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The Dispersion of Price Movements

The Unique Price, as we observed, is a myth. Differences among prices paid or received are almost universal. They arise for good cost reasons: economies of lot size, differences in quality tolerances. They arise also, at times, because of systematic price discrimination. They arise because it is uneconomic—still another cost basis—to collect full, continuous information on prices.

For at least some, and possibly all, of these reasons the relative movements of prices paid or received do not march together with fixed cadence. The individual price relatives which constitute a price index almost invariably display some dispersion. This dispersion can arise from differences in timing of purchases or sales, as well.[1] An annual average of the standard deviations of these monthly movements is reported with each of our price series in Appendix C. The average value of this standard deviation for ammonia, for example, is 1.145: with a normal distribution some two-thirds of the individual ammonia prices change each month by the average amount of the change in the index (.403 per cent in absolute value) ± 1.145 per cent. Measures of the dispersion of price movements are the subject of the present chapter.

THE DETERMINANTS OF DISPERSION

If there were a unique price, there would be a unique price change from one date to the next. The converse is less simple. It would be

[1] For example, if a seller raises his price 5 per cent on January 1 but an irregular buyer does not purchase again until March, almost any interpolation or linking procedure will give a different time profile to seller's than to buyer's price.

possible that there was no dispersion of movement even with dispersion of prices, at a given time, because the differentials due to transportation costs, quality, lot size, etc., were stable. The dispersion in prices due to incomplete knowledge, however, would lead to dispersion of price movements. If seller A has a price 3 per cent higher than B today, and yet makes sales because of incomplete price search by buyers, it is unlikely that A and B will change prices simultaneously and in identical proportion, and impossible if *they* have incomplete knowledge of all prices. Hence the theory of information, which is concerned with dispersion of prices, is also relevant to the dispersion of price movements. We now adapt it to this end.

The buyer who seeks the best price and supplier at time t will also seek the best price at time $(t+1)$. He will search the market—the potential suppliers—until the marginal gain from further search is no larger than the cost. Since the cost of search is much the same for a large buyer and a small buyer, we expect the larger buyer to search more intensively; therefore obtaining a lower price. We also expect the price movements of large buyers to have less dispersion than those of small buyers.[2]

The dispersion of prices is probably also a function of the number of sellers. The reason one must say "probably" is that the intractable problem of oligopoly appears. As the number of sellers increases from one to many, one expects the probability of independent price behavior by the several sellers to rise—and in good part precisely because it becomes more expensive to police any agreements on price.

The dispersion of prices is also dependent upon the rate of change of prices in the market. If "the" conditions of supply and demand were

[2] In period 1 let the prices asked by sellers be uniformly distributed between 0 and 1, so after n searches a buyer on average encounters a minimum price of $1/(n+1)$, with variance $n/(n+1)^2(n+2)$. (For a derivation, see G. Stigler, *The Organization of Industry*, Homewood, Ill., 1968, pp. 173–74.)

In period 2 let the distribution of asking prices shift upward by k, so the mean rises by k and the variance is unchanged. The mean price change is k, and the variance of the price change is

$$\sigma^2_{P_{t+1}-P_t} = \frac{2n}{(n+1)^2(n+2)}.$$

The variance of the price change is smaller, the larger n (the number of price searches made by a buyer); and n is larger, the larger the buyer. If the prices at the two dates are correlated, as usually they will be, the variance of the price change is smaller the larger the correlation between prices at the two dates.

to remain the same forever, buyers would gradually learn of the existence of lower prices (and sellers, of higher prices) and shift to the lower price sellers (and sellers to higher price buyers) until dispersion was eliminated. Changes in supply and demand conditions not only prevent this asymptotic approach to complete knowledge but also reduce the rewards from intensive search in any period.

Some Empirical Investigations

For any one commodity, we expect the standard deviation of individual price changes about the mean (index) change ($\sigma_{\Delta p}$) to be larger, the larger the fluctuations in the (mean) price in the market. This effect should be the same with both price increases and price decreases, so we take the standard deviation of the index of prices σ_p as our measure of price change. We accordingly fit to each industry's semiannual data an equation,

$$\sigma_{\Delta p} = a + b\sigma_p,$$

with the expectation that b is positive. The standard deviations pertain to the same period, e.g., $\sigma_{\Delta p}$ is based upon the six changes (from December 1964) in the first six months of 1965 and σ_p is based upon the fluctuations of the index during these six months.

The results strongly support the expectation: without exception the regression coefficients for the seventy commodities are positive. Moreover, the regression coefficients are, in general, highly significant: sixty of the seventy t-ratios are in excess of two, and forty are in excess of four.[3] The elasticity of the variance of price relatives with respect to the variance of the price index is usually between .3 and .8.

We also investigate the comparative dispersion of price relatives in different industries. It is then possible to introduce the average concentration ratio (C) for producers of the commodity and the number of price reporters (N). This latter variable is positively, but probably loosely, related to the number of buyers of a commodity because we collected our data by presenting the same commodity list to each company when requesting data. Here the regression equation takes the form

$$\sigma_{\Delta p} = a + b\sigma_p + cC + dN$$

Here we expect that $b > 0$, $c < 0$, $d > 0$.

[3] Most of the products with low t-ratios have only a small number of price series.

The regression equation derived from the data for all seventy products is:

$$\sigma_{\Delta p} = \underset{(.203)}{.620} + \underset{(.073)}{.432}\,\sigma_p - \underset{(.0028)}{.0062}\,C + \underset{(.0041)}{.018}\,N,$$

$$R^2 = .404 \qquad df = 66$$

where the standard errors are given in parentheses under the regression coefficients. The results are gratifyingly kind to our expectations:

(1) The larger the fluctuations in the rate of change of a price index, the larger the dispersion of the rates of change of the individual price series (where the latter variable is an average of 119 monthly measures). The fluctuations of average prices serve to render obsolete the knowledge of prices in the market, and hence to lead to price dispersion.

(2) The dispersion of price series is smaller, the higher the concentration ratio for sellers (where C is the share in total sales of the four largest producers in 1958). High concentration implies fewer sellers, and a lesser task of obtaining information on market prices.

(3) The dispersion is greater, the larger the number of price series (measured at February 1962). The strength of the relationship is a little surprising. The number of price series in our sample is no doubt positively correlated with the true number of buyers, but this correlation may not be large. Still, the larger the number of buyers, the larger is the informational problem in the market. The argument is symmetrical for buyers and sellers.

When the standard deviation of prices ($\sigma_{\Delta p}$) and of price index changes (σ_p) are measured over each year, and the various years are treated as dummy variables, the regression coefficients are virtually the same as in the equation above. There is a modest tendency for the variance of prices to rise over the early years of the period, but this probably reflects the rising number of price series available in these years.[4]

[4] The equation, with the T's representing dummy variables for the years denoted by subscripts, becomes:

$$\sigma_{\Delta p} = \underset{(.026)}{.488}\,\sigma_p - \underset{(.0013)}{.0048}\,C + \underset{(.0018)}{.0162}\,N + \underset{(.116)}{.399}\,T_{1957} + \underset{(.115)}{.499}\,T_{1958}$$

$$+ \underset{(.114)}{.478}\,T_{1959} + \underset{(.114)}{.573}\,T_{1960} + \underset{(.113)}{.611}\,T_{1961} + \underset{(.112)}{.734}\,T_{1962}$$

$$+ \underset{(.113)}{.762}\,T_{1963} + \underset{(.113)}{.757}\,T_{1964} + \underset{(.112)}{.765}\,T_{1965} + \underset{(.113)}{.659}\,T_{1966}$$

$$R^2 = .390$$

TABLE 7-1

The Effect of Antitrust Complaints Upon the Level of Prices

Commodity	Date of Complaint or Indictment	Average Price: 3 Months after Complaint [a]		Average Price: 9 Months after Complaint [a]	
		Direct	Adjusted [b]	Direct	Adjusted [b]
Carbon steel sheet	7/64	100.00	100.04	99.73	99.72
Aluminum conductor cable	10/62	96.92	98.88	88.55	91.93
Gasoline (mid-Atlantic)	4/65	100.38	100.50	98.79	99.12
Rubber belting	3/59	100.05	99.64	100.69	99.42
Chlorine	12/64	96.77	96.79	95.42	95.96
Soda ash	12/64	100.00	99.95	100.00	100.57
Tetracycline	8/61	95.90	n.a.	91.70	n.a.
Terramycin	8/61	93.23	n.a.	89.26	n.a.
Meprobamate	1/60	94.73	n.a.	96.15	n.a.

[a] The average price for same number of months preceding the date of complaint = 100.
[b] Adjusted prices are deflated by prices of other commodities of the same general category.
n.a. = data not available for adjustment.

PRICE BEHAVIOR AND ANTITRUST CASES

Although our choice of commodities for the present study was wholly unrelated to the problem of monopoly, it happens that nine of our commodities were involved in antitrust cases with convictions for price-fixing during the period of our study.[5] These cases are listed in Appendix E, and the commodities are given in Table 7-1. The cases are dated in the month when the complaint or indictment was filed.

We are obviously unequipped to discuss the economic merits of these cases, but we can assess the effects of bringing the cases on the level and the variance of prices. Does the bringing of the case lead to a reduction of prices? Two answers are given in Table 7-1. One is based upon the mean price index in the three and nine months preceding the

[5] There were also a few cases involving mergers (Section 7, Clayton Act) but they do not raise any conventional questions about price behavior. We also omit price-fixing cases involving a *regional* offense where we do not have data for a regional price index.

date of the charge (complaint or indictment) and the mean price in the succeeding three and nine months. A second answer is obtained if the pre- and post-complaint prices are adjusted for movements of similar commodities not involved in the case (using the price index of the other commodities of the same general category).

The only commodities whose prices fell appreciably after a case was brought were the pharmaceutical drugs (in this area we had no satisfactory comparable products whose prices might be used to adjust for changes in general market conditions) and aluminum cable. Perhaps even this degree of impact is all one can expect. Antitrust cases pay much more attention to attempts to collude than to success in raising prices.

The variance of movements of prices paid by buyers can be measured in the behavior of both the price index and the individual buyers' prices. For the price index, we compare the variance of the price index in the nine months preceding and succeeding the beginning of the complaint, corresponding to the longer period in which the level of the index has been studied. The variance of the price relatives of the individual buyers' prices is also calculated for nine month periods. We would expect both

TABLE 7-2

The Effects of Antitrust Complaints upon the Variance of Price Index and of Individual Buyer's Prices

	Variance of Price Index		Variance of Individual Buyer's Prices	
	9 Months		9 Months	
Commodity	Before	After	Before	After
Carbon steel sheet	.156	.301	.135	1.656
Aluminum conductor cable	23.325	9.610	5.420	6.966
Gasoline (mid-Atlantic)	1.590	.208	8.938	.384
Rubber belting	.113	.430	.093	.193
Caustic soda	.760	.313	3.107	2.588
Chlorine	.292	.975	1.912	2.532
Tetracycline	16.073	24.663	7.563	15.074
Terramycin	26.586	3.535	16.479	18.622
Meprobamate	2.446	.604	.677	.857

these variances to increase substantially after a complaint is brought if there had been collusion and if it was weakened or terminated when the complaint was brought.[6] The results are given in Table 7-2.

The results are thoroughly puzzling. In four cases (gasoline, aluminum cable, terramycin, and meprobamate) there were large *declines* in the variance of the price index over time after the case was brought; and in one case, tetracycline, a large increase. The variances of individual price relatives in the indexes were slightly more in keeping with our expectations. Only one variance, gasoline, fell appreciably and several rose modestly. The antitrust history appears to shed little light upon price behavior in our sample.

[6] See G. Stigler, "A Theory of Oligopoly", *Journal of Political Economy*, February 1964, pp. 44–61.