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STOCHASTIC MARKET STRUCTURE: CONCENTRATION MEASURES AND MOTION PICTURE ANTITRUST

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Abstract

This paper examines the usefulness of concentration indices in characterizing the degree of competition in the motion picture industry. It shows that concentration ratios and the Herfindahl-Hirschman index give a misleading picture of the degree of competition in the industry. All these indices exhibit large fluctuations that make the common practice of calculating a static measure erroneous. Market shares are shown to follow a stochastic Pareto-Lévy motion in which the market shares of the leading distributors are unstable, and positions often change. We show that this stochastic industry structure implies that the expected value of the HHI is undefined (infinite!). The motion picture industry is (stochastically) concentrated but highly competitive. We argue that this is likely to be true of other industries with similar stochastic features.

INTRODUCTION

Concentration indices are widely used to characterize industry structure. In some models, these indices can be linked to market power and this relationship may seem to justify concentration measures as a screening mechanism in antitrust investigations. In its *Horizontal Merger Guidelines* the Department of Justice indicates that when a given post-merger Herfindahl-Hirschman Index (HHI) exceeds a critical threshold level they may initiate an antitrust investigation or action. But, if concentration indices do not accurately reflect the nature of competition in an industry, their use by the DOJ and other agencies could lead to misguided interventions. Moreover, if the nature of competition in an industry differs from what the theories predict or assume, then the theories fail on scientific grounds and the theoretical basis of concentration measures collapses.

This paper examines the limitations of concentration indices in assessing the degree of competition in the motion picture industry and it raises issues that go to the assessment of competition in other industries. It argues that concentration measures give an inaccurate measure of competition in the motion picture industry. The reason is simple: box office revenues and market shares in the industry are highly variable and a static measure cannot

capture the dynamics of competition among motion pictures and the companies that release them into the theatrical market. We show that market shares follow a *Pareto-Lévy* motion in which they change dramatically and where there are reversals among the ranks of the leading firms and deep plunges and extreme rises in shares over time. In this volatile industry the HHI is a stochastic variable and its expected value does not exist mathematically! Even the mean market share exhibits volatility. Moreover, the motion picture market is organized and operates in a manner that is completely different from what is assumed in the theoretical models that link pricing with concentration. Its organization is an adaptation to the volatility that is inherent in the “nobody knows” principle proposed by William Goldman and with modern statistical research on motion pictures (De Vany and Walls: 1997, 1999, 2001; De Vany and Lee (2001); Sornette and Zajdenweber (1999)). We conclude that the use of concentration measures to assess the degree of competitiveness of the motion picture industry is without theoretical or empirical justification.

The volatility of market shares in motion pictures is driven by the continual release of new films and in the nature of the way audiences react: together, these create an expansive dynamical process that can “go anywhere” (De Vany, et al op cit.). New entrants compete with the leading and lesser films so that market leaders lose their shares and new leaders emerge as the contenders challenge the box office leaders. The market resembles a tournament where the biggest prizes (box office revenues) are distributed to the top finishers while the contenders get little. But, the top ranked (highest grossing) movies are replaced by new releases or contenders moving up so that there is a continuing turnover at the top and at all ranks in the box office tournament. A movie’s box-office success cannot be predicted before its release and how long it will last is unknown. Its fate unfolds over time as both exhibitors and distributors adapt supply to meet demand. Under these conditions, the firms at the top and their market shares change rapidly and often---these are the indicators of a vigorous, dynamic competition.

Concentration measures mask the volatility of market shares and give a false sense of stability where there may be vigorous competition and no stability. They are typically calculated using the average market shares of firms or their shares at a point in time. Either way, a random variable is replaced with one that is certain and the volatility of market shares is completely eliminated. In order to look at concentration without suppressing the volatility

of market shares, one must record the variation in market shares and estimate the probabilities that firms will realize different market shares. The probability distribution can be used to calculate the expectation and variance of the concentration measure. Even this approach may fail to capture how rapidly market share leaders turn over.

For reasons that are tied to the variable nature of the business, we show that the expectation of the HHI is undefined in motion pictures because it is infinite! Moreover, calculated HHI values are unstable and depend on sample size. Static and non-stochastic models of pricing that rely on the HHI and derivative measures are irrelevant and misleading characterizations of the dynamic competitiveness of the motion picture industry. One of the absurd conclusions of these models is that when the expected HHI is infinite the expected price is infinite. The models can equally be misleading in other industries where demand is uncertain and market shares are volatile.

MEASURES OF MARKET POWER: THEORY AND POLICY

In this section we briefly review the common measures of market power, the theories behind them, and their use in antitrust.

Measures of Market Power and their Theoretical Basis

One of the earliest measures of market power is the *Lerner Index* (L) which is defined as:

$$L = (\text{Price} - \text{Marginal Cost}) / \text{Price}. \quad (1)$$

The theoretical basis for the index comes from the assumption that firms with monopoly power can charge prices above marginal cost¹. The index can be derived from a profit-maximizing single-product monopoly model or a one-stage Cournot oligopoly model². Because of the difficulties associated with obtaining marginal cost data, the index has not been used very often to measure market power. This notwithstanding, the Lerner Index's influence in the antitrust literature remains substantial chiefly through other measures of market power that rely on it indirectly to link pricing to market concentration. Two such indices are the *M*-firm concentration ratio (CRM) and the Herfindahl-Hirschman Index (HHI).

The ***M-firm concentration ratio*** (CRM) is defined as the cumulative market share of the number of firms, M , with the largest market shares:

$$CRM = \sum_{i=1}^M s_i \quad i = 1, 2, \dots, M \quad (2)$$

The variable s_i is the market share of the i -th firm. The most commonly used M -firm concentration ratios are the CR4 and CR8 – which measure the cumulative market shares of the four and eight largest firms in the industry, respectively.

Saving (1970) provides theoretical support for the use of the CRM as a measure of market power³. In his paper, firms produce a homogeneous product and are divided into two groups – a collusive dominant group (consisting of M firms) and a price-taking fringe group. The dominant group as a whole jointly maximizes their profit given a conjectural derivative ($\lambda_{FM} = \Delta Q_F / \Delta Q_M$), which represents the fringe group's output (Q_F) response to the dominant group's output (Q_M)⁴. Saving shows that the Lerner Index (L_M) for the dominant group is related to the M -firm concentration ratio (CRM):

$$L_M = \frac{p - c'_M}{p} = \frac{(1 + \lambda_{FM})(CRM)}{\varepsilon_{Qp}}, \quad (3)$$

where p is price, c'_M is the (common) marginal cost of firms in the dominant group, and ε_{Qp} is the absolute value of the market price elasticity of demand. Hence, the CRM is linked to market power via the dominant group's Lerner Index (L_M). The excess of price over marginal cost as a proportion of price is directly proportional to the CRM.

The ***Herfindahl-Hirschman Index*** (HHI) is defined as the sum of the squared values of the n firm market shares:

$$HHI = \sum_{i=1}^n s_i^2 \quad , \quad i = 1, 2, \dots, n. \quad (4)$$

s_i is the market share of the i -th firm. As in the case of concentration ratio, the link between market power and the HHI is through the Lerner Index. It can be shown that the industry-average Lerner Index (L) for a homogenous product industry is given by⁵:

$$L = \frac{(1 + \lambda)(HHI)}{\varepsilon_{Qp}} \quad (5)$$

The variable λ is the conjectural derivative (assumed to be identical) for all firms in the industry, and ε_{Qp} is the absolute value of the market price elasticity of demand. This equation reduces the variation in market shares to a single number---the average market share.

Concentration Measures in Horizontal Merger Policy

The argument that market concentration is a determinant of pricing rests on the hypothesis that concentration is related to the likelihood of collusion among dominant firms. The more highly concentrated an industry, according to this theory, the more likely it is that firms will be able to collude to raise price above marginal cost⁶. This view and the use of concentration measures are integral parts of the Department of Justice's horizontal merger analysis. The *Horizontal Merger Guidelines* (1997) contain the analytical framework and standards that agencies, such as the Department of Justice and the Federal Trade Commission, use in analyzing horizontal mergers.

The four-firm concentration ratio (CR4) was first formally used in the *1968 Merger Guidelines*⁷. In 1982, the Herfindahl-Hirschman Index replaced the CR4 Index. The argument given for relying on the HHI rather than the CR4 is the more comprehensive nature of the HHI⁸:

“Unlike the four-firm concentration ratio, the HHI reflects both the distribution of the market shares of the top-four firms and the composition of the market outside the top four firm. It also gives proportionately greater weight to the market shares of the larger firms, in accord to their relative importance in competitive interactions.”

In the *Horizontal Merger Guidelines*, market power is defined along the lines of the Lerner index: “Market power to a seller is the ability profitably to maintain prices above competitive levels for a significant period of time”⁹. The *Horizontal Merger Guidelines* explicitly considers concentration as a necessary (but not sufficient) condition for the exercise of market power:

“A merger is unlikely to create or enhance market power or to facilitate its exercise unless it significantly increases concentration and results in concentrated market, properly defined and measured. Mergers that either do not significantly increase concentration or do not result in a concentrated market ordinarily require no further analysis.”¹⁰

Hence, given an appropriate market definition, the HHI is used by the Department of Justice as a screening mechanism to indicate whether the merger case under scrutiny merits further investigation. For this purpose the spectrum of market concentration is divided into three categories¹¹:

- (a) unconcentrated---HHI below 1000;
- (b) moderately concentrated---HHI between 1000 and 1800; and
- (c) highly concentrated---HHI above 1800.

In investigating a proposed merger, the Department of Justice considers both the level of post-merger market concentration as well as the increase in concentration. When the post-merger HHI is below 1000 further investigation is unlikely. If the post-merger HHI falls between 1000 and 1800, the Department of Justice will investigate a case further depending on the extent of the increase in the HHI following the merger. If the HHI increases by more than 100 points, a merger is likely to be investigated further. Finally, the *Horizontal Merger Guidelines* consider a post-merger HHI of above 1800 and a HHI increment of 100 points to be indicative of the creation or enhancement of market power.

It should be reiterated that even though the HHI is only one component of the guidelines used by the Department of Justice, it is an important one partly due to its role as a screening mechanism¹². The HHI is supplemented by other criteria such as: (a) factors influencing collusion or coordination (e.g. availability of information on market conditions, firm and product heterogeneity and marketing practices, contracting practices; and historical precedence of collusion); (b) degree of product differentiation; (c) entry-exit conditions; and (d) efficiency gains. These criteria are especially important when the post-merger HHI falls in the “gray area” (or moderate concentration) between 1000 and 1800.

The HHI has come under criticism. Schmalensee (1987) contends that the empirical link between concentration and collusion is weak. Furthermore, the HHI has not been proven to be superior to the CR4 in terms of predicting noncompetitive behavior¹³. Others go so far as to suggest that measures of market concentration have no predictive value at all, an argument we support with our results for motion pictures¹⁴. Despite theoretical arguments for a link between market power and concentration, some economists regard the model as weak or wrong and the link as far from exact or certain¹⁵. We would add that, if both the HHI and the size ranking of firms vary, then empirical studies that fail to account for this are flawed. Moreover, if market shares are volatile, there is evidence that concentration is endogenous so that it cannot be treated as an explanatory variable and will have weak predictive power.

In setting forth the HHI as a screening test, the Guidelines make a strong assertion: that a universal theory of pricing and concentration applies to every industry, in spite of their many different institutions and economic environments. The subsidiary claim is that the Cournot model of pricing is accurate for all industries. These are remarkable claims that should not be readily accepted in the absence of compelling evidence. The claims do not stand up to the evidence in the motion picture business.

CONCENTRATION RATIO IN US VS. PARAMOUNT PICTURES

Concentration indices were already in use in motion picture antitrust before they were formally incorporated in the *1968 Merger Guidelines*. The most important example is the *United States vs. Paramount Pictures, Inc.* litigation filed in 1938 (amended and supplemented in 1940) resulting in the Consent Decree that forced the studios to divest their theaters and alter their licensing practices. In the Paramount case five major studios (Loew's/MGM, Paramount, RKO, Twentieth Century Fox, and Warner Brothers) and three minor studios (Columbia, Universal and United Artists) were charged with conspiring to fix film license terms, runs, clearances, and minimum admission prices. A central piece of evidence the courts relied on to infer market power of the defendants was the combined market shares of the defendants¹⁶:

“If viewed collectively, the major defendants owned in the 1945 at least 70% of the first-run theaters in the 92 largest cities and the Supreme Court has noted that they owned 60% of the first-run theaters in cities with populations between 25,000 and

100,000. As distributors they received approximately 73% of the domestic film rental from the films, except Westerns, distributed in the 1943-44 season. These figures certainly indicate, when coupled with the strategic advantages of vertical integration, a power to exclude competition from these markets when desired.”

The court used an eight firm concentration ratio (representing the eight defendants), which is remarkable since there were only eleven distributors of any magnitude in the industry at the time. The court excluded Westerns and used a point-in-time measure of theater shares and an average of film rentals, eliminating all the variation in these variables. De Vany and Eckert (1991) show that the use of market share in inferring market power in the Paramount case was flawed because of the high variability in the distributor-defendants’ market shares¹⁷.

THE MOTION PICTURE INDUSTRY

A crucial step in the construction of concentration indices involves the definition of the relevant market. For a long time the primary market for motion pictures was theater exhibition. Since the mid-1980s, revenue from ancillary markets such as home video (rental and sales) and pay per view cable has become increasingly important. In 1995, 40.6 percent of the revenues in the film industry came from home video, 7.8 percent from pay cable and 6.7 percent from foreign television¹⁸. Theatrical exhibition (domestic and foreign) accounted for some 27 percent of total revenue in the film industry. About half of the theatrical exhibition revenues are collected from the domestic market, the rest abroad¹⁹.

Despite the moderate share of domestic theatrical exhibition in total revenues of the film industry, it remains a very important market. This is because films are released sequentially through these different markets. Typically, U.S. made films are first released in the domestic theatrical exhibition market followed by the foreign theatrical exhibition market, pay per view cable, video rental and sales, and finally network television. Under this system, the information generated in the domestic theatrical exhibition market---in terms of box-office revenues and word-of-mouth transmission of movie quality assessment---has great influence on consumer demand in the ancillary and foreign exhibition markets.

The weekly *Variety* box office revenue data covers the top-60 grossing movies in the U.S. domestic theatrical exhibition market. The coverage of the top-60 list is likely to be

sufficiently comprehensive because it accounts for 94 percent of all theater screens in the nation. In addition, box office revenues for films outside the top-60 list are small. That said we next construct concentration indices for distributors in the U.S. domestic theatrical exhibition market. Henceforth, in this paper we will use the term “motion picture industry” to refer to the domestic theatrical exhibition market for the top-60 grossing movies in the United States.

The *Variety* Data

The box office revenues of films were collected from the weekly trade journal *Variety*. The data are compiled by *Entertainment Data Inc.* (EDI) and are based on a sample of about 28,000 screens in major metropolitan areas. The total number of screens in the U.S. is estimated to be 29,700 screens in 1996-20. Hence, the *Variety* sample covers about 94 percent of total screens in the country. Two sets of data were used. The first set comprise of weekly box office revenues covering the period is the 55 weeks between May 24, 1996 and June 12, 1997. During this period 365 films played on the top-60 list. Of these, 254 films entered and exited within the sample period. The total number of observations during the sample period is 3,300. The total number of distributors in the sample data is 53. The second set of data comprise of the total box office revenues of films released during the period 1990-1995. About 1,983 films were released during this period.

Concentration Ratios and the HHI in Motion Pictures

In the sample data, the top four major distributors’ share of total box office revenue (CR4) is equal to about 59 percent. The corresponding measure for the top eight distributors (CR8) is 95 percent (see Table 1). From Table 1, one can see that each of the top six major distributors has a market share exceeding ten percent. These six firms have a combined market share of 84 percent.

Table 1: Box Office Revenue Market Shares of Major Distributors, 1996/97*

Rank & Distributor	Market Share (%)	Cumulative Market Share (%)
1: Buena Vista	18.37	18.37
2: 20 th Century Fox	14.12	32.49
3: Sony	13.75	46.24
4: Warner Bros.	13.00	59.24
5: Paramount	12.93	72.17
6: Universal	11.69	83.86
7: Newline	6.08	89.94
8: Miramax	5.29	95.23
9-53	4.77	100.00
Total	100.00	

Source: *Variety*, various issues.

* From 5/24/96 to 6/12/97

It is interesting to note that during the half century following the Paramount Consent Decrees, all but one of the distributors-defendants (RKO, who exited in 1957) continue to survive²¹. The current total market share of the top five distributors (at 72 percent) is similar to that of the total market share of the five major distributors-defendants during the Paramount litigation (at 73 percent in 1943-44)²². The current CR8 at 95 percent is the same as in 1943-44²³. Hence, if arguments similar to those employed in the Paramount case were to be made today, the current level of concentration in the motion picture industry should be a concern to regulators²⁴. We now show that these measures are as irrelevant today as they were fifty years ago.

The average value of the HHI for the industry over the sample period is 1268, a value that falls in the category of “moderate concentration” according to the *Horizontal Merger Guidelines*²⁵. A merger of any two of the top six distributors, according to the guidelines, would raise “significant competitive concerns” depending on other additional factors²⁶. Such a merger would produce an increase in the HHI of more than 100 points in what is a moderately concentrated market according to the pre-merger HHI of 1268²⁷. An increase of 100 points in the HHI occurs whenever each of the two merging parties has a pre-merger market share of at least 10 percent²⁸. All the top six distributors in our sample meet this condition (Table 1). Furthermore, the *Guidelines* views previous incidences of collusion – as argued in the Paramount case – as conducive to collusion²⁹.

INSTABILITY OF CONCENTRATION INDICES AND MARKET SHARES

It is common practice to compute the values of concentration indices using annual data³⁰. Annual data from a recent study of the motion picture industry indicates that industry concentration measures have fluctuated in recent years (Table 2)³¹. Between 1990 and 1995 the cumulative market shares of the six major distributors (CR6) ranged between 78 to 94 percent³². During these years the HHI fluctuated between 1200 and 1577. Moreover, there has been turnover at the top ranks. These data mask the extreme volatility of shares.

Table 2: Box Office Revenue Market Shares of Major Distributors, 1990-1995

	1990	1991	1992	1993	1994	1995
Buena Vista	15.5	13.9	19.4	16.3	19.3	19.0
Warner Bros.	13.1	13.7	19.8	18.5	16.1	16.3
Universal	13.1	11.0	11.7	13.9	12.5	12.5
Sony	13.9	20.0	19.1	17.5	9.2	12.8
Paramount	14.9	12.0	9.9	9.3	13.9	10.0
20 th Century Fox	13.1	11.6	14.2	10.7	9.4	7.6
Others	16.4	17.8	5.9	12.7	19.6	21.8
Total	100.0	100.0	100.0	100.0	100.0	100.0
CR4	57.4	59.6	72.5	66.2	61.8	60.6
CR6	83.6	82.2	94.1	87.3	80.4	78.2
CR8	90.8	88.5	97.4	92.5	90.4	91.0
Herfindahl	1200	1204	1577	1333	1367	1335

Source: Litman (1998), p.23

Weekly shares correspond more closely with the natural time scale of the theatrical market, where new films open each week and supply adjustments are made by extending runs week by week. The weekly CR6 fluctuates from 62 percent to 97 percent (Figure 1). Instability is not just confined to the CR6. The values of the HHI also exhibit large fluctuations (Figure 2). Weekly HHI fluctuates between 1305 and 4166 in our sample data.

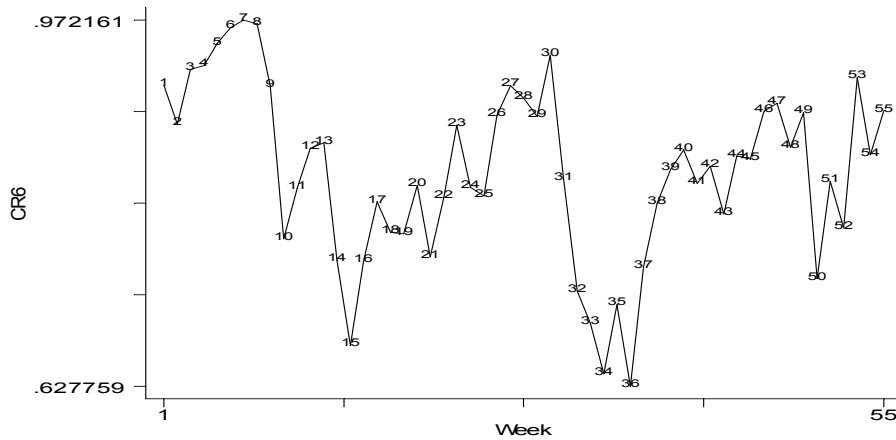


Figure 1: Market Share of Top Six Distributors (CR6) over time

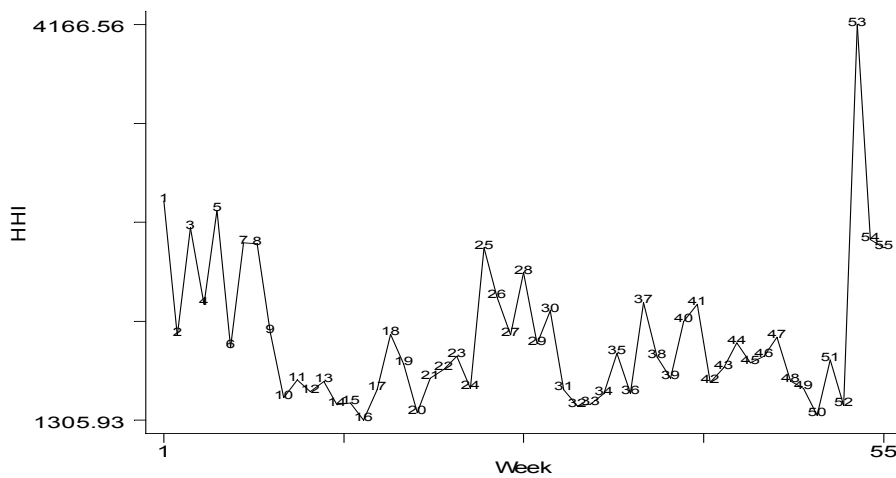


Figure 2: The Herfindahl-Hirschman Index (HHI) over time

Table 3 indicates that the mean value of the absolute percentage change for the HHI is higher than the CR6 and so is the standard deviation (see also Figures 3 and 4). The HHI is less stable than the CR6 because the squared terms amplify large changes in market share. This can be seen by comparing the HHI's pattern of fluctuation in Figure 2 with that of the market share of the highest grossing films (CR1) in Figure 5. The pattern of fluctuation for both indices is similar. Peaks and troughs match showing that the HHI is heavily influenced by the CR1. This is confirmed by the high correlation between the HHI and CR1 reported in Table

4. The HHI and CR1 are highly correlated (the coefficient of correlation equals 0.84). In contrast, the coefficient of correlation between CR6 and CR1 at 0.51 is much smaller^{33, 34}.

Table 3: Summary Statistics of Absolute Value of Percentage Change in Average Annual Herfindahl-Hirschman Index and CR6

Variable	Obs	Mean	Std. Dev.	Min	Max
HHI	54	20.65869	27.58705	0.2906254	195.235
CR6	54	6.378546	4.774425	0.1745894	18.16611

Figure 3: Percentage Change in CR6 over time

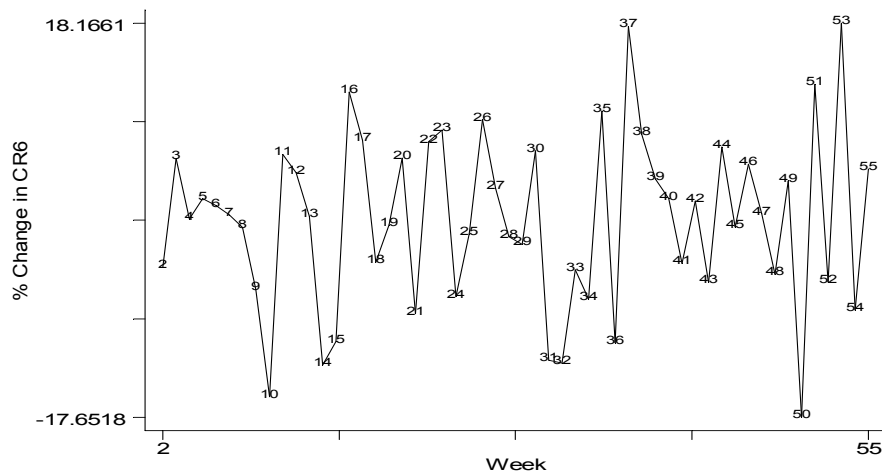


Figure 4: Percentage Change in HHI over time

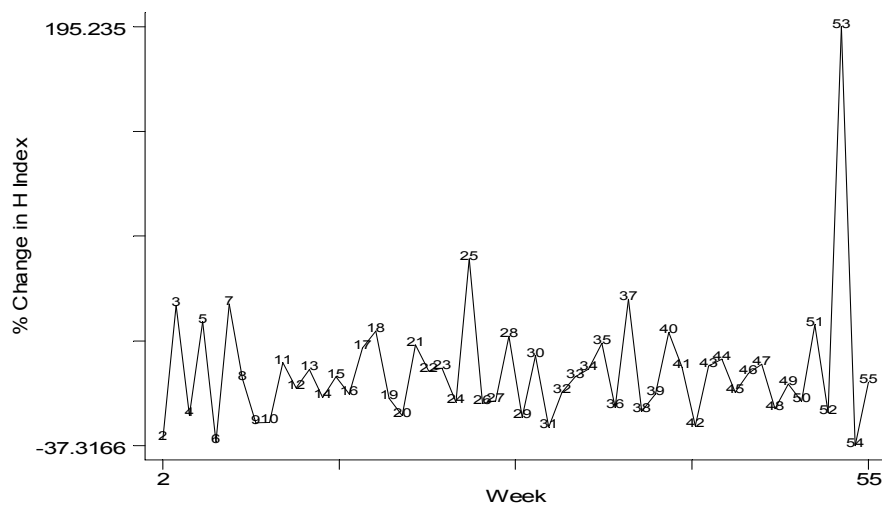


Table 4: Correlation Matrix for the Concentration Indices

	Herfindahl	CR6	CR1
Herfindahl	1.000000	0.580491	0.835353
CR6	0.580491	1.000000	0.509260
CR1	0.835353	0.509260	1.000000

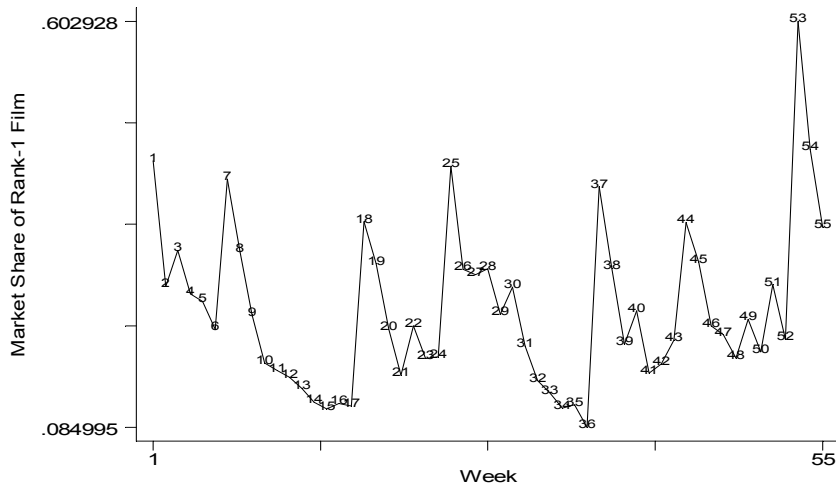


Figure 5: Market Share of Rank-1 Films over time

The short-run instability in the concentration indices is a window on competition in motion picture industry. The instability of market shares among the six major distributors is striking when we examine weekly box office revenues (Figure 6). Each distributor’s share varies from less than one percent to as high as 62 percent! Just a few weeks before Universal achieved it 62 percent share, its market share was less than 2 percent. Annual market shares hide the underlying volatility of shares and the way they depend on a few extremely successful movies. What is driving this volatility is the birth and death of products and the unpredictability of the reaction of the motion picture audience. There is no correlation between these market shares except a negative correlation between the leading distributor’s share and the shares of the other distributors when the leading distributor has a huge hit. Models of collusion require a positive correlation of firm shares.

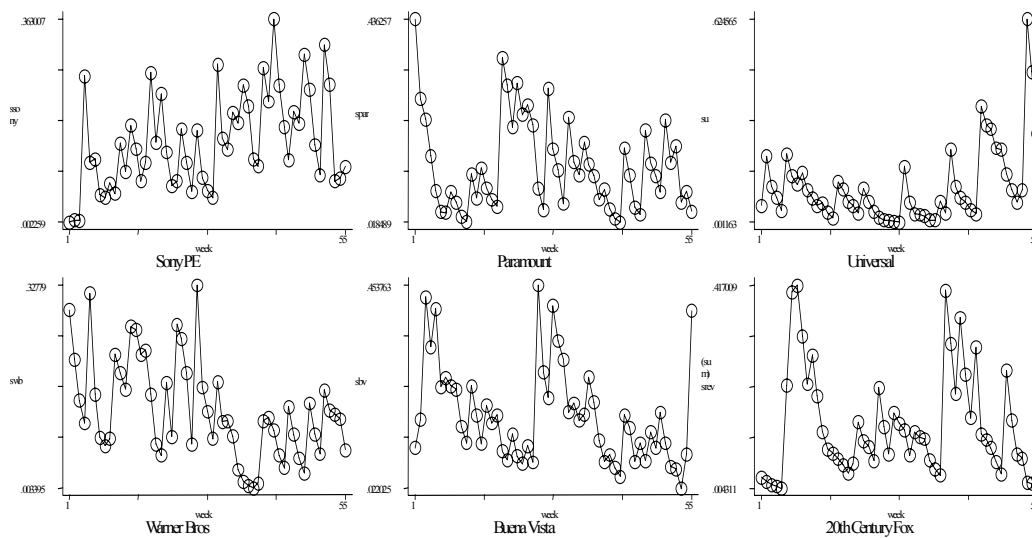


Figure 6: Weekly Market Shares of Box Office Revenues of Six Major Distributors

TURNOVER OF THE LEADING FIRMS AT RANKS 1 AND 2

The existence of competition in an industry can be gauged by instability in the ranking of dominant firms. Curry and George (1983, p.213) express this elegantly:

“One criticism of conventional indices is that they are ‘static’, in the sense that they simply record the characteristics of a size distribution at some particular point instant. *If however, the identity of the dominant firms were to change over time then even persistent high levels of concentration would not imply the absence of competition.*” (italics added)

To see how closely volatility in market shares is tied to turnover among dominant firms we track the identities, week by week, of the first- and second-ranked distributors on the *Variety* top-60 list³⁵.

Only a handful of the distributors in the motion picture industry occupy the top two ranks of the *Variety* box office list. There are 53 distributors in our sample, but only eight occupied one of the top two ranks during the sample period. They are Buena Vista, 20th Century Fox, Paramount, Universal, Sony, Warner Bros., Miramax and Newline.

How important are rank-1 and rank-2 positions? The significance of these positions is revealed by the relationship between rank and the number of screens and box office revenues

(Figure 7 and Figure 8)³⁶. The convex-to-origin plots in Figure 7 and Figure 8 indicate that higher-ranking distributors (e.g. ranks 1, 2) have disproportionately large shares of theater screens and box office revenues. Table 5 shows that the identities of the distributors occupying the top two ranks change over time (Table 5). For example, on week five Warner Bros.' *Eraser* was at rank-1 and Buena Vista's *The Hunchback of Notre Dame* was in rank-2. The following week, both were replaced by 20th Century Fox (with *Independence Day* at rank-1) and Universal (with *The Nutty Professor* at rank-2).

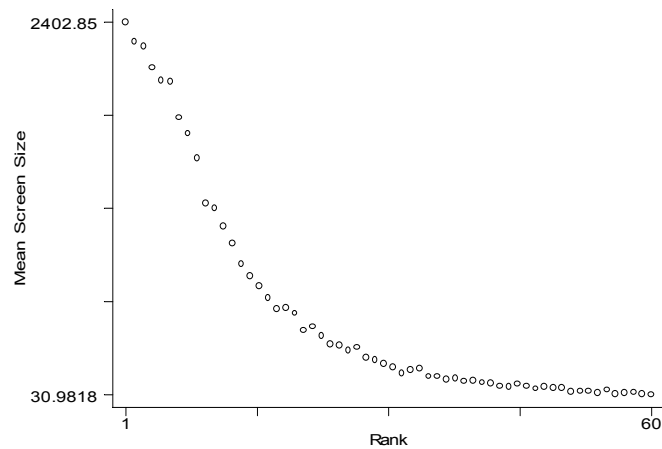


Figure 7: Mean Number of Screens vs. Rank

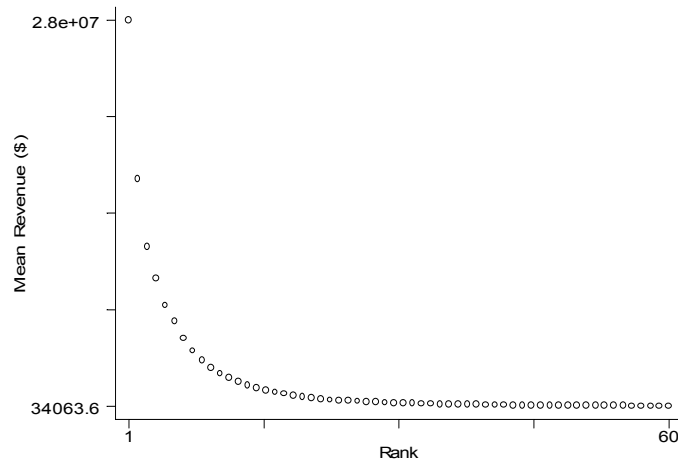


Figure 8: Mean Revenue vs. Rank

There is some persistence in the top ranks. Both *Independence Day* and *The Nutty Professor* occupied rank-1 and rank-2, respectively, for two weeks. However, such inertia is short-lived because new films enter at high frequency; five or six new movies enter the top-60 list every week³⁷. The longest duration of a movie and its distributor at rank-1 was four weeks (*Independence Day*).

The high turnover in firms that occupy the rank-1 and rank-2 positions and the brief occupancy in top rank indicate that competition between major distributors in the motion picture industry is very intense³⁸.

We can examine the turnover of distributors by computing the probability of a transition in rank. The probability that a distributor who is ranked number 1 will remain there or make a transition to rank 2, 3 and so on gives a measure of the stability of market shares among the top firms. We use the data to calculate the transition probabilities for 23 of the top distributors. We also calculate the probability of transitions in rank. To do this, we define a Rank = Zero to all ranks outside the top 23. This gives us 24 ranks in all. Hence the dimension of the rank transition matrix is 24x24 (including the Zero rank). In Table 6 we report the transition probabilities only among the top ten firms (the full matrix is available on request).

Table 5: Occupancy of Rank 1 & 2 by Major Distributors

(Numbers indicate rank; Boxes indicate newly released films)

Week	Fox	B.Vista	Para	Sony	Universal	Warner B.	Miramax	Newline
1			1			2		
2			1			2		
3		1	2					
4		2		1				
5		2				1		
6	1				2			
7	1				2			
8	1	2						
9	1	2						
10	2					1		
11	2					1		
12		1				2		
13		2				1		
14						2		1
15						2	1	
16					1	2		
17				1,2				
18			1					2
19			1	2				
20			1			2		
21			1					2
22			2			1		
23				2		1		
24	1					2		
25		1						
26		2				1		2
27			1			2		
28		1	2					
29		1			2			
30				1		2		
31			1	2				
32				2				1
33				1				2
34		2	1					
35		2		1				
36		1,2						
37	1			2				
38	1				2			
39	1			2				
40	1-new, 2							
41	1			2				
42		2	1					
43	1	2						
44					1	2		
45				2	1			
46			2		1			
47				1	2			
48				1	2			
49	1	2						
50			1					2
51				1		2		
52				1		2		
53					1	2		
54					1	2		
55		1			2			

Source: *Variety*, various issues, from 5/24/96 to 6/12/97

Table 6: Transition Matrix among Ranks

	1	2	3	4	5	6	7	8	9	10	Zero
1	0.4074	0.3519	0.2037	0.037	0	0	0	0	0	0	0
2	0.1667	0.2037	0.2778	0.2037	0.0926	0.037	0.0185	0	0	0	0
3	0.0556	0.0926	0.0741	0.3519	0.3519	0.037	0.037	0	0	0	0
4	0.1111	0.037	0.0741	0.2407	0.2037	0.2778	0.037	0.0185	0	0	0
5	0.0926	0.037	0.1667	0.0556	0.1481	0.2593	0.2037	0.037	0	0	0
6	0.0926	0.0741	0.0556	0.0556	0.1111	0.2222	0.2037	0.1667	0.0185	0	0
7	0.0185	0.0926	0.0926	0	0.0556	0.0741	0.2963	0.2222	0.0741	0.037	0
8	0.0556	0.0556	0.037	0	0	0.0185	0.1481	0.3148	0.1852	0.1481	0
9	0	0	0	0.0185	0	0.037	0.0185	0.0926	0.3148	0.2407	0.0185
10	0	0	0.0185	0.037	0	0.037	0	0.0741	0.2222	0.1852	0.0185
11	0	0.0185	0	0	0.0185	0	0	0	0	0.1852	0
12	0	0.0185	0	0	0.0185	0	0.0185	0	0.0926	0.0741	0
13	0	0.0185	0	0	0	0	0	0.037	0.0185	0.0556	0.0741
14	0	0	0	0	0	0	0	0.0185	0	0.0185	0.0185
15	0	0	0	0	0	0	0	0	0	0	0.0556
16	0	0	0	0	0	0	0	0	0	0.0192	0.1923
17	0	0	0	0	0	0	0	0	0	0	0.1875
18	0	0	0	0	0	0	0	0	0	0	0.5227
19	0	0	0	0	0	0	0	0	0	0	0.4483
20	0	0	0	0	0	0	0	0	0	0	0.5
21	0	0	0	0	0	0	0	0	0	0	0.2
22	0	0	0	0	0	0	0	0	0	0	1
23	0	0	0	0	0	0	0	0	0	0	1
Zero	0	0	0	0	0	0	0.0005	0.0005	0.0022	0.0011	0.9569

Reading across a row of the matrix, the entry in each cell is the probability that a distributor in a row-rank will make a transition to a column-rank. For example, the entries indicate that the probability a distributor that is ranked number one remains at rank 1 is 0.4074 and the probability of a move from rank 1 to rank 2 is 0.2037.

Several features of the transition matrix are of interest:

- (1) There is some persistence: the probability of remaining in a rank usually exceeds the probability of moving up or down in rank. This is evident by the fact that the probabilities in the on-diagonal cells exceed the probabilities in the off-diagonal cells. The highest probability of remaining in rank is at the rank Zero which corresponds to the state of being a distributor with no movie among the Top-60. A distributor who is in that position has a 0.95 probability of staying there. Nonetheless, there is no barrier to entering the Top 23 distributors as is shown by the positive transition probabilities along the Zero row. The highest rank to which a distributor off the list ascended was rank 7.
- (2) There is upward and downward mobility. A distributor as low as rank 8 can ascend to rank 1 in one week (with probability 0.056). A 2-ranked distributor can, with probability

0.167, ascend to rank 1. A distributor at rank 1 can descend to rank 2 (probability 0.35), to rank 3 (probability 0.204) and to rank 4 (probability 0.037). The lowest rank from which a distributor can move in one week from rank 1 is to rank 8.

- (3) The transition probabilities are higher for moving down (e.g. rank 1 to rank 2) than up (e.g. rank 2 to rank 1); this holds for all ranks, but especially for the higher ranks.
- (4) The probability of remaining off the top list, given that one is off the list is 0.9569.

STANDARD MODELS DO NOT APPLY TO MOTION PICTURES

Kwoka (1985) and Krouse (1998) point out that choosing a concentration index is equivalent to choosing the oligopoly theory that links concentration to market power³⁹. If the indices do not measure competition, then the conclusions of these models are flawed. But, the second issue is this. The very volatility that makes these indices fail to capture competition also requires the industry to organize in a fundamentally different way from what the oligopoly model assumes.

Supply and Pricing

First, it is important to recognize that, in the motion picture industry, supply is not static. Supply adapts to demand dynamically over time as moviegoers make their decisions based on a variety of information sources, both global (e.g. advertisement) and local (e.g. word-of-mouth)⁴⁰. Since the number of theater engagements and the length of the run are adjusted in response to demand, supply cannot be used strategically to affect the admission or rental price.

Second, the Cournot hypothesis that firms are able to make stable conjectures about the responses of their rivals to their supply decisions is implausible. Since demand is not known and the number of theater screens and the length of the run are adjusted as the film runs, supply is a dynamic and adaptive process. No firm is able to predict its market share and would not be able to perceive a change in its market share as originating from the actions of its rivals. The Cournot model assumes fixed demand that allows firms to decode changes in price or market share to read the actions of their rivals. None of this is true when demand is not known until the film is released and when demand is volatile. Motion picture distributors have only vague (and often unrealized) ideas about the level and elasticity of demand for their movies before they begin to play.

Third, the price-cost margin, which is the crucial element in the theory linking market power to concentration, is different in the motion picture industry. There are three “prices” in the industry and they are not determined by the studio/distributor---they adapt to demand and supply conditions. The first price is the exhibition ticket price that moviegoers pay. This price is set by the exhibitor and is usually constant during the run in order to mute an incentive problem and to preserve a pure demand signal⁴¹. The second price is the film rental rate that sets the payment from the theater to the distributor. The rental rate is a percentage royalty that applies to box office revenues. The rate is adjusted biweekly and is contingent on the state of demand. Hence, it too, is an adaptive form of pricing, the specifics of which are determined by the reaction of filmgoers to the movie. Thus the rental price is contractually delegated to the motion picture audience whose response to the film determines its rental rate and total rentals.

The rental rate increases when demand is high through a contingent pricing arrangement that requires the exhibitor to pay the higher of either⁴²,

- (a) a minimum percentage starting at 70% that declines biweekly to a minimum of 40% of box office revenue; or
- (b) 90 percent of box office revenue above a fixed amount known as the “house nut.”

Should demand be very high, this state will trigger the 90% rate. There may also be a guaranteed rental payment against which rentals accrue.

This means that the rental price adapts to demand *after* it is revealed as a film plays in the theater; it is not set before demand is revealed.

The third price is the price of the distributor’s services. The distribution fee is the negotiated percentage (commonly 30%) of gross film rentals⁴³. The distribution fee thus varies with the state of demand and high fees will be earned on highly successful movies. The rentals and distribution fees that a movie will earn are unknown until it plays to an audience and their demand for it is finally revealed. Hence, neither the producer nor the distributor can determine the price (distribution fee) of a motion picture before it plays. In effect, the pricing of distribution is delegated to the audience.

After a movie is released, the number of prints or copies is fixed and the opening distribution is made, so the marginal cost of accommodating higher demand is small. Essentially, the marginal cost of extending the run is the opportunity cost of the revenue foregone by the distributor and the theater on another film that could be playing on the same screen. Thus, a higher film rental implies an increase in the distributor price-cost margins. While this is true, it does not validate the Lerner Index as a measure of market power in the industry. The potential for a price increase is contracted *a priori* before the movie is released and whether it occurs or not depends on an unpredictable demand response. Hence, the rental price increases not because distributors have the market power to do so but because demand dynamics trigger the relevant pricing clause in the rental agreement.

Fourth, the application of the concept of conjectural variation to the motion picture industry runs into severe problems. The supply response of distributors and exhibitors occurs chiefly through length-of-run adjustments and this is determined adaptively in response to demand that is revealed during the run. At the time of release, the length of run of a film is unknown. Hence, distributors will not be able to form conjectures regarding how films from other distributors are affected by their own. The best they may be able to do is to try to move the opening date to avoid movies they fear will be “blockbusters” that might reduce the revenues of their own films. This is largely a guessing game because it is not impossible to predict which films will be blockbusters or how long competitive films will play or if other distributors will also change their opening dates.

THE PROBABILITY DISTRIBUTION OF THE HHI AND ITS EXPECTED VALUE

These key features, and the empirical evidence presented above, require a probabilistic approach to modeling motion picture demand and supply dynamics. Recognizing that a static and certain view of the industry is inappropriate requires one to treat the HHI for what it is--- a probabilistic measure rather than a static one. The expectation of the HHI is the more relevant measure than a static calculation of the HHI at a point in time or for a given number of firms.

The market share of firm i is its box office sales divided by total box office revenue. We now distinguish between sample market shares and theoretical market shares calculated from the statistical distribution. This is an important distinction because when the HHI is calculated it

is from a sample and this quantity is fixed in each sample. When shares are recognized as stochastic, the sample statistics are used to try to obtain the underlying probability distribution. So we can distinguish between a sample value and a theoretical parameter of the distribution. If one estimates the probability distribution of shares, then one can calculate each firm's expected market share from its probability distribution as

$$E[s] = \int_0^1 s P_i(\tau) d\tau \quad (6)$$

Where $P_i(\tau = s)$ is the probability a firm i realizes market share s . The expected square of market share is the second moment (variance) of market shares.

The sample HHI is the sum of squared market shares for a sample period for the industry. It is a little unclear whether the HHI for stochastic market structure should be defined as the sum of the expected market shares squared or the expectation of the sum of squared market shares. The latter is difficult to compute; the first is easy and seems to capture the essence of the HHI as an index of structure. The HHI, by this reckoning, is the sum over firms of their expected squared market shares, i.e. $E[\text{HHI}] = \sum E[s_i^2]$.

Research⁴⁴ has established that the probability distribution of box office revenues is a Pareto-Lévy distribution with finite mean but infinite variance. Given the parameters of this distribution, the mean exists (is finite), but the variance (second moment) does not (it is infinite). We show now that the infinite variance of box office revenues carries over also to market shares. That is, we show that the variance of market shares is infinite. This means that the HHI is infinite! The expectation of the HHI does not exist mathematically for movies. Nor does it in any industry where the distribution of (random) market shares is Pareto with a tail weight parameter (exponent) less than 2. Moreover, the sample HHI, whether calculated at a point in time or over a sample period, is an unstable estimate of its expected value.

The HHI value calculated from any sample may differ from the theoretical value of the parameter. When the distribution of shares is normal, the sample estimate of the variance converges to the true value when the size of the sample increases. But, that is not true when

the distribution of shares is a Pareto distribution. In this case, the HHI estimate is unstable and dependent on sample size. The HHI, therefore, cannot be estimated through the procedure of summing the squares of the market shares that is commonly used (because it yields unstable estimates that depend on sample size and the estimates cannot give the true value since it is infinite). This is the point Mandelbrot (1997, p.215) emphasized when he criticized the use of the HHI by arguing that the use of a sample second moment is questionable when the existence of the second moment is itself in doubt:

“This (Herfindahl) Index has no independent motivation, and we shall see that its behavior is very peculiar. It is odd that it should ever be mentioned in the literature, even solely to be criticized because it is an example of inconsiderate injection of a sample second moment in a context where even the existence of expectation is controversial.”

The HHI must be calculated via more sophisticated means that reflect the underlying volatility of the industry. One must use the probability distribution of market shares to correctly estimate the HHI. Following Mandelbrot, the preferred procedure is to estimate the **tail index α** of the probability distribution of box office revenues. Pareto-Lévy distributions have heavy tails that depart significantly from the normal distribution. The weight of the upper (or lower) tails is important because significantly higher probability is attached to the extremely high grossing movie in the Pareto distribution than in the normal distribution.

The tail weight can be estimated by estimating α in the following probability distribution:

$$P[X > x] \propto x^{-\alpha}, \text{ for } x > k \quad (7)$$

where x is the box office revenue, $P[X > x]$ is the probability that X exceeds x , and x is greater than some box office revenue k . The method of Mandelbrot is used to estimate the value of α . This involves a regression of the log of the survival probability $P[X > x]$ against the log of market share. When $\alpha < 2$, the expected HHI is infinite⁴⁵.

Performing this estimation with market shares shows the existence of a linear region in the upper tail of the distribution of market shares where it becomes Paretian. The estimated value of α for shares in the upper tail is larger than -2.00 (i.e. $|\alpha| < 2$) (see Table 7). The kernel density estimation shown in Figure 9 for all the data reveals the skew and long upper

tail of the distribution that are characteristic of Pareto-Levy distributions. Since market share is bounded above at 1, there is a bit of truncation in the upper tail due to this upper bound. Nonetheless, the mass at high market share values is enough to cause the integral in equation to fail to converge, implying an infinite variance and expected HHI.

Table 7: OLS Estimates of Alpha (α), 1990-1995

	1990	1991	1992	1993	1994	1995
α	-0.62 (0.18)	-0.52 (0.17)	-2.16 (1.57)	-0.40 (0.12)	-0.42 (0.13)	-0.47 (0.12)
R-Square	0.60	0.53	0.19	0.57	0.59	0.64
N / M	10/55	10/63	10/62	10/71	10/67	10/77

Notes: standard errors are in parentheses
 N = number of tail observations
 M = sample size (total number of distributors)

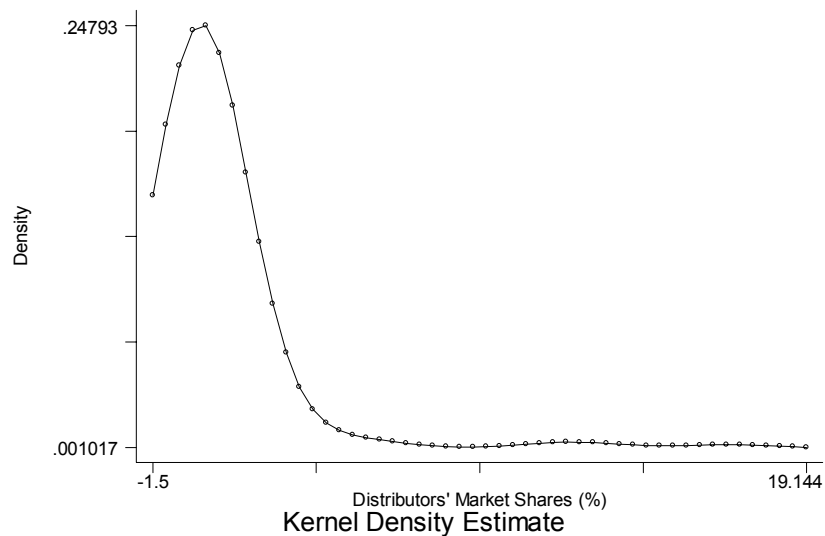


Figure 9: Kernel Density Estimate for Distributors' Market Shares

The evidence indicates that the second moment of the probability distribution of motion picture distributor market shares is infinite. We have done this estimation in the manner of an HHI investigation; that is, we have used the annual shares of the distributors to estimate the probability distribution of market shares. Using annual shares masks the underlying volatility in the weekly market shares.

The volatile nature of the motion picture industry is connected to the non-Gaussian form of the distribution of revenues and market shares. Unevenness in market shares is the consequence of a complex demand process that produces large variations in film revenues; in this business, averages depend on extremes. This means that a snap shot picture of market shares will show high concentration even though there is competition among films. In other words, it is large variations in the demand for the products of firms that produce the high concentration one finds in motion pictures. And that variation is the consequence of a vital competitive tournament among films in which the top finishers capture the biggest box office prizes.

The calculated values of the HHI will depend on the sample period and its size and will be unstable. The sample variance will depend on the size of the sample and the period of observation; the larger the sample, the larger will be the sample variance. The theoretical variance (not the sample variance) is infinite. When the expectation is finite but the theoretical variance is infinite, the HHI (a sample statistic) tends to 0 as the number of firms goes to infinity⁴⁶. Antitrust policy ought not to be so vulnerable to the discretion of the statistician or the availability of data.

CONCLUSIONS

This study shows that Concentration Ratio and the Herfindahl-Hirschman indices do not accurately reflect competition in the motion picture industry. In motion pictures both the CR and the HHI exhibit large fluctuations. The HHI is less stable than the CR because the movies is a business where extreme events drive the statistics and the HHI heavily weights extreme events (large deviations in market shares). Even though a distributor may at times gain a large market share, these episodes are temporary and the wide fluctuations are evidence of that a Pareto-Lévy process is at work in which demand takes large leaps among films and their distributors. The identities of first and second-ranked films and their distributors on *Variety's* top-60 list change almost weekly.

The structure that captures these properties is a stochastic one; the process that governs the rank-swapping among the market-leaders and the volatility of market shares is the stable Pareto-Lévy motion. In this process, changes in market shares are driven by the way audiences respond to films and have little to do with the number of films produced and

released by studios. Changes in market shares occur on a scale or magnitude that corresponds to a power $\Delta t^{1/(\alpha-1)}$ of the interval over which the observations are made (McCulloch, 1978). This means that some decreases may be so large that the bottom may appear to fall out for an individual firm. Or it may experience such a large positive increment that it may appear to be in a rapid expansion. But, these surges and falls are fully consistent with the Pareto-Lévy motion; dramatic changes just "happen" and do not signal a trend or structural change.

The assumptions underlying the HHI and CR indices are inconsistent with the characteristics of the movie industry: both indices are volatile and annual averages mask the extreme competition for the motion picture audience. The identity of the top firms changes almost weekly and the probability distribution of revenues has an infinite variance.

Because movie revenues vary in the extreme, there is no typical movie or typical market share. The use of an average of market shares is misleading because there is no stable average to which shares converge. And the average is uninformative because variance about it is infinite.

We have shown that, in a volatile industry, a static HHI is theoretically unjustified. In order to give the proper weight to variation in revenues, the HHI must be defined as the sum of the expectation of squared market share. The evidence shows that the second moment of the distribution of market shares may not exist, which implies that the expectation of the HHI may not exist. The theory of concentration and market power fails completely in this case.

The static, one-stage Cournot model often used to justify a connection between concentration indices and market power is inconsistent with the adaptive and dynamical pricing practiced in the motion picture industry. Ranges of film rental rates are contracted a priori but the actual rental rate and total rentals paid are determined by demand. Through sophisticated contracts with demand-dependent pricing clauses, studio distributors actually delegate the pricing (rentals) of their movies to the audience and they are strategically and contractually incapable of making conjectures about how the supply of another firm may affect their ability to alter prices. When the length of a movie's run, its rental price, and its audience are unknown until

a movie is released and the audience reacts, notions of conjectural variation go out the window.

More importantly, in a probabilistic model of box office revenues and market shares---the only class of models capable of fitting the motion picture industry (and many other industries) where it is known that the probability distributions of revenues are of the Pareto-Lévy kind---the HHI cannot be justified. Its sample value is non-stationary and its expected value may be infinite! None of the theoretical models of collusive price making are well defined when the HHI is infinite---they imply that each firm will choose an infinite price!

In the potential for abuse in the application of concentration indices to antitrust, the motion picture industry may not be rare. The size distribution of firms in many industries is known to be a Pareto distribution⁴⁷. Not all industries exhibit the exceptional volatility of motion pictures, but on closer examination, they are likely to show enough variation for our criticisms to apply. The customary practice of calculating the HHI index at a point in time and for a whole year masks the underlying volatility of market shares and the turnover of the leading firms. We conclude that the HHI is an invalid measure of competitiveness for any volatile industry, that it is usually incorrectly calculated, and that theoretical models of pricing that are based on it are deeply flawed.

Notes

- 1 Lerner (1934).
- 2 See Tirole (1988, p.66, pp.218-219).
- 3 See Saving (1970) and Curry and George (1983).
- 4 Marginal cost is assumed to be identical for all firms in the dominant group. See Martin (1993).
- 5 Martin (1993, pp.166-167 and pp.169-170). The model can be extended for case of differentiated products. In this case, market power would be affected by the degree of product differentiation in addition to conjectured reactions of rivals, price elasticity of demand and market share.
- 6 U.S. Department of Justice and Federal Trade Commission (1997). Other factors could mitigate dominant firms' ability to coordinate include high degree of product differentiation and easy entry conditions.
- 7 U.S. Department of Justice (1968). Reprinted as Appendix A in Williamson (1995). Originally formulated to bring some predictability to firms contemplating a merger, the Guidelines have now assumed a status far beyond that.
- 8 U.S. Department of Justice (1968, p.15).
- 9 U.S. Department of Justice and Federal Trade Commission (1997, p.2).
- 10 U.S. Department of Justice and Federal Trade Commission (1997, p.4).
- 11 U.S. Department of Justice and Federal Trade Commission (1997, p.15).
- 12 The other variable considered to be important is the ease of entry. See Salop (1987). According to Lawrence J. White, one of the principal authors of the 1982 Merger Guidelines (a predecessor of the HMG), the DOJ looks at market concentration before entry barriers because of the practical ease of measuring market shares compared to entry barriers. See White (1987, p.17).
- 13 Schmalensee (1987).
- 14 Salop (1987, p.10).
- 15 Fisher (1987, p.30-31).
- 16 United States v. Paramount Pictures, Inc., 85F.Supp.881, 894 (S.D.N.Y. 1949). See Conant (1960, p.44-45) and De Vany and Eckert (1991, p.90). During the 1943-1944 season, the eight defendants had received 95 percent of domestic film rentals (Westerns excluded).
- 17 De Vany and Eckert (1991, p.75).
- 18 Vogel (1998, p.55). The film industry includes made for television movies.
- 19 Seagrave (1997, pp.287-288).
- 20 Vogel (1998, p.81). According to the 1992 U.S. Census Data, there were some 22,401 screens in motion picture theaters in 1992.
- 21 Recall that the original distributors-defendants were: Loews, Paramount, RKO, 20th Century Fox, Warner Brothers, Columbia, Universal and United Artists. Loews and United Artists are now part of MGM while Columbia is now part of Sony Pictures. The new entry into this upper echelon is the Disney-owned Buena Vista.
- 22 Note that in the Paramount case, concentration was also measured in terms of the number of films produced and distributed. For example see United States v. Paramount Pictures, Inc., 66F.Supp. 323, 894 (S.D.N.Y. 1946). See Conant (1960, p.36). Another case which looked at market share in terms of features distributions is United States vs. Loew's Inc. See Conant (1960, p.45). This approach is questionable because releasing a large number of films does not necessarily translate into greater box office success.
- 23 Values of CR5 and CR8 for 1943-44 are computed from United States vs. Loew's Inc., 334 U.S.131. Final Finding of Fact 100, February 8, 1950. See Conant (1960, Table 13, p.46).
- 24 United States v. Paramount Pictures, Inc., 85F.Supp.881, 894 (S.D.N.Y. 1949).
- 25 U.S. Department of Justice and Federal Trade Commission (1997, p.15).
- 26 These additional factors relate to the presence/absence of conditions conducive to collusion, entry-exit conditions, and efficiency gains from merger. See U.S. Department of Justice and Federal Trade Commission (1997, pp.18-34).
- 27 U.S. Department of Justice and Federal Trade Commission (1997, p.16).
- 28 U.S. Department of Justice and Federal Trade Commission (1997, p.16, fn.18).
- 29 U.S. Department of Justice and Federal Trade Commission (1997, p.19): "It is likely that market conditions are conducive to coordinated interaction when the firms in the market previously have engaged in express collusion and when the salient characteristics of the market have not changed appreciably since the most recent such incident."
- 30 See for example Scherer and Ross (1990). This is also explicitly acknowledged in U.S. Department of Justice and Federal Trade Commission (1997).
- 31 Litman (1998, p.23).

- 32 We use the CR6 because the market shares of the top-six distributors appear to be roughly equal and larger than other firms.
- 33 The correlation between the HHI and CR6 is significantly lower than those reported for some manufacturing industries (larger than 0.9). See Scherer and Ross (1990). Our results support Hausé's (1977, p.75) finding that concentration indices are not highly correlated especially at high levels of concentration.
- 34 Note that a comparison between Figure 1 and Figure 2 indicates that there are many instances where both concentration indices move in different directions. For example, the HHI declined between week 3 to week 4, and between week 5 and week 6. During the same two periods, the CR6 increased. This could happen if the increase in the market shares of the top six distributors is accompanied by increases in market shares of some lower ranked distributors.
- 35 De Vany and Walls (1997). Alternatively, we can regress $\text{Log}(\text{revenues})$ against $\text{Log}(\text{rank})$ or $\text{Log}(\text{revenues})$ against $\text{Log}(\text{rank})$ and $[\text{Log}(\text{rank})]^2$ to take into account concavity of the relationship between $\text{Log}(\text{revenues})$ and $\text{Log}(\text{rank})$.
- 36 This was carried out by De Vany and Walls (1996) and subsequently replicated by Lee (1997). The regression results from both papers confirm a downward concavity relationship between $\text{Log}(\text{revenues})$ and $\text{Log}(\text{rank})$.
- 37 The probability distribution of new entrants (births) and of exits (deaths) is a Poisson distribution, which implies that births and deaths are unpredictable. See De Vany and Walls (1996, p.15).
- 38 We can extend this to include more ranks, for example, rank-1, rank-2 and rank-3. The conclusions we can draw are essentially the same. However, as we include more ranks, each distributor will likely to have more films in a given week. Clearly, a more sophisticated model would be one in which distributors maintain a portfolio of films.
- 39 See Kwoka (1985) and Krouse (1998).
- 40 Global transmission of information affects all agents simultaneously while local information is transmitted locally from one agent to other neighboring agents (e.g. network of immediate friends).
- 41 De Vany and Eckert (1991, p.110).
- 42 De Vany and Eckert (1991, p.102, fn.16).
- 43 See Cones (1997, p.31-32).
- 44 De Vany and Walls (1996, 1999), Lee (1999), and De Vany and Lee (2001).
- 45 When $\alpha < 2$, the second moment, $\text{Var}(x) = \int x^2 f(x) dx = \int x^2 x^{-\alpha} dx$, does not converge as $x \rightarrow \infty$.
- 46 Mandelbrot (1997), at 216.
- 47 For example, see Axtell (1999).

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