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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-

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[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.

vidual commodity prices between given dates. The index of dispersion of which chief use has been made in the present investigation has been derived from the standard deviation of logarithms of price relatives. The dispersion both of fixed base and link relatives has been measured. Price displacement, which reflects a second type of internal instability, results from the shifting of the relative positions of commodity prices. The index of price displacement is derived from the coefficient of rank correlation.

The third type of price instability is a group attribute. In studying it we deal with the entire population of prices as an organic entity. The investigation of this type of instability deals with questions of homogeneity, and with the character of the forces which bring about particular types of distributions. In the description of groups the criteria of distribution types developed by Karl Pearson have been employed. Accepting the Gaussian (normal) distribution and distributions of Type III in Pearson's classification as stable types, the degree of departure of various price distributions from these types has been measured. Changes from year to year in the characteristics of frequency distributions of price relatives have been followed. Distributions of fixed base and link relatives, of unweighted and weighted relatives, and of relatives in natural and in logarithmic form have been contrasted in respect to their basic characteristics.

2. In connection with the measurement of changes in the level of wholesale prices a number of measures of the sampling reliability of different types of index numbers have been computed. Among the facts revealed by these measures of reliability are the following:

a. When about 200 commodity price series are used and when there is an approximately normal degree of dispersion of wholesale prices, the standard errors of unweighted arithmetic and geometric means of link relatives average slightly less than one per cent of their respective means.

b. The sampling errors of averages computed from fixed base relatives increase sharply during the first several years after the base year, but thereafter the change in the sampling error is slight. With about 200 commodity price series, and in the absence of extreme dispersion, the standard errors of unweighted arithmetic and geometric means of fixed base relatives amount to about 1.8 per

cent of their respective means when the base of the relatives is ten years removed.

c. Except during periods of extreme price disturbance the sampling errors of arithmetic and geometric means are about equal. In periods of disturbance the arithmetic mean is subject to much greater sampling errors.

d. The use of weights adds to the sampling errors of index numbers. The standard errors of weighted averages, as estimated in the present study, are from one-half to two-thirds again as large as the standard errors of corresponding unweighted averages.

3. The dispersion of price relatives on a fixed base tends to increase as the base year becomes further removed, but under ordinary circumstances this increase is at a decreasing rate after the sharp initial increase during the several years immediately following the base year.

4. During the years from 1891 to 1913 the movement of the index of dispersion computed from link relatives was gradually downward. This tends to substantiate other evidence that during the several decades prior to the war the price system was becoming somewhat more stable.

5. The index of dispersion computed from link relatives registered higher values during the years 1916-1923 than in any previous year since 1890. The maximum degree of internal disturbance, as measured by this index, was experienced in the price movements between 1920 and 1921. By 1924 the index had declined to a level which approximated pre-war standards.

6. There has been found no tendency for the dispersion of price relatives to increase with rising prices and to decline with falling prices. There is, however, a relation between the degree of dispersion and the degree of change in the price level. The dispersion tends to increase the greater the disturbance of the price level, whether prices be rising or falling.

7. In measuring price displacement during the war and post-war years three different sets of price relations have been used as standards, or criteria.

a. The first of these is based upon the ranking in 1914 of relatives on the 1913 base. This ranking defines a set of

price relations which is the result of economic changes during but a single year. This set of relations was almost completely destroyed as the result of developments between 1914 and 1916. By 1918 not a vestige of it remained. In 1925 and 1926 there was a slight swing back toward the relations defined by this criterion.

b. The second criterion of pre-war price relations is furnished by the ranking in 1914 of relatives on the 1891 base. This ranking reflects a firmly established set of price relations, since it represents the net effect of economic changes over a period of 23 years. As is to be expected, the index of displacement with reference to this criterion shows much less radical shifts during the war and post-war years. There were fundamental alterations in these relations, but in its main outlines this system survived the war. Maximum displacement was recorded in 1923. The three succeeding years brought a distinct swing back toward pre-war relations.

c. In securing a third criterion, which would represent a fairly well-founded set of pre-war price relations, but one which did not depend upon prices so far removed as those of 1891, relatives on the 1909 base were computed. The values of these relatives, for individual commodities, were averaged for the years 1911-1914, and the ranking of these averages furnished the desired standard. The set of relations thus defined was profoundly modified by the changes of the war period, but was not destroyed. The degree of change was greater than the change in the set of relations based upon 1891 relatives, and less than the change in the set of relations based upon 1913 relatives. It is noteworthy that there is a close correspondence between the year-to-year changes in the three indexes of displacement described above. All agree in showing some movement back toward pre-war price relations during the years from 1924 to 1926.

8. A study of the frequency distributions of price relatives, and of the changes from year to year in such distributions yields information concerning the forces affecting the general system of prices. A condition of stable equilibrium is attained, and stable distribution types appear, when the causal factors are independent of each other and when there are so many forces in operation that

no one force exerts a preponderant influence. This stability is generated by the balance of forces affecting the prices of individual commodities.

The general analysis leads to the following conclusions:

a. Distributions of price relatives are of an erratic and extremely unstable character. They do not conform to any one ideal frequency type, although Type IV of Pearson's classification predominates.

b. The conditions which give rise to the normal distribution are seldom realized in the distribution of price relatives. Of 190 distributions analyzed in detail only 18 could be classed as conforming to the normal type, even when generous allowance is made for errors of sampling.

c. There is some improvement in stability of distribution type and in the efficiency of the orthodox descriptive measures when logarithms of price relatives are used, in place of relatives in natural form, when weights are employed, and when link relatives rather than fixed base relatives are combined.

9. The year-to-year changes in the form of distributions of price relatives reflect disturbances in the equilibrium of the price system which are due to variations in business conditions.

a. Distributions of fixed base relatives pass through a series of swings away from and back to a symmetrical form. Sharp rises and declines in prices, such as those which occurred in 1893, 1895 and 1916 distort these distributions and carry them far from the Gaussian type. These deviations may be in the direction of positive or negative skewness. Swings away from symmetry during periods of disturbance are followed by clear movements back toward a stable, symmetrical type of distribution, which approaches in several instances the Gaussian type. A striking example of the re-attainment of group stability after a severe disturbance is found in the changes in the characteristics of distributions of fixed base relatives between 1916 and 1923.

b. Somewhat similar departures from and returns to a symmetrical type are observable in the year-to-year changes in the distributions of link relatives, but the conditions under which the stable types emerge are not the same as those

under which stability of fixed base relatives is attained. In general, departures from symmetry in the direction of positive skewness are found in the years during which business activity is steadily increasing, with few conflicting movements. Swings in the direction of negative skewness come in years of recession or of depression. Symmetrical distributions appear to be characteristic of years during which there are reversals of business and price trends.

10. An attempt has been made to measure the relationship between instability of the price level and internal instability, the latter being measured by the indexes of dispersion and displacement, in combination. There has been found a tendency for the degree of internal disturbance to vary with changes in the price level, the internal disturbance being greater the greater the change in the price level. (It is the degree of change in the price level, not the direction of change, which appears to be related to internal disturbances.) If we assume that the causal relationship runs from changes in the price level to variations in the degree of internal disturbance, the evidence of the present study indicates that, during the years 1893-1926, approximately 40 per cent of the internal instability of wholesale prices could be attributed to fluctuations in the wholesale price level. The remaining 60 per cent may, on this evidence, be attributed to other causes which would, presumably, continue to operate if there were no changes in the level of prices.

The proportion of internal instability attributable to changes in the level of wholesale prices was somewhat greater, as measured by monthly indexes, during the years 1920-1926. Again assuming a causal connection, there is evidence that during this period some 66 per cent of the internal disturbance of price relations was due to changes in the price level. There is a suggestion here that during a period of violent change in the price level there is a closer relation between external changes and internal disturbance than there is during more settled times.