiri and Quirk (1971), competition is necessary to the survival of a sports franchise. After all, without opposition the New York Yankees would be 25 oddly dressed men chasing after a small ball with a stick. However, the issue here is about social optimality and is therefore from a social planner view the issues remain the same.

Applied Economics ISSN 0003–6846 print/ISSN 1466–4283 online © 2004 Taylor & Francis Ltd
http://www.tandf.co.uk/journals
DOI: 10.1080/0003684042000280571

though, that consumer demand in sports is driven by the uncertainty of outcome (Rascher, 1999). Specifically, while fans may prefer that their team win, they are not as interested if the outcome of the contest is relatively certain.[2] In which case, the probability of winning enters the demand function and would therefore impact profit levels.

Overall, we find that while aggregate measures of competition show improvement in the competitive environment within the MLB industry, the regime-switching model highlights significant disparities between the individual industry participants. For example, while there are several examples of teams which routinely move between regime-states, there exist others where such movements have only happened once or twice. In the end, aggregate measures hide this lack of movement and therefore give a false sense of the true competitive environment within a industry.

The outline of the paper is as follows. Section II offers a brief description of Hamilton's (1989) regime-switching model and its possible use as a measure of the competitive environment within an industry. Section III presents the results of applying the model to the MLB industry. Finally, section IV concludes the paper.

II. A REGIME-SWITCHING APPROACH

In order to examine the degree of intra-industry movement, we incorporate Hamilton's (1989) regime-switching model. As a starting point, consider the following equation:

$$y_{nt} - \mu(s_{it}) = \sum_{j=1}^{k} \alpha_j \left(y_{nt-j} - \mu(s_{it-k})\right) + u_t$$

where y_{nt} represents a measure of the n-th firm's competitiveness in year t, $\mu(*)$ represent the mean of y_{nt} at each regime, and s_t represents the unobserved latent variable which is subject to stochastic regime-switching between states, i.e.,:

$$\mu(s_t) = \begin{matrix} u(1) & \text{if } s_t = 1 \\ u(2) & \text{if } s_t = 2 \end{matrix}$$

Further let us assume that the probability that s_t equals some value j depends only upon its k lags, i.e., $s_{t\text{-}k}$. This allows us to write the transition probabilities of s_t, p_{ij}, as an ergodic Markov chain:

$$P(s_t = j \mid s_{t-1} = i) = p_{ij}$$

or in the 2-regime (state) case, the transition matrix, **P**, may be written as:

$$\mathbf{P} = \begin{pmatrix} p_{11} & p_{21} \\ p_{12} & p_{22} \end{pmatrix}$$

where the element of the i-th row and j-th column describes the transitional probability p_{ij}. The individual p_{ij}'s represent the likelihood that the firm would transition from the i-th regime to the j-th regime, given that the firm is in the i-th regime. For example, the value of p_{12} represents the probability that y_{nt} will move from regime 1 to regime 2, given that the firm is in regime 1.

Since the state variable is assumed to be unobservable, the estimated procedure is based on the iterative Baum-Lindgren-Hamilton-Kim filter that infers the regime-probability at each point in time (Krolzig, 1998). As a by product of the filter inferences, a likelihood function may be derived and maximized in order to obtain the estimated model parameters, i.e., the $\mu(*)$'s and p_{ij}'s. The log-likelihood function, $L(\theta|y_t)$ is given:

$$L(\theta| y_t) = \sum_{j=1}^{t} \ln f(y_t \mid y_{t-1}; \theta)$$

The maximum likelihood estimate of θ is a function of non-linear equations and it is therefore generally estimated, as in Hamilton (1989), with the use of the EM algorithm, i.e., the EM algorithm is applied to solve the problem:

$$\theta_{ML} = arg \max L(\theta| y_t)$$

where the estimated model parameters are in θ.

The competitive environment may then be examined by comparing the individual firms' state means, $\mu_{\text{y}}(1)$ and $\mu_y(2)$, and their individual transitional probabilities, p_{12} and p_{21}. One might expect that under a competitive environment, individual teams would have similar average high and low states and also have similar transitional probabilities. Furthermore, one would expect that these transitional probabilities would be large. This would signify that individual firms may move into high state and earn above normal returns, but that through the dynamics of competition these high returns would quickly diminish. The opposite would also be true, as a firm could also move easily from a low period to a high period.

III. AN APPLICATION

As an application, the regime-switching model of Equation 1 is applied to analyse competition within MLB. While aggregate measures of the level of competitiveness within the industry are abundant, they generally all tell a similar story: Competitive balance in MLB has improved across time. This is true whether one examines the standard deviation of winning percentage (Quirk and Fort, 1992), the

[2] For example, consider the audience a live broadcast of the World Series can draw. Such a broadcast will generally attract more viewers than a re-broadcast of the greatest series ever played.

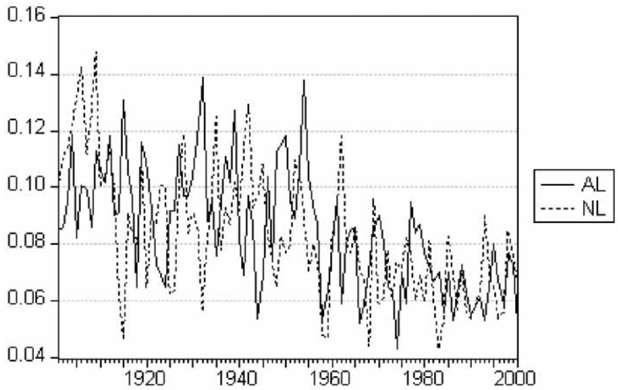

Fig. 1. *Gini coefficients for American (AL) and National League (NL) Sample: 1901–2001*

dispersion and season-to-season correlation of team winning percentages (Butler, 1995; Quirk and Fort, 1992; Balfour and Porter, 1991), the relative entropy approach (Horowitz, 1997), or the Herfindahl-Hirschman index (Depken II, 1999).

Figure 1 provides one possible measure of the distribution of wins, the Gini Coefficient, originally applied to MLB in Schmidt (2001). Specifically, consider, the following (Lambert, 1993) measure for the Gini coefficient (G):

$$G_i = \left(1 + \frac{1}{N_i}\right) - \frac{2}{N_i^2 \mu_{x_i}} \times (x_{N,i} + 2x_{N-1,i} + 3x_{N-2,i} + \cdots + Nx_{1,i})$$

where, in the present context, N represents the number of teams, x_N represents the winning percentage of team N, μ represents the average value of x, and i represents the time period. In addition, each team is ranked relative to its winning percentage, such that $x_N \geq x_{N-1} \geq \cdots \geq x_1$. This measure is attractive because it has a defined range between (0) and (1), with (0) indicating perfect equity and (1) indicating perfect inequity. In the MLB context, a value of (0) would be obtained in the unique situation where each team won 50% of their games, i.e., where wins are evenly distributed. The further wins deviate from this unique situation, the larger the associated Gini coefficient and the lower the degree of competitive balance.

The estimation of the Gini Coefficient requires data on team winning percentage. Such data were obtained from The Sporting News Complete Baseball Record Book (2002) and are available on an annual basis from 1901–2002.[3]

Overall, this measure is consistent with the earlier literature and continues to highlight the increase in competitive environment within the industry. This result stands in contrast however with the prevailing view offered by both industry insiders and various members of the media.[4] From their perspective, baseball at the conclusion of the 20th century has a competitive balance problem. A clear statement of this argument was offered by Major League Baseball's Blue Ribbon Panel (Levine *et al.*, 2002).[5] The Blue Ribbon report suggested that significant disparities exist in the distribution of both revenue and wins. From 1995–1999, the only years the panel considered, no team with a payroll in the bottom 50% of the payroll rankings appeared in Major League Baseball's annual post-season competition. The panel members argued that such a result renders the outcome of the season a foregone conclusion for teams without the revenues necessary to compete.

These two views however are not necessarily mutually exclusive. It is possible that in the aggregate MLB has become more competitive with the probability of *poor* teams beating *good* teams rising across time. Even though the probability of winning for *poor* teams have risen across time, their probabilities are still below those of the *good* teams and therefore *good* teams still win season-long competitions. Consider, for example, the regular success of the New York Yankees and Atlanta Braves over the past decade. The point is that while the aggregate measures are improving, there may be little movement within the industry which produces the image of lack of competition.

As cursory evidence of the first view, the third column of Table 1 reports the historical winning percentage of the pre-1970 expansion MLB teams. Interestingly, the first is that of the 24 teams, 11, or roughly half have overall winning percentages (μ_y) above 0.500 with the New York Yankees producing the highest percentage at 0.565. In contrast, the Philadelphia Phillies had the lowest percentage of 0.457. This result suggests that, on average, the difference between best and worst performance is roughly

[3] Furthermore, the source provides information on the number of teams within the American and National Leagues. As was mentioned in the introduction and as is highlighted in Table I, each League has expanded several times in the post-1960 period. In which case, the value of N changes across time. Specifically, $N=8$ for the American League over the 1901–1960 period, $N=10$ from 1961–1968, $N=12$ from 1969–1976, and $N=14$ from 1977–1998. As for the National League, $N=8$ over the 1901–1961 period, $N=10$ from 1962–1968, $N=12$ from 1969–1992, $N=14$ from 1993–1997, and $N=16$ for 1998. Also, the Milwaukee Brewers moved from the American to the National League after the 1997 season. Finally, the introduction of inter-league play in 1997 allows for each league's μ to differ from (0.5).

[4] Bud Selig, the commissioner of Major League Baseball, argued during the 2002 season that the lack of competitive balance in Major League Baseball has had such a detrimental effect that between 6–8 teams would be bankrupt by the end of 2003.

[5] The Commissioner's Blue Ribbon Panel on Baseball Economics was convened by Major League Baseball to investigate the issues of competitive balance and economic health. Specifically, the panel's stated purpose was to "examine the question of whether Baseball's current economic system has created a problem of competitive imbalance in the game" (Levine *et al.*, 2000)

17 games. This further highlights a degree of competition consistent with Fig. 1, as no team appears to dominate the market.

As for the second view, a different question is asked: To what degree do losing teams become winning teams and vice versa? The aggregate measure of Equation 7 cannot be used to answer this question as the measure can decline (and competitive balance improve) with very little interchange between teams. The regime-switching approach of Equation 1, however, offers a different perspective.

Specifically, suppose one defines two possible states that an individual team can be in, low and high, i.e., $s_t = 1$ when the team is in its low state and $s_t = 2$ when in its high state. One could therefore compare individual teams both on the basis of their state means and their probabilities of switching states. As was mentioned, one would expect that in a competitive environment, no team would dominate the market for an extended period of time. Therefore one would expect that individual team regime means, i.e., $\mu_y(1)$ and $\mu_y(2)$, be similar across teams. Also, there would be an expectation of large and similar individual transition probabilities, i.e., p_{12} and p_{21}.

The results of estimating Equation 1 for the 24 individual MLB teams are reported in the last 6 columns of Table 1.[6,7] In general, Table 2 suggests a greater degree of imbalance in individual team success than might be inferred from the aggregate measure. Specifically, consider the third and fourth columns of Table 1 where the individual means, $\mu_y(1)$ and $\mu_y(2)$, for each of the 24 incorporated teams are reported. Cursory examination of these state means suggests that there exists a good deal of variability in the individual team $\mu_y(s)$'s. The New York Yankees, for example, had the highest winning percentage for regime 2 with a value of 0.609 and the highest value in their respective low state of 0.488. In contrast, the San Diego Padres had the lowest winning percentage in their high state (0.474) and the second lowest in their low state (0.357). This reveals that even in their worst periods, the Yankees produce a stronger performance than the Padres do in San Diego's best state. In addition, while the average difference between the two states for all

Table 1. *Regime switching estimates Major League Baseball*

			μ_y (Regime)		Probability of Regime-Switching		Duration (Regime)	
y	k	μ_y	$\mu_y(1)$	$\mu_y(2)$	p_{12}	p_{21}	1	2
ANA 1961–2002	1	0.485	0.451	0.534	49.3%	72.3%	2.03	1.38
ATL 1901–2002	1	0.480	0.403	0.550	18.0%	15.4%	5.55	6.52
BAL 1901–2002	1	0.476	0.398	0.541	21.8%	17.6%	4.60	5.68
BOS 1901–2002	1	0.512	0.389	0.542	17.4%	2.8%	5.76	35.94
CHC 1901–2002	1	0.504	0.470	0.606	2.0%	9.8%	50.43	10.26
CIN 1901–2002	1	0.505	0.436	0.549	17.8%	12.2%	5.62	8.19
CLE 1901–2002	1	0.512	0.472	0.571	9.8%	15.4%	10.45	6.50
CWS 1901–2002	1	0.505	0.452	0.547	57.1%	38.1%	1.75	2.62
DET 1901–2002	1	0.509	0.442	0.545	29.5%	10.4%	3.39	9.39
HOU 1962–2002	2	0.496	0.421	0.512	53.0%	14.7%	1.89	6.82
KC 1969–2002	1	0.498	0.425	0.524	14.1%	4.8%	7.09	20.77
LA 1901–2002	1	0.523	0.428	0.551	80.0%	28.6%	1.25	3.49
MIL 1969–2002	1	0.474	0.438	0.551	13.9%	31.8%	7.21	3.15
MIN 1901–2002	0	0.477	0.412	0.521	14.3%	8.9%	6.98	11.27
MON 1969–2002	1	0.487	0.436	0.525	11.7%	8.1%	8.52	12.31
NYM 1962–2002	1	0.474	0.375	0.529	27.2%	67.0%	3.67	1.47
NYY 1901–2002	1	0.565	0.488	0.609	17.3%	6.4%	5.78	15.72
OAK 1901–2002	1	0.481	0.400	0.584	14.9%	17.9%	6.73	5.58
PHI 1901–2002	1	0.457	0.380	0.514	11.8%	5.7%	8.46	17.52
PIT 1901–2002	1	0.516	0.425	0.557	15.6%	8.0%	6.40	12.54
SD 1969–2002	1	0.456	0.377	0.475	38.6%	69.5%	2.59	1.44
SF 1901–2002	1	0.539	0.484	0.582	9.6%	7.9%	10.39	12.61
STL 1901–2002	1	0.516	0.417	0.538	34.0%	15.9%	2.94	6.28
TEX 1961–2002	2	0.466	0.405	0.501	28.8%	17.4%	3.47	5.74

[6] In order to estimate Equation 1 and its associate results, we used the MSVAR OX package written by Hans-Martin Krolzig. The package is available at http://hicks.nuff.ox.ac.uk/Users/Doornik/index.html. The MSM option was chosen for the estimation. Other alternatives produced different estimates but the general conclusions where robust to these.

[7] At present there exist 30 Major League Baseball teams. However, teams which entered the market, through expansion, after 1970 are excluded as these six teams had less than 30 data points.

Table 2. *Regime dates*

y	ANA		ATL		BAL		BOS		CHC		CIN	
Regime	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	1963 1965–1966 1968–1969 1971–1977 1980–1981 1983 1987–1988 1990 1992–1994 1996 1999–1999 2001	1962 1964 1967 1970 1978–1979 1982 1984–1986 1989 1991 1995 1997–1998 2000 2002	1902–1913 1922–1929 1935 1951 1975–1979 1985–1990	1914–1921 1930–1934 1936–1950 1953–1974 1980–1984 1991–1902	1902–1959 1988–1921 1998–1902	1960–1987 1989–1997	1906–1907 1922–1932	1902–1905 1908–1921 1933–1902	1940–1902	1902–1939	1906–1916 1929–1937 1945–1955 1959–1960 1982–1984 2001–2002	1902–1905 1917–1928 1938–1944 1956–1958 1961–1981 1985–1900

y	CLE		CWS		DET		HOU		KC		LA	
Regime	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	1909–1916 1924–1929 1942–1946 1960–1993 2001–2002	1902–1908 1917–1923 1930–1941 1947–1959 1994–1900	1903 1910–1911 1913–1914 1918 1921–1924 1928–1934 1938 1948–1950 1968–1970 1975–1976 1978–1980 1984–1989 1995–1999	1904–1909 1912–1912 1915–1917 1919–1920 1925–1927 1935–1937 1939–1947 1951–1967 1971–1974 1977 1981–1983 1990–1994 2000–2002	1902–1904 1920–1920 1928–1931 1951–1954 1974–1977 1989–1902	1905–1919 1921–1927 1932–1950 1955–1973 1978–1988	1964–1968 1970–1971 1975 1978 1982 1984 1987–1988 1990–1991 2000	1969 1972–1974 1976–1977 1979–1981 1983 1986 1989 1992–1994 1998–1999 2001–2002	1970 1996–1902	1971–1995	1904–1905 1908–1915 1917–1919 1921–1923 1925–1927 1929–1929 1933–1941 1943–1945 1948 1950–1952 1954–1954 1958–1958 1960–1961 1964–1964 1967–1968 1972–1973 1975–1976 1979 1984–1984 1986–1987 1989–1990 1992–1992 1998–1999	1903 1906–1907 1916 1920 1924 1928 1930–1932 1942 1946–1947 1949 1953 1953–1957 1959 1962–1963 1965–1966 1969–1971 1974 1977–1978 1980–1983 1985 1988 1991 1993–1997 2000–2002

(*continued*)

Table 2. *Continued*

y	MIL		MIN		MON		NYM		NYY		OAK	
Regime	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	1970–1977 1984–1986 1993–2002	1978–1983 1987–1992	1901–1911 1939–1942 1947–1960 1951 1980–1983 1994–2000	1912–1938 1943–1946 1961–1979 1984–1993 2001–2002	1970–1978 1997–2002	1979–1996	1963–1968 1970–1974 1977–1983 1987 1989 1991–1993 1995–1996 2001–2002	1969 1975–1976 1984–1986 1988 1990 1994 1997	1902–1918 1965–1975 1986–1993	1919–1964 1976–1985 1994–2002	1904 1908 1915–1924 1934–1946 1950–1967 1977–1979 1982–1987 1993–1998	1902–1903 1905–1907 1909–1914 1925–1933 1947–1949 1968–1976 1980–1981 1988–1992 1999–2002
y	PHI		PIT		SD		SF		STL		TEX	
Regime	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	1902–1905 1919–1945	1905–1918 1946–1902	1914–1917 1946–1957 1985–1986 1993–2002	1902–1913 1919–1945 1958–1984 1987–2002	1970–1977 1979–1981 1987 1993–1994 2002	1978 1982–1986 1988–1992 1995–2001	1938–1902	1902–1937	1902–18	1919–2002	1963–1968 1970–1973 1982–1985 2000–2002	1969 1974–1981 1986–1999

teams is 0.118 or roughly 19 games, the Oakland Athletics having the largest swing of nearly 30 games and the Montreal Expos having the smallest with a roughly 14 game difference. Finally, these results are consistent with the industry and the media, who argue that the perpetual domination of the New York Yankees suggests a lack of competitive balance.

The transitional probabilities are reported in columns 6 and 7 of Table 1. These continue to highlight a degree of competitive imbalance not captured in measures such as Equation 7. Specifically, the Table reports that only 10 teams have a greater that 20% chance of moving from their low to high state. The situation is worse for teams moving from their respective high state to their low state with only six teams having a greater than 20% probability of switching. Individually, the Anaheim Angels, Chicago White Sox, Los Angeles Dodgers and San Diego Padres appear to be the most competitive with movement between the two regimes being common place. The last two columns of Table 1 report the average duration (in years) for each team.[8] These results suggest that Boston spends the greatest amount of time in a high state, although the level of excellence Boston achieves is far less than the success the Yankees enjoy in this regime.

Table 2 reports the estimated regime periods for the individual teams.[9] As was mentioned earlier, competitiveness would suggest that teams transition out of low and high periods regularly. While there are a few examples of teams which routinely move between states, i.e., the Angles and White Sox, there are others where such movement has only happened once, i.e., the Chicago Cubs, San Francisco Giants and the St. Louis Cardinals.

Finally, while Tables 1 and 2 do suggest that market leadership can be maintained even when the industry is becoming more competitive, the evidence is not entirely consistent with the story offered by MLB's Blue Ribbon Panel. The panel maintains that market share influences individual team potential regimes and would therefore impact both state means and transitional probabilities. This result is not entirely clear from Table 1. While the Yankees and Giants, two teams that were located in the largest market for a significant portion of the 20th century, enjoyed both the greatest success in regimes 1 and 2, the other teams located in New York, the Mets and Dodgers, failed to achieve a similar level of success. Moreover, the Cleveland Indians achieved greater success in both regimes than the Mets or Dodgers, despite playing the entire century in a relatively small metropolitan area. Finally, the Chicago Cubs, another team located in a large market, offer a winning percentage in state 2 which is quite similar to the New York Yankees. Unfortunately for their fans, no team matched the Cubs with respect to the amount of time spent in state 1.

CONCLUSION

The level of competition in an industry is generally examined in terms of static measures, which highlight the dispersion of market share at a specific point in time. When such measures are applied to Major League Baseball, the story told is that competitive balance has improved throughout the 20th century. Such a view stands in stark contrast to the arguments offered by the industry and members of the media. Given the domination of the New York Yankees for much of the 20th century, it is difficult for many to see how competitive balance could have improved. In essence, the industry is arguing that competitive balance is not simply defined by the dispersion of market share, but rather the persistence one firm can dominate the industry.

The regime-switching approach offered here provides some support for this viewpoint. Although the evidence suggests that teams move between both individual regimes, some teams, e.g. the New York Yankees, consistently enjoy greater success in the latter state. This results suggest that competition is dynamic and one should look at competition from various angles. The regime-switching model allows us to examine one of these angles, i.e., intra-industry movement.

REFERENCES

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

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

Depken II, C. A. (1999) Free-agency and the competitiveness of Major League Baseball, *Review of Industrial Organization*, **14**(3), 205–17.

El-Hodiri, M. and Quirk, J. (1971) An economic model of a professional sports league, *Journal of Political Economy*, **79**, 1302–19.

Hamilton, J. D. (1989) A new approach to the economic analysis of nonstationary time series and the business cycle, *Econometrica*, **57**(2), 357–84.

Horowitz, I. (1997) The increasing competitive balance in Major League Baseball, *Review of Industrial Organization*, **12**(3), 373–87

Krolzig, H.-M. (1998) *Econometric Modelling of Markov-switching Vector Autoregressions using MSVAR for Ox*, Department of Economics, University of Oxford, Oxford.

Lambert, P. J. (1993) *The Distribution and Redistribution of*

[8] These follow directly from the transitional probabilities.

[9] These are the smoothed estimates and therefore do not exactly correspond to the results of Table 1. See Krolzig (1998).

Income: A Mathematical Analysis, Manchester University Press, Manchester.

Levine, R. C., Mitchell, G. J., Volcker, P. A. and Will, G. F. (2000) Blue Ribbon Panel on baseball economics [http:\www.majorleaguebaseball.com/u/baseball/Major League Baseballcom/pressrelease/blueribbon_release.htm]

Quirk, J. and Fort, R. (1992) *Pay Dirt: The Business of Professional Team Sports,* Princeton University Press, Princeton, NJ.

Rascher, D. (1999) A test of the optimal positive production network externality in Major League Baseball, *Sports Economics: Current Research* (Eds) J. Fizel, E. Gustafson and L. Hadley, Praeger Westport, CT, pp. 27–45.

Rottenberg, S. (1956) The baseball player's labor market, *Journal of Political Economy*, 242–58.

Schmidt, M. B. (2001) Competition in Major League Baseball: the impact of expansion, *Applied Economics Letters*, **8**(1), 21–6.

The Sporting News Complete Baseball Record Book (2000) The Sporting News, St Louis, MO.