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# Entropy and Popular Culture: Product Diversity in the Popular Music Recording Industry

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## Introduction

Sociologists Peterson and Berger (1975; henceforth P&B) have argued that increasing market concentration leads to a decrease in the diversity of products offered by the music recording industry. P&B's influential paper has been cited by other sociologists, as well as by some economists, as evidence of one consequence of increased industrial market concentration (e.g., see Rothenbuhler and Dimmick, 1982; Anderson et. al. 1980). In fact, Peterson and Berger's work was mentioned by Douglas Greer, an expert witness in Federal Trade Commission *v.* Warner Communications Inc. (1984, U.S. District Court, Central District, CA), as evidence that a proposed merger between Warner and Polygram would have deleterious effects on consumer welfare because the merger would result in higher industry concentration and hence less product diversity.

I develop a new measure of product diversity and use it to present evidence that contradicts one of P&B's primary results. According to P&B, market concentration affects the diversity of products offered in a linear fashion: The more concentrated the industry, the less the diversity of product. My findings suggest that *both* low and high levels of market concentration are associated with decreased product diversity, and that maximum diversity results from a moderately concentrated market structure.

## MEASURING CONCENTRATION IN THE MUSIC RECORDING INDUSTRY

P&B measure market share from 1948 through 1973 using four- and eight-firm concentration ratios, based on the percentage of weekly Top 10 Hits distributed across firms. My method for compiling share figures is the same for 1948 to 1954, but I examine the 1955 to 1988 interval using the Top 40 Hits as published by Billboard Magazine (and its related publications, such as *The Billboard Book of Top 40 Hits*, [Whitburn, 1989]).

The simple correlation for the years 1948 to 1973 between P&B's and my four-firm concentration ratio is .97, while the eight-firm correlation is .97. I also compared my data on market share to Greer's. Greer was an expert witness in Federal Trade Commission v. Warner Communications, Inc. (1984, U.S. District

Court, Central District, CA) and had access to confidential industry sources of market-share data. The simple correlation between Greer's market-share data and my own for the years 1970 to 1983 (the only years reported by Greer) is .95. These correlations suggest that my method for compiling market share figures is robust.

## ENTROPY AS A MEASURE OF DIVERSITY IN THE MUSIC RECORDING INDUSTRY

P&B measure product diversity by counting in each year the number of different Top 10 hit songs in Billboard's weekly charts. Although they mention other sources and techniques for measurement (e.g., analysis of song lyrics), their method is essentially a counting (or turnover) technique. I suggest that this technique is largely inadequate, and is probably a misleading measure of product diversity because the hit charts can have many songs of a similar product type, or conversely, they may have a small number of more disparate products (i.e., fewer hits but greater product diversity).

I propose that more robust measures for evaluating product diversity are feasible and that an *entropy index* is one such measure. Entropy is intimately connected to thermodynamics, statistical mechanics, and information theory. Entropy can be thought of as measuring the degree of randomness or chaos within a closed system. In the present context, entropy measures the degree of uniformity in the characteristics of products of the popular music recording industry.[1] My measure is based on the analysis of sheet music (from the Top 40 in each year), which is in essence a blueprint of the recorded product. Sheet music can be decomposed into discrete categories; the categories I explore are time and meter, form, accent, harmonic structure, and melody.[2]

In each decomposition, a qualitative metric (0,1) was used. If the *time and meter* was 4/4 (or 2/2), that variable was assigned a value of 0; any other time and meter was assigned a value of 1. If the traditional, popular ABACB *form* was used, the form variable was assigned a 0; for all other forms, the variable was assigned a value of 1. If the *accent* fell on the first and third beats, the variable was assigned a value of 0; if the accent fell on the second and fourth beats, the variable was assigned a value of 1. If the *harmonic structure* followed the "classical" Western framework delineated by Rameau (1722), the variable was assigned a value of 0. All other harmonic structures were assigned a value of 1. Finally, if the *melody* was confined to

[1] One simple measure of entropy is given by $-\Sigma\Sigma p_{ij}\ln p_{ij}$. That is, entropy (roughly, the degree of sameness) is the sum of the product of the probabilities and the natural logarithm of the probabilities that a product type exists.
[2] Ph.D. musicologists helped develop this framework

one octave, the variable was assigned a value of 0; if the melody extended over more than one octave, the variable was assigned a value of 1.

This framework provided a set of *n*-characteristics (time and meter, form, accent, harmonic structure, and melody) measured in *m*-dimensions (0 or 1). The (random) probability that any product-type or variety exists is equal to $1/m^n$, or in the present case, $1/(2)^5$ or 1/32.

Each piece of sheet music in the sample of 30 annual observations encompassing the years from 1955 to 1988 was decomposed into its constituent elements (e.g., time and meter, form, etc.) and entered into a matrix.[3] The matrix for each year has a 5 by 32 dimension because there are 5 variables and 32 possible combinations of these variables. From the matrix, the number of observations in each of the 32 categories was computed and converted to a percentage of the total. Next, the natural logarithm of the percentage was computed and then multiplied by the original percentage. The sum of the product of the percentages and the natural logarithms of the percentages was then computed, yielding a single value for the product diversity of the sample in that year.

The visual result of this technique is shown in Figure 1, along with four- and eight-firm concentration ratios for the years 1955 to 1988. Note that the highest score entropy can take on is 0, indicating the complete absence of product diversity; as entropy becomes more negative, product diversity *increases*.

Several features of Figure 1 are particularly salient. First, during the early years of the so-called "rock revolution" (roughly, 1955 to 1966), the top hit records were relatively homogeneous when compared to those of the years 1967 to 1977, when concentration in the industry was higher. This result contradicts P&B's finding that increased concentration per se results in less product diversity, and that the rock revolution was characterized by relatively high levels of product diversity. On the other hand, for the period 1971 to 1988, diversity decreases while concentration increases. The relationship between market structure and product diversity is apparently nonlinear.

Regression analysis supports this finding. I regressed the entropy measure of diversity against the four-firm concentration ratio using a nonlinear (quadratic) specification. The nonlinear specification was also tested using the Herfindahl-Hirschman Index (the sum of the squared market shares) to determine if the outcome is sensitive to the choice of market structure specification. The results, reported in Table 1, show statistically significant squared terms, and thus support the hypothesis

[3]An abundant supply of sheet music covering the Top 100 hit songs is available for the years 1955 to 1988. Although this supply probably does not cover *every* song that was produced during the period, it does include those that were *popular (*and *profitable*).

of a nonlinear relationship between market structure and product diversity (columms 1 and 2). I then regressed the entropy measure of diversity on the four-firm concentration ratio and the Herfindahl-Hirschman Index as simple linear functions (columms 3 and 4). The results in Table 1 do not support a linear specification.

I then regressed P&B's primary measure of diversity, the number of records making the Top 10 weekly charts, against the four-firm concentration ratio for the period from 1948 to 1973. The results are reported in columm 5 of Table 1. A nonlinear (quadratic) specification of P&B's data is also reported in columm 6 of Table 1. This nonlinear specification is not supported using their "count" measure of diversity. I believe that P&B's "count" measure of diversity may relate linearly to concentration simply because (increasing) concentration reduces the total number of records released (rather than the musical diversity of those released).[4] Note also that P&B's results "flunk" the Granger-Newbold (1974) test. Given the arguable superiority of my entropy measure, I conclude that diversity is nonlinearly related to concentration.

## Conclusions

My findings suggest a nonlinear relationship between market concentration and product diversity in the music recording industry, and imply that product diversity is maximized when the industry is moderately concentrated. Thus, when industry concentration is very high or very low, product diversity is reduced.

These results may have important implications for antitrust policy. If moderate levels of concentration maximize product diversity in the music recording industry, and if product diversity is an important component of consumer welfare, then intervention by the government to induce a more competitive market structure may be counterproductive. However, given the very high concentration that currently exists in the music recording industry (six large international firms account for nearly 98 percent of the output), perhaps a review is in order. On this point, I concur with Peterson and Berger.

Finally, I believe the entropy technique is robust and would be useful in other areas of research, particularly in other culture-based industries (e.g., book publishing, motion pictures). However, some products (or some aspects of products) resist quantification, and therefore informal techniques may continue to be appropriate.

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[4] See notes (a) and (b) above. Black and Greer (1987) and Alexander (1994) derive models in which the number of new releases in the music recording industry decrease as industry concentration increases. Given the (counting) measure P&B use, a statistically significant linear relationship would be expected, *ex ante*, between concentration and the number of hits (assuming a monotonic relationship between the number of releases and the number of hits).

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Table 1: Linear and Nonlinear Specifications

| | (1) | (2) | (3) | (4) | (5) (**a**) | (6) (**b**) |
|---|---|---|---|---|---|---|
| Dependent Variable | Entropy | Entropy | Entropy | Entropy | Top Ten, P&B | Top Ten, P&B |
| Constant | -1.03<br>(-3.18) | -1.69<br>(-10.43) | -2.14<br>(-18.64) | -2.11<br>(-27.48) | 44.4<br>(11.23) | 51.3<br>(3.69) |
| CR4 | -0.430<br>(-3.37) | | 0.00284<br>(1.35) | | -0.342<br>(-4.46) | -0.634<br>(-1.13) |
| CR4 Squared | 0.00042<br>(3.63) | | | | | .00264<br>(0.52) |
| HHI | | -8.57<br>(-2.50) | | 1.17<br>(1.68) | | |
| HHI Squared | | 42.8<br>(2.88) | | | | |
| Form | Nonlinear | Nonlinear | Linear | Linear | Linear | Nonlinear |
| Adj. $R^2$ | 29.4% | 22.9% | 2.5% | 5.3% | 47.4% | 45.6 |
| DW | 2.01 | 1.95 | 1.25 | 1.30 | 2.30 | 2.32 |

**Notes:**

(**a**) Original regression corrected for autocorrelation (Durbin-Watson: 0.63) using the Theil-Nagar modified d statistic. The original adjusted $R^2$ was .71%. Granger and Newbold (1974) have suggested that an *$R^2 > d$ is a good rule of thumb to suspect that the estimated regression suffers from spurious regression.*

(**b**) Original regression corrected for autocorrelation (Durbin-Watson: 0.64) using the Theil-Nagar modified d statistic. The original adjusted $R^2$ was .70%. Again, we find the original $R^2 > d$ (see note (a) above).

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