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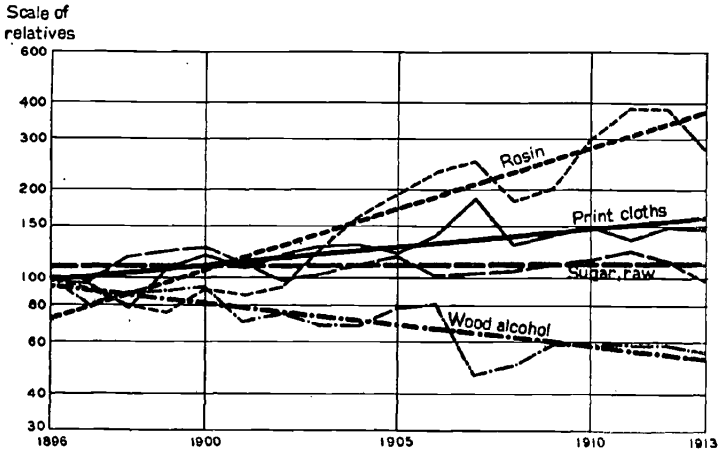
III Trends of Commodity Prices

If the prices of a number of commodities be plotted over a period of years, there will be observed notable differences between the rates at which the respective series have been increasing or decreasing. While the general price level may be moving upward at a fairly constant rate, as it was from 1896 to 1913, there will not be uniformity in the movements of individual commodities. Some will be moving at a higher rate than the general index, some at a lower rate, while some may be moving downward. The nature of these differences is graphically illustrated in Figure 5, showing the movements of the prices of four commodities during the period 1896-1913. (The prices have been reduced to relatives on the 1896 base, in order that the series might be comparable.)[1]

FIGURE 5

RELATIVE PRICES OF FOUR COMMODITIES, AT WHOLESALE, 1896-1913, WITH LINES OF TREND.*

(1896=100)



*Sugar, raw: $y=109.3\ (1.0006)^x$
Print cloths: $y=98.6\ (1.0285)^x$
Rosin: $y=71.5\ (1.1019)^x$
Wood alcohol: $y=94.4\ (.9663)^x$
(origin: 1896)

[1]The 1913 relatives of these four commodities, taking the 1896 prices as 100, are as follows:

Wood alcohol	56.3
Raw sugar	96.7
Print cloths	146.2
Rosin	276.2

Such differences in trend as are revealed in the above graph are of considerable economic significance. They result, presumably, from differences in extractive or manufacturing conditions, or from differences in demand. They represent shifting economic relations, changes in the relative position of different groups of producers. Those commodities and commodity groups which are increasing in price at a greater average rate than the general index are increasing in purchasing power in the wholesale markets; those which are increasing at a lower rate are declining in purchasing power. (The reference is, of course, to the purchasing power per unit of each commodity.) Such long-term shifts in relationship may be accurately traced if comparable measures of trend may be secured.

1. The Measurement of Price Trends

If a great many commodity price series be studied it will be noted that most series are marked by fairly constant rates of change during the years from 1896 to 1913. The era of falling prices culminating in the middle '90's marks one limit to this period, while the price revolution of 1915-1921 sets another limit. The intervening period was an era of well-sustained growth in American industry generally, though it was broken by one major and several minor recessions. The long-term shifts in the relations between different commodities and commodity groups which took place during this period therefore possess great economic interest. They represent changes due to the action of the general forces which were shaping our economic development during this stage of industrial and commercial expansion. The broader economic reasons for studying the changes which were taking place during these years are, fortunately, supported by the practical consideration that the trends of most price series during this period may be measured without resorting to complex functions.

A suitable measure of the rate of increase of a series which is subject to irregular fluctuations but which is changing at a constant rate may be obtained by fitting a curve of the type $y = ar^x$. This is a curve which appears as a straight line on ratio paper. It is a great advantage of this exponential curve that the constant r has a simple and immediate significance for the present purpose. The value of r is the ratio which the trend or computed price for each year bears to the trend price of the year preceding. Thus if r has a value of 1.06, it means that the trend price for each year exceeds the trend price of the year preceding by 6 per cent. In other words, the

average annual rate of increase of the series in question has been 6 per cent, when all fluctuations are smoothed out and the underlying trend alone is considered. Because of its simplicity of interpretation and because the exponential curve gives, in general, a good fit to most price series for the years 1896-1913, this measure has been used throughout the present study in measuring rates of change.[1]

The average annual rates of change in price during the years 1896-1913 are given in Table IX, for all the commodities studied. The measures for a selected list of commodities appear in column (3) of the following table. For the purpose of comparison similar measures relating to certain series of general interest are included in the table.

TABLE 14

AVERAGE ANNUAL RATES OF CHANGE IN PRICES AND PURCHASING POWER OF SELECTED COMMODITIES, AT WHOLESALE, AND IN SEVEN GENERAL ECONOMIC SERIES 1896-1913

(1) Ref. No.	(2) Commodity	(3) Rate of change in price 1896–1913 percent	(4) Rate of change in purchasing power 1896–1913 percent
149	Sugar, raw	.2	—2.1
239	Coke	.5	—1.8
280	Steel rails	.9	—1.4
259	Pig iron	1.0	—1.3
293	Copper, ingot	1.0	—1.3
276	Steel billets	1.1	—1.2
120	Flour, wheat	1.8	— .5
441	Leather	1.9	— .4
236	Bituminous coal	2.1	— .2
233	Anthracite coal	2.3	— .1
451	Rubber	2.3	— .05
6	Wheat	2.6	.2
202	Cotton yarns	2.6	.2
64	Beef	2.6	.3
195	Print cloths	2.8	.5
13	Cattle	3.1	.8
247	Petroleum	3.5	1.1
25	Cotton	3.9	1.5
51	Potatoes	4.3	1.9
	Interest rate on call loans	— .2	
	Yield on fifteen railroad bonds	— .1	
	Discount rate on 60-90 day commercial paper	.7	
	Population of the United States	1.9	
	Index of wholesale commodity prices (U. S. B. of L. S.)	2.3	
	Index of industrial stock prices (Dow-Jones)*	3.4	
	Pig iron production	6.4	

*The corresponding value for Macaulay's index of railroad stock prices is 4.9.

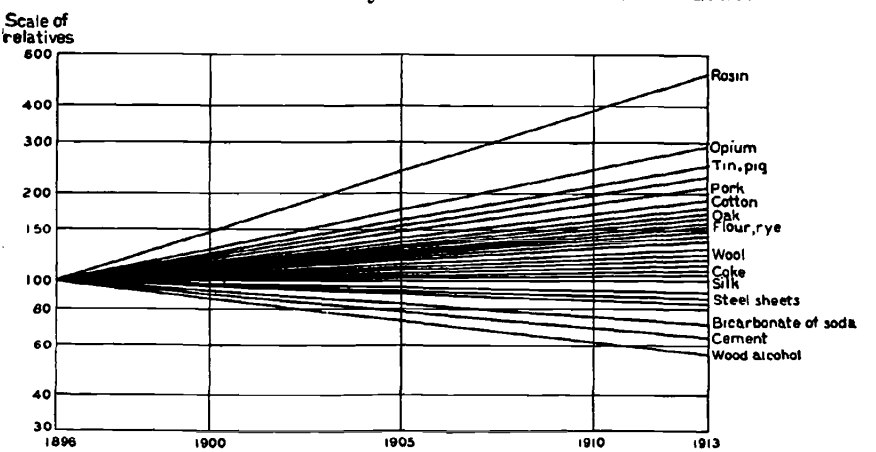
[1]The value of r has been determined, in each case, by the use of the mean value table constructed by Glover (see Glover's *Tables of Applied Mathematics*, Ann Arbor,

A graphic portrayal of the differing trends is afforded by Figure 6, on which are plotted the trend lines of a group of commodities. (Lines for other commodities are omitted, in order not to complicate the diagram.) Only the slopes of these lines, it should be observed, are significant. They are represented as branching from a common base in 1896, but that is merely to facilitate comparison. The impression which this chart conveys is of a multitude of price series rising or falling over a period of years at varying rates. The graph furnishes a true conception of the long-term shifts in price relations which reflect changes in economic processes and in general economic relations.

FIGURE 6

ILLUSTRATING THE DIVERSITY OF TRENDS IN WHOLESALE COMMODITY PRICES.

Lines of Trend Measuring the Average Annual Rates of Change in Individual Commodity Prices between 1896 and 1913.



Michigan, George Wahr, 1923, p. 468). In addition to the great advantages of simplicity which this method possesses, it avoids distortions which result from fitting to the logarithms by the method of least squares. This latter procedure gives a line from which the sum of the squares of the logarithmic deviations is a minimum, a condition which lends greater weight to the lower values than would the least squares method if it could be applied to the natural numbers. With price series of the type dealt with here this is undesirable. Glover's method gives a more reasonable fit for the present purpose.

In some cases the straight line on ratio paper does not give as good a fit as would some other function. Even in these cases it has been employed as a measure of the average annual change during the period in question, and the r derived from the fitting process has been compared with and combined with similar figures for other price series. If our present purpose were the measurement of cyclical and accidental deviations from trend this procedure would not be justified in such cases, but the immediate object is something quite different. During the period covered (1896-1913) general commodity prices were following a course which could be very accurately represented by a simple exponential curve. This represents the combined influence of all the constituent series. Even though the constituent series did not in all cases follow the same type of trend, it seems justifiable to evaluate their general change during this period in terms of such a trend.

The rates for all commodities are plotted in Figure 7 in a form convenient for the comparison of individual commodities. Here they are grouped according to the Bureau of Labor Statistics classification, the commodities in each group being ranked in the order of magnitude of their rates of change. Measures have been computed for 223 commodities in all. The pronounced differences between these measures indicate the degree of change which was taking place in the relative positions of different commodities. The greatest rate of increase in price during the period 1896-1913 was registered by rosin, which rose at an average annual rate of 10.2 per cent.[1] Next below rosin stood opium, with a rate of 6.5 per cent. At the other extreme were wood alcohol, with a rate of —3.4 per cent per year, and quinine, —3.1 per cent. Detailed comment upon other individual figures is unnecessary at this point. In the second volume of this study outstanding differences between groups will be discussed in some detail.[2]

2. The Measurement of Trends in Purchasing Power

If interest attaches to the relations between commodities, rather than to the absolute rates of increase or decrease in given prices during this period, the figures given in column (3) of Table 14 must be interpreted in their relation to the average annual rate of increase in the index number for all commodities during this period. For it is not the absolute rate of increase which is important, from the point of view of those interested in a particular commodity, but whether the commodity in question is increasing in price more

[1]The significance of these rates will be clearer if the doubling period to which various rates of increase correspond be borne in mind. The following summary may be helpful in the interpretation of the results:

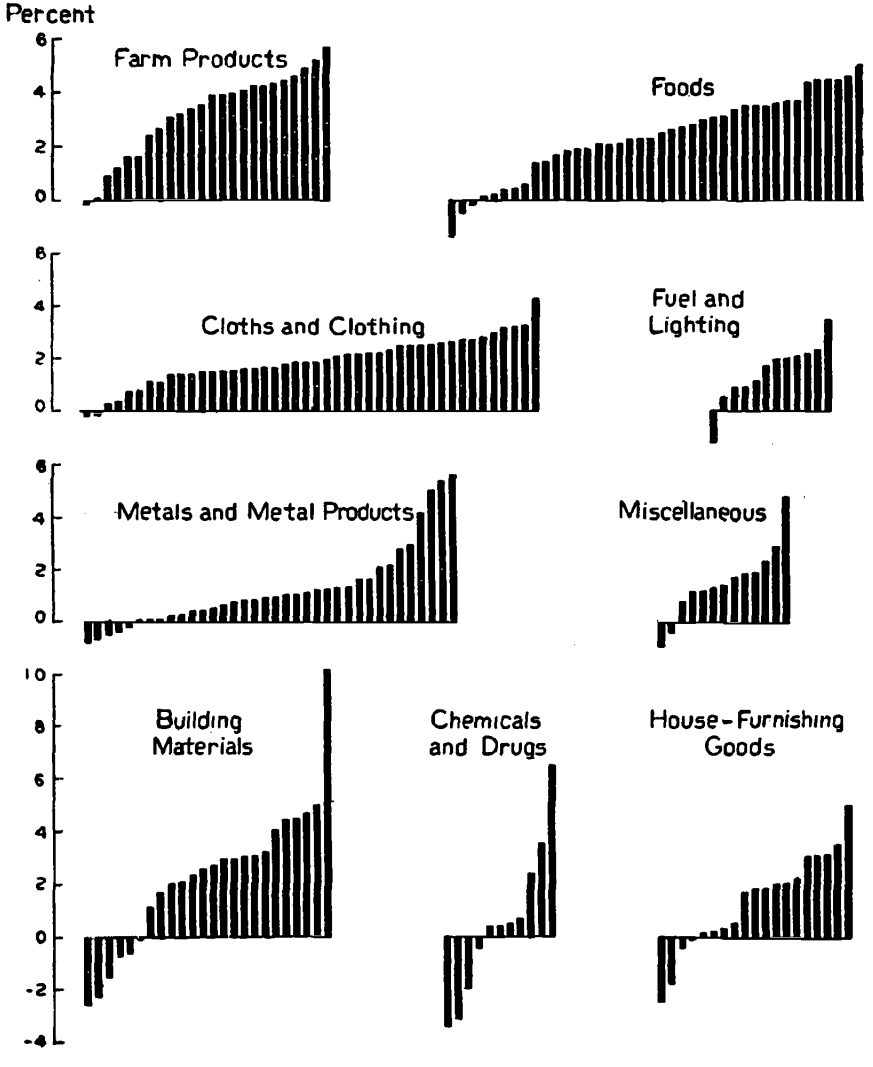
Average annual rate of increase	Approximate doubling period
1%	70 years
2	35 "
3	23 "
4	17 "
5	14 "
6	12 "
7	10 "
8	9 "
9	8 "
10	7 "

[2]Julius Lehr, in *Beiträge zur Statistik der Preise* (Frankfort, 1885), made use of a measure identical with that employed above. An exponential curve was fitted to certain series, and rates of change, as measured by the constant r in the equations to the fitted curves, were compared. The method of fitting differed from that employed in the present study, but in other respects the procedure was the same.

FIGURE 7

AVERAGE ANNUAL RATES OF CHANGE IN COMMODITY PRICES, AT WHOLESALE.

Ranking of Commodities by Groups according to the Average Annual Rates of Change in their Wholesale Prices during the Period 1896-1913.[1]



[1]The average annual rates of change for specific commodities are given in Table IX in order of magnitude, by groups, as plotted in this diagram.

or less rapidly than the average for all commodities. It is, therefore, the rate of change in purchasing power, or the change in value in terms of other commodities, which is the point of major interest in considering long-term movements such as these.

The average annual rate of change in the purchasing power of any commodity may be determined by fitting an exponential curve to the actual prices, deflated by a general price index. A shorter method is available, however. The rate of change in the deflated series may be derived directly from the figures for the rates of change in the general index and in the price of a specific commodity. If we divide the r of the specific commodity series by the r of the price index (the rates must for this purpose be expressed in full, i. e., as 1.0235, not as 2.35) we secure as quotient the r for the series which measures the purchasing power of that commodity.[1] Thus in the case of wheat, as listed in Table 14, we have r (purchasing power) $= \frac{1.026}{1.0235} = 1.002$. This represents an average annual increase in purchasing power of .2 per cent.

[1]We are to fit to certain data a curve of the type $y=ar^x$. Casting this into logarithmic form, we have

$$\log y = \log a + (\log r)\, x$$

The normal equations for fitting by least squares are

$$\Sigma \log y = n \log a + (\log r)\, \Sigma x$$
$$\Sigma (x \log y) = \log a\, \Sigma x + (\log r)\, \Sigma x^2$$

If the origin be at the middle of the period covered we have, as a general relation,

$$\log r = \frac{\Sigma (x \log y)}{\Sigma x^2}$$

If, now, we have three series, A, B and C, covering precisely the same period, the annual values of C being derived by dividing A by B (i. e. A is the original series, corresponding to the price of the specific commodity, B is the deflating series, corresponding to the general price index, while C is the deflated, or purchasing power series) we may write

$$(1)\quad \log r_A = \frac{\Sigma (x \log y_A)}{\Sigma x^2}$$

$$(2)\quad \log r_B = \frac{\Sigma (x \log y_B)}{\Sigma x^2}$$

$$(3)\quad \log r_C = \frac{\Sigma (x \log y_C)}{\Sigma x^2}$$

But $y_C = \frac{y_A}{y_B}$ or $\log y_C = \log y_A - \log y_B$

Substituting in (3) above

$$\log r_C = \frac{\Sigma [x (\log y_A - \log y_B)]}{\Sigma x^2}$$
$$= \frac{\Sigma (x \log y_A)}{\Sigma x^2} - \frac{\Sigma (x \log y_B)}{\Sigma x^2}$$
$$\log r_C = \log r_A - \log r_B$$
$$r_C = \frac{r_A}{r_B}$$

Similarly, it may be shown that $a_C = \frac{a_A}{a_B}$

(Footnote continued on next page.)

These methods possess considerable significance in affording a ready device for measuring changes in the values of given commodities in terms of other commodities. For it is these relationships, not absolute rates of increase or decrease, which are of economic importance. Having computed the average annual rates of change in the prices of individual commodities, and having a similar measure for all commodities,[1] the rates of change in purchasing power over the period 1896-1913 may be readily derived. These figures are presented in column (4) of Table 14 and of Table IX.

The relative position of each commodity is, of course, the same as it is with respect to rate of change in actual prices. Rosin, with an average annual rate of increase of 7.7 per cent in purchasing power in the wholesale markets, stands at one extreme, while wood alcohol, with an average annual decrease of 5.6 per cent, stands at the other. The individual figures given in Table IX need no further explanation. Detailed comparison of groups is deferred for treatment in a later volume.

§Rates of Change in the Earnings of American Workers

The methods illustrated above may be applied to advantage in the study of changes in the relative position of different groups of wage-earners. In comparing index numbers of wages the choice of a base period affects all conclusions as to relative changes in the wages received by different groups. If comparison be made in terms of the rate of change over an extended period no such difficulty is encountered. Paul H. Douglas has constructed index numbers of earnings for seven major groups of employed workers and for nine groups of wage-earners in manufacturing plants ("The Movement of Real Wages and Its Economic Significance," *American Economic Review*, Vol. XVI, No. 1, *Supplement*, March, 1926). The average annual rates of change in the earnings of these groups during the period 1896-1913 are given in column (2) of the tables below. (The index numbers for only eight of the manufacturing groups cover this period.) In column (3) of these tables are shown the rates of change in the real wages of these groups. These values have been secured by dividing the rates of increase in money wages by the rate of increase in living costs, using the index of cost of living constructed by Professor Douglas. This index increased at an average annual rate of 1.9 per cent between 1896 and 1913.

The above demonstration relates to the least squares method of fitting, applied to the exponential equation in logarithmic form. In the present study the value of r in the equation $y = ar^x$ has been determined throughout by the use of Glover's mean value table. Within the limits of accuracy of this table the same relationship holds between the r's of the original series, the deflating series and the deflated series.

[1]This is based upon the wholesale price index of the U. S. Bureau of Labor Statistics.

TABLE 15

AVERAGE ANNUAL RATES OF CHANGE IN MONEY EARNINGS AND REAL EARNINGS OF EMPLOYED AMERICAN WORKERS
1896-1913

(1) Group	(2) Rate of increase in money earnings percent	(3) Rate of change in real earnings percent
Government employees	.5	—1.4
Ministers	1.2	— .7
Postal employees	1.3	— .6
Clerical workers, trans. and mfg.	1.4	— .5
Wage earners, mfg.	2.0	.1
Wage earners, trans.	2.0	.1
Teachers	3.9	2.0
All groups	2.4	.5

TABLE 16

AVERAGE ANNUAL RATES OF CHANGE IN MONEY EARNINGS AND REAL EARNINGS OF WORKERS IN MAIN GROUPS OF MANUFACTURING INDUSTRIES
1896-1913

(1) Group	(2) Rate of increase in money earnings percent	(3) Rate of change in real earnings percent
Tobacco products	.8	—1.1
Textiles	1.8	— .1
Iron and steel	1.9	.0
Lumber and its products	1.9	.0
Leather and leather goods	1.9	.0
Paper and printing	2.0	.1
Clothing	2.3	.4
Land vehicles	2.5	.6
All manufacturing	2.0	.1

Of the seven major groups, only three showed an increase in real earnings during the period 1896-1913. Of the eight groups of workers in manufacturing industries, two had declining real wages, three showed neither an upward or a downward tendency, while the real wages of three groups increased.

3. ON "NORMAL" RELATIONS BETWEEN COMMODITY PRICES

The measures shown in Tables 14 and IX bear upon a problem which has received considerable attention in the last several years—

the question as to whether there is a "normal" relation between the prices of commodities and of commodity groups. The difficulties of agricultural producers resulting from the drastic liquidation of 1920 and 1921 gave a very practical emphasis to this question. Efforts to answer it have taken several forms.

One of the most common standards of "normality" derives from the facts that 1913 is the base of most current index numbers, and that 1913 was the last year before war-time disturbances set in. If a given commodity has risen above its 1913 price by less than the average rise in prices, as measured by a general index, it is assumed, in some discussions, that the normal relations of this commodity to other commodities have been disturbed. The re-attainment of a normal relation, from this viewpoint, would involve a decrease in the average of all prices or an increase in the price of the given commodity.

A similar argument may be based upon some base other than 1913. Thus the twelve months, July, 1913 - June, 1914, may be employed. Average prices in a broader base period, such as the five years from 1909 to 1913, may be used in securing a standard. The argument, however, is essentially the same, whether the base be 1890, 1913, 1919, or any combination of years. It is an argument which has been employed in comparing commodity prices and wages, wages and living costs, and other measures, as well as in comparing prices in various commodity groups.

On the basis of the evidence presented in the preceding section it does not appear justifiable to assume that prices in any one year, or that average prices over any period of years, stand in a "normal" relation to each other. There was no normal pre-war relation between prices, in their absolute form. The only normal factor bearing on pre-war price relations (if we mean by normal a situation sustained in a fairly regular fashion over a number of years) was the existence of fairly constant rates of change in individual commodity prices, rates of change which differed materially from commodity to commodity and from group to group. What was constant in the pre-war price situation was not a set of fixed price differences but relations which changed at fairly regular rates year by year. Figure 6 furnishes a graphic representation of these shifting relations. To assume that actual prices in a given year stand in a normal relation to each other is to crystalize a cross-section of a constantly changing situation, a procedure which seems equally faulty whether a single year or a number of years be used in computing the basic averages.

But is it possible to set up any standard by means of which price relations may be adjudged "normal" or "abnormal"? This is a problem to which some attention is given below in discussing price stability. It is pointed out that price relations are always changing, and that it is the degree or rapidity of change rather than the degree of departure from any hypothetical state of normality which may be measured. Distinction is made, in that discussion, between short-term and long-term changes in price relations. In considering long-term changes of the type resulting from differences in average annual rates of increase, it is desirable to substitute some other concept for that of normal relations. If we substitute for normal that which is *expected* as a result of past experience we have a more workable and useful concept, and we suggest a problem upon which the present results may throw some light.

When an average annual rate of change in the price of a given commodity has been sustained over a considerable period of years, it is reasonable to assume that this constant annual increment (or decrement) in price comes to be expected by those handling this commodity. The effects of accidental and cyclical forces are, of course, superimposed upon the tendencies due to trend, so that there may be no conscious expectation of a certain annual change. Nevertheless, the fact of a sustained long-term tendency to increase or decrease will have affected the attitudes of manufacturers and dealers, and will be reflected in their business dealings and expectations. Plant extensions, investments in equipment and other long-term commitments by manufacturers will be partially conditioned by these expectations. The land holdings and other investments of agriculturalists will be based upon like expectations. In this case the expectations will relate not only to the prices of specific commodities but to land values which reflect these expected prices.

All these plans and commitments are not, in general, based upon definite expectations of a single commodity's price change, for the profits in business dealings depend upon the relations between prices. A sense of the profit to be expected in handling a given commodity will rest upon a conscious or unconscious appreciation of the price trends of related articles. The manufacturer considers probable future costs of raw materials and supplies, of labor and equipment, as well as the probable future course of selling prices, in making his plans.[1] There thus develops a sense, not of what consti-

[1]This procedure has become conscious and definite in many organizations, with the development of statistical control and long-range planning. Lines of trend are fitted to

tutes a normal relation between commodity prices, but of the alterations in relations which are to be expected in the future. When such expectations are not realized, as in the case of farmers in general in 1921 and succeeding years, there arises the feeling that normal price relations have been shattered. Though the concept of normal relations be illusory, the feeling of disturbance and unsettlement arising from the failure of past tendencies to continue may be a very real one.[1]

The figures presented in Table IX may be used in determining what were the expectations, in 1913, of those producing and handling the various commodities there listed.[2]

IV Timing, Duration and Amplitude of Individual Price Changes During General Price Movements

During the major cyclical swings of commodity prices there are pronounced differences in the movements of individual commodities, though the general movement may affect all commodities in some degree. A study of these differences may be expected to yield information concerning the price behavior of individual commodities, and should, at the same time, throw some light on the price aspects of business cycles. A detailed investigation of this type, based upon reports concerning quantities and prices from a great many markets, representing important commodities at all industrial stages, should enable the incidence of the business cycle and its propagation throughout the industrial system to be more effectively studied. Such a broad survey must wait, however, upon the compilation of adequate data. The present inquiry is re-

all relevant price and quantity series, and future plans are based upon careful projections of these trends. All this is but a conscious and more accurate application of processes upon which all careful business planning has been based.

[1]The present discussion is confined to the case in which the feeling of unsettlement is an enduring one, as it has been in the field of agriculture in recent years. During every price cycle there are pronounced alterations in relations, exemplified by the case in which the cost of a good may exceed its selling price. But such cyclical disturbances are temporary, quite different in character from the more enduring changes which result from differences in long-term trends. More fundamental economic readjustments are necessitated by changes of the latter type.

[2]A concept having some relation to that discussed above serves as the foundation of the theory of business crises developed by Dr. Emanuel H. Vogel. (*Die Theorie des volkswirtschaftlichen Entwickelungsprozesses und das Krisenproblem*, 1917.) The moving equilibrium between economic processes which is necessary to prosperity is ruptured periodically, according to Vogel, because of differences in the rates of growth of the various elements in this equilibrium. (A summary of Vogel's theory is given in Chapter I of *Business Cycles*, by Wesley C. Mitchell, National Bureau of Economic Research, 1927.) The present inquiry has been confined to rates of change in commodity prices, with merely incidental reference to other economic series. Vogel's theory emphasizes the general economic importance of differences between these rates of change.