Volume Title: The Behavior of Prices

Volume Author/Editor: Frederick C. Mills

Volume Publisher: NBER

Volume ISBN: 0-87014-010-8

Volume URL: http://www.nber.org/books/mill27-1

Publication Date: 1927

Chapter Title: Relations among Measures of Price Instability

Chapter Author: Frederick C. Mills

Chapter URL: http://www.nber.org/chapters/c5333

Chapter pages in book: (p. 355 - 364)

typic area. Under other conditions we may find them equally distorted in the direction of negative skewness. The liability of such data to material changes from year to year in their group attributes is a fact of considerable economic importance.

Since frequency distributions of price relatives are subject to marked changes in type, the problem of sampling is a particularly difficult one. During years in which the universe of price relatives is distributed in accordance with the normal law, or years in which their distribution follows any fairly stable frequency type, successive samples may be expected to possess common group attributes, and to yield statistical constants differing but slightly in value from sample to sample. In other years, when the sample distributions fall within the heterotypic area, the evidence suggests that the universe of price relatives is highly unstable. In such cases there can be no assurance that successive samples would possess common group attributes, or that statistical constants derived from the higher moments would approach each other closely in value, when computed from different samples.[1]

VII Relations Among Measures of Price Instability

The various quantities described in the preceding pages have been presented as measures of different kinds of price instability. It remains to determine whether there are any consistent relationships among these measures. Some attention has been given in an earlier section to one phase of this question, the relation between changes in the price level and variations in the degree of dispersion of price relatives. Our present problem is the broader one of measuring relationships among all the measures relating to price stability, whether it be stability of the price level, stability of internal relations, or stability of distributions of price relatives in combination.

In the following tables certain of the results previously discussed are summarized, with additional measures relating to other

[1]The statistical constants commonly employed in studying price movements (the mean and the standard deviation) involve only the first and second moments. These are stable over a wider range than are the higher moments from which the criteria of curve type are derived, and are not subject to the same wide sampling fluctuations. Note should be made, however, of the limited validity of the first two moments for distributions of the J-type which have been found to occur occasionally among price relatives. (Cf. R. A. Fisher "On the Mathematical Foundation of Theoretical Statistics," *Phil. Trans. of the Royal Society of London*, Vol. 222, pp. 338-355.)

factors than dispersion. The price indexes and the indexes of dispersion which are employed in the four tables immediately following have been computed from weighted logarithms of link relatives. In computing the coefficients in Table 114 the sign of the change in the price level has been retained.

TABLE 114

CORRELATION COEFFICIENTS MEASURING THE RELATIONS BETWEEN CHANGES IN THE PRICE LEVEL AND OTHER GROUP MOVEMENTS OF PRICES

(1) Series correlated with percentage change in price level from year to year	(2) Period covered	(3) No. of observations	(4) Coefficient of correlation
Index of dispersion	1891–1926	36	+.02
Index of displacement (year-to-year displacement, fixed base relatives)	1893–1926	34	+.10
Criterion κ_1 (wtd. logarithms of link relatives)	1891–1926	36	—.07
Variability of prices, monthly data	1891–1925	35	+.37

These measures give no evidence of any relation between the dispersion of link relatives and changes in the price level, when account is taken of the direction of the change in prices, nor of any relation between the year-to-year displacement of fixed base relatives and changes in the price level. The criterion κ_1, which measures degree of departure from the stable Type III distribution, shows no significant relation to changes in the price level. The highest coefficient of correlation is that measuring the relation between the measures of monthly variability and the index of changes in the level of wholesale prices.

In computing the above measures account was taken of the direction of change in the price level. Employing measures of the degree of change, without sign, the results in Table 115 are secured.

We have here a distinctly higher set of coefficients than in the preceding table. The coefficient which measures the relations between price dispersion and changes in the price level is changed from +.02 to +.61 when the direction of change in the price level is ignored.[1] There appears to be, also, some relation between the degree of change in the price level and the amount of price displace-

[1]See, however, the note on p. 364.

TABLE 115

CORRELATION COEFFICIENTS MEASURING THE RELATIONS BETWEEN CHANGES IN THE PRICE LEVEL (WITHOUT SIGN) AND OTHER GROUP MOVEMENTS OF PRICES

(1) Series correlated with percentage change in price level from year to year (without regard to sign)	(2) Period covered	(3) No. of observations	(4) Coefficient of correlation
Index of dispersion	1891–1926	36	+.61
Index of displacement (year-to-year displacement, fixed base relatives)	1893–1926	34	+.42
Criterion κ_1 (wtd. logarithms of link relatives)	1891–1926	36	—.21
Variability of prices, monthly data	1891–1925	35	+.69

ment, but the coefficient (+.42, based on 34 observations) is too low to indicate that price level changes are a material factor in causing price displacement. The criterion κ_1 shows a slight negative correlation with the index of price level changes, but the coefficient is not significant.

The above measures show a significant relationship between changes from year to year in the mean variability of individual commodity prices (measures of variability being computed from monthly prices) and corresponding changes in the level of wholesale prices. In securing this result account has been taken of those changes which occurred between 1915 and 1921, as well as of changes during earlier and later years. The coefficient is lowered materially if the study is restricted to pre-war years. Changes in the degree of variability of the prices of individual commodities seem to be closely associated with changes in the price level only during times of relatively violent change in the general level of prices. At a later point further reference is made to this subject.[1]

When the index of dispersion is correlated with the various other measures discussed we have the results given in Table 116.

The positive correlation between dispersion and displacement is to be expected. The sort of disturbance which produces a wide scatter of prices tends, also, to cause a shifting of price relations. If we accept κ_1 as a significant measure of group stability we may conclude, from this evidence, that the degree of price disper-

[1]See pp. 374-376 and the footnote on p. 364.

TABLE 116

CORRELATION COEFFICIENTS MEASURING THE RELATIONS BETWEEN PRICE DISPERSION AND OTHER GROUP MOVEMENTS OF PRICES

(1) Series correlated with index of dispersion	(2) Period covered	(3) No. of observations	(4) Coefficient of correlation
Percentage change in price level (without regard to sign)	1891–1926	36	+.61
Index of displacement (year-to-year displacement, fixed base relatives)	1893–1926	34	+.63
Criterion κ_1 (wtd. logarithms of link relatives)	1891–1926	36	—.14
Variability of prices, monthly data	1891–1925	35	+.78

sion has no bearing upon group stability. The correlation between the measures of monthly variability and the index of dispersion is relatively high. The years which are marked by wide dispersion are characterized by a considerable movement of individual commodity prices within the year, a correspondence which is to be expected.

In the next table are summarized the results secured when the index of displacement is correlated with various other measures.

TABLE 117

CORRELATION COEFFICIENTS MEASURING THE RELATIONS BETWEEN PRICE DISPLACEMENT AND OTHER GROUP MOVEMENTS OF PRICES

(1) Series correlated with index of displacement (measuring the shifting from year to year of fixed base relatives)	(2) Period covered	(3) No. of observations	(4) Coefficient of correlation
Percentage change in price level (without regard to sign)	1893–1926	34	+.42
Index of dispersion	1893–1926	34	+.63
Criterion κ_1 (unwtd. fixed base relatives)	1893–1926	34	+.67
Variability of prices, monthly data	1893–1925	33	+.58

Certain of the above relations have already been commented upon. Some degree of correlation exists between the shifting of fixed base relatives and the instability of the distributions composed of such relatives, when instability is measured by κ_1. There is a

suggestion here that the sort of disturbance which is reflected in a high value of the index of displacement tends to produce unstable frequency distributions. A relation such as that found between displacement of prices and monthly variability is to be expected, since a considerable movement of individual prices would tend to increase the degree of displacement.

The preceding discussion has been concerned with annual measures only. For the years 1920 to 1926 we have a set of monthly measures of price level movements, of dispersion, and of displacement. These measures, which represent changes over a twelve-month period, are shown in graphic form in Figures 34 and 41. It is apparent from an inspection of these graphs that there has been no consistent relationship between changes in the price level and changes in dispersion or displacement, if account be taken of the direction of change in the general price index. There appears to have been a negative relationship during the period of violent price change in 1920 and 1921, and a positive relation in subsequent years. Accordingly, in testing these relationships, the percentage change in the price level has been used without sign.

TABLE 118

CORRELATION COEFFICIENTS MEASURING THE RELATIONS AMONG MONTHLY MEASURES OF THE GROUP MOVEMENTS OF PRICES

(1) Series correlated	(2) No. of observations	(3) Coefficient of correlation
Percentage change in price level, without sign, and index of dispersion, both computed from twelve-month link relatives for the period 1920-1926	84	+.80
Percentage change in price level, without sign, computed from twelve-month link relatives, and index of displacement of fixed base relatives over twelve-month period, for years 1920-1926	84	+.73
Index of dispersion, twelve-month link relatives, and index of displacement of fixed base relatives over twelve-month period, for years 1920-1926	84	+.95

The above coefficients give evidence of the same relationships as were found in studying the various measures of year-to-year change, the only difference being that the relations among the monthly measures appear to be closer.

Because of the intercorrelation between indexes of price level changes, dispersion, and displacement, it is desirable to compute

coefficients measuring the net or partial correlation between these variables. Annual measures have been employed in the first calculations. The variables, with the symbols representing them, are the following:

x_1: Percentage change in price level, from year to year, as computed from weighted logarithms of link relatives. (This variable measures the degree of change, without regard to sign.)

x_2: Index of price dispersion, computed from weighted logarithms of link relatives.

x_3: Index of price displacement, measuring the shifting of fixed base relatives from year to year.

All measures are for the period 1893-1926. The simple and net coefficients are given below. Some of the zero order coefficients differ slightly from those in the preceding section, because the period covered is slightly shorter in the present case.

$r_{12} = +.63$ $\quad$ $r_{12.3} = +.52$

$r_{13} = +.42$ $\quad$ $r_{13.2} = +.04$

$r_{23} = +.63$ $\quad$ $r_{23.1} = +.51$

These figures show an appreciable degree of net correlation between changes in the price level (without regard to sign) and price dispersion, and approximately the same degree of correlation between the dispersion of prices and the displacement of prices. There appears to be no relationship between changes in the price level and the displacement of prices. The apparent relationship shown by the simple coefficient of correlation is due to the intercorrelation of the variables being studied. Changes in the price level do not tend to increase or decrease the degree of price shifting, except indirectly through the effect of such changes upon the degree of dispersion.

A measure of the multiple correlation between price level changes, on the one hand, and price dispersion and displacement on the other, possesses significance. For this we have:

$$R_{1.23} = .63$$

This coefficient measures the relationship between two types of price instability, instability of the price level and internal instability.[1] In combining x_2 and x_3, as we do in computing the coefficient

[1]It appears, from the coefficients of net correlation, that the influence of changes in the price level upon degree of price displacement is felt only through the medium of dis-

of multiple correlation, we treat the factors of dispersion and displacement as a composite unit. This composite constitutes the best available measure of disturbances in the relations among commodity prices, disturbances due either to changes in relative position or to alterations in the established margins which separate individual commodity prices. For convenience we may represent by the symbol w the composite variable which measures internal disturbances, and by z the variable which measures changes in the level of wholesale prices. As a measure of correlation we have, then:

$$r_{wz} = .63$$

This coefficient throws some light on the following question: Assuming that the relationship measured by this coefficient is a causal one,[2] to what extent would the violence of internal price disturbances be lessened if the price level could be stabilized? The coefficient of determination may be derived from r. In the present case we have:

$$d_{wz} = r^2_{wz} = .40$$

We may interpret this coefficient in the following fashion: If we assume a causal connection between a dependent and an independent variable, and if we measure variability in terms of the standard deviation squared, the coefficient of determination is a measure of the percentage of variability in the dependent variable which is attributable to the independent variable. The correlation of $+.63$ between w and z means, on the assumption of a causal connection between the two, that 40 per cent of the variability of w (the dependent variable) is attributable to z.[3]

In the present case this interpretation of the results throws some light on questions of considerable importance. Granting that w, the composite index of dispersion and displacement, truly reflects those internal disturbances which upset business and distort eco-

persion. Yet I think it desirable to carry forward the discussion in terms of the multiple coefficient, though it is in this case identical with the simple coefficient which measures the relation between price level and dispersion changes. Internal changes in business relations result both from dispersion and displacement, and the two in combination constitute the most appropriate measure of business disturbance.

[2]Stated values of the coefficient of correlation do not, of course, warrant the assumption of a causal relationship between variable quantities. There is probably, in the present case, some justification for assuming a causal connection between external and internal instability, between changes in the price level, as cause, and disturbances of internal relations, as effect.

[3]The *remaining variability* of w is 60 per cent of the original variability, as measured in terms of the standard deviation squared. If there were a single other factor, y, which accounted in full for this remaining variability, the value of d_{wy} would be .60, and the value of r_{wy} would be $+.77$.

The coefficient of determination is discussed in the footnote on pp. 147-148.

nomic relations, the coefficient of +.63, measuring the relatio between changes in the general level of prices and this index c internal disturbance, indicates that changes in the level of price are responsible only in part for internal instability. Assuming tha the relationship is causal, the internal disturbances would be re duced by about 40 per cent if the price level were stabilized. Ap proximately 60 per cent of the dispersion and displacement c prices must be attributed to the play of other forces.

This conclusion, of course, applies only to wholesale prices The broader question of the effect of stabilization of the price leve upon other price relations lies outside the present discussion. An within the field of wholesale prices it is presented with the qualifi cations and limitations suggested above.

The monthly measures of change in the price level, in pric dispersion and in price displacement, covering the years 1920 t 1926, may be treated in a similar fashion. Following are the varia bles and the corresponding symbols:

x_1: Percentage change in price level over twelve-month in terval, without sign.

x_2: Index of dispersion computed from twelve-month link relatives.

x_3: Index of displacement over twelve-month interval, com puted from 1913 base relatives.

The simple and partial coefficients of correlation are:

$r_{12} = +.80$ $\quad$ $r_{12.3} = +.53$

$r_{13} = +.73$ $\quad$ $r_{13.2} = -.19$

$r_{23} = +.95$ $\quad$ $r_{23.1} = +.89$

These measures confirm the conclusions based upon the annua measures of price changes. There is a significant relationship though not an extremely close relationship, between the degree o change in the price level (without sign) and the degree of disper sion. The net relation between these variables, on the monthly basis, is almost identical with that found in the study of annua measures ($r_{12.3} = +.53$ for the twelve-month links, +.52 for th annual links). Changes in the price level are not related to th shifting or displacement of prices except through the effect of pric level changes upon dispersion. There is a close positive correlatio between the degree of dispersion of twelve-month link relative and the displacement, over the same twelve-month interval, c

fixed base relatives. This latter relationship is materially higher than that found to prevail between the annual measures of dispersion and displacement ($r_{23.1} = +.89$, as compared with $+.51$ for the annual measures).

As in handling annual data, we may consider the coefficient of multiple correlation, $R_{1.23}$, to be equivalent to a simple coefficient, r_{wz}, where w represents a composite measure of internal disturbance, due both to the dispersion and the displacement of price relatives, and z represents changes in the general price level. We have

$$R_{1.23} = r_{wz} = .81$$

For the coefficient of determination we have

$$d_{wz} = r^2_{wz} = .66$$

We may interpret this in the following fashion: On the assumption of a causal connection between changes in the level of prices and internal disturbance of price relations, we may say that during the seven year period from 1920 to 1926, 66 per cent of the internal disturbance in price relations was due to changes in the price level. Thirty four per cent of the internal disturbance was due to other causes.

These last results differ somewhat from those secured in the study of annual data. The coefficient of determination which, on the assumptions made, measures the percentage of internal disturbance which may be attributed to price level changes, had a value of 40 per cent, when annual measures over the period 1893-1926 were employed. The higher value of the coefficient based on monthly values between 1920 and 1926 is, perhaps, attributable to the fact that the latter period includes a time of violent change in the price level. There is reason to believe that during such a period there is a closer relation between external changes and internal disturbance than there is during more stable times.

Both results lead to the same general conclusions: There is a significant relation between changes in the level of prices and internal disturbance in wholesale price relations. There is a tendency for the degree of internal disturbance to vary with changes in the price level, the internal disturbance being greater the greater the degree of change in the price level. It is the amount of change in the price level, not the direction of change, which is significant. If we may assume that the connection between these variables is a causal one, internal disturbance being influenced by external changes

in the price level, the results indicate that the relationship is one of partial dependence only. The samples here studied indicate that from 34 to 60 per cent of the internal disturbance in price relationships is apparently due to other factors. There is some indication that the proportion of the internal disturbance which is attributable to price level changes tends to become greater during periods of violent change in the purchasing power of the dollar.[1]

VIII Summary

1. The investigation of the behavior of price relatives in combination has been approached as a study of price instability. Three types of instability have been distinguished and corresponding measures have been employed.

In measuring *instability of the price level* index numbers of the usual type have been used.

In measuring *internal instability*, arising from alterations in the relations among the prices of different commodities, use has been made of indexes of price dispersion and of price displacement. The dispersion of prices results from the varying movements of indi-

[1]The above conclusions are to be interpreted in terms of the particular measures of internal disturbance which have been employed and with reference to the methods used in measuring the relations among the several variables. The price dispersion which has been measured is that of link relatives, while the index of displacement is derived from fixed base relatives. The conclusions are valid to the extent that these two measures reflect internal disturbances in the relations among different elements in the business system. It is quite possible that more satisfactory indexes of changes in price relations may be developed. In any case it is desirable that the conclusions be tested when broader data or better measures are available.

Although it seems desirable to put the conclusions in the definite form employed in the text, the impression of accuracy which such figures give is misleading. It is misleading partly because of the relative smallness of the sample; more important, I think, is the probability that the relations in question vary from period to period. It appears, from a study of the results in detail, that the degree of relationship between changes in the price level and changes in dispersion and displacement is far from constant, and that the differences between periods are even greater than those which the two sets of results given above would indicate. During periods of extreme disturbance those monetary and credit changes which are reflected in changing price levels are of dominant importance in determining the degree of internal instability. If the study were restricted to monthly data drawn from such a period (say the period from 1915 through 1921) one might expect an even closer relationship than that found for the period 1920 to 1926. During periods marked by only minor changes in the price level a very much lower degree of relationship between external and internal changes would be expected. At such times those specific price-making forces which affect the prices of individual commodities are vastly more important in causing shifts in internal relations than are the general factors which touch individual prices only through changes in the purchasing power of the monetary unit. For this reason, the coefficients of correlation and of determination derived from annual data for the period 1891-1926 are probably too low if relations between external and internal changes during periods of extreme price disturbance are in question, too high if interest attaches to the same relations during periods marked by minor changes in the level of prices.