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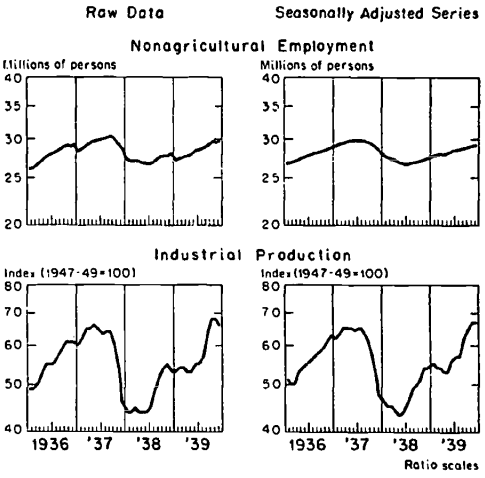
show the data as they usually come from the primary sources; the other curves show these raw data after adjustment for seasonal variations.[2] The two series show a rapid rise during 1936 and the early part of 1937. A sharp drop begins in mid-1937 and continues to June, 1938. A rise starts in July, 1938, and continues at a moderate pace during the remainder of 1938 and during 1939. This pattern is shown more clearly in the seasonally adjusted series (e.g., the December to January dips in employment are erased in the adjusted data), though it is also discernible in the series of original observations.

The series on non-agricultural employment and industrial production are relatively smooth; that is, the irregular and seasonal factors are relatively small. Thus the cyclical movements are discernible even in the original observations. Other series are also good economic indicators, though not in their raw form, because relatively large seasonal and irregular movements obscure the cyclical movements. The raw data and seasonally adjusted data for five such series are shown in Chart IV for 1936–39 and 1953–56. Two are series which usually lead at cyclical turning points in the economy as a whole—residential building contracts and liabilities of firms failing (on an inverted basis). Two usually turn at about the same time as general business—total unemployment (on an inverted basis) and freight carloadings; and one usually lags at cyclical turning points—retail sales. All these series are much more difficult to interpret in their original form than those for factory employment and industrial production. At this point, the problem of this paper may be put in this way: How can series like business failures and retail sales be made to show their cyclical movements as clearly as those for factory employment and industrial production?

The illustrative series are plotted in various forms to show how the usefulness of raw economic data can be enhanced by various statistical adjustments. The figures for 1936–39 are plotted in Part A in Chart IV and for 1953–56 in Part B.

CHART III

RAW AND SEASONALLY ADJUSTED DATA FOR TWO SMOOTH ECONOMIC SERIES, 1936–39




It is plain from the first panel of the charts that it is difficult to trace the path of the business cycle in the raw data. Declines during 1937–38 and during 1953–54 are discernible, but the patterns of the series and the timing relations among them are obscure.

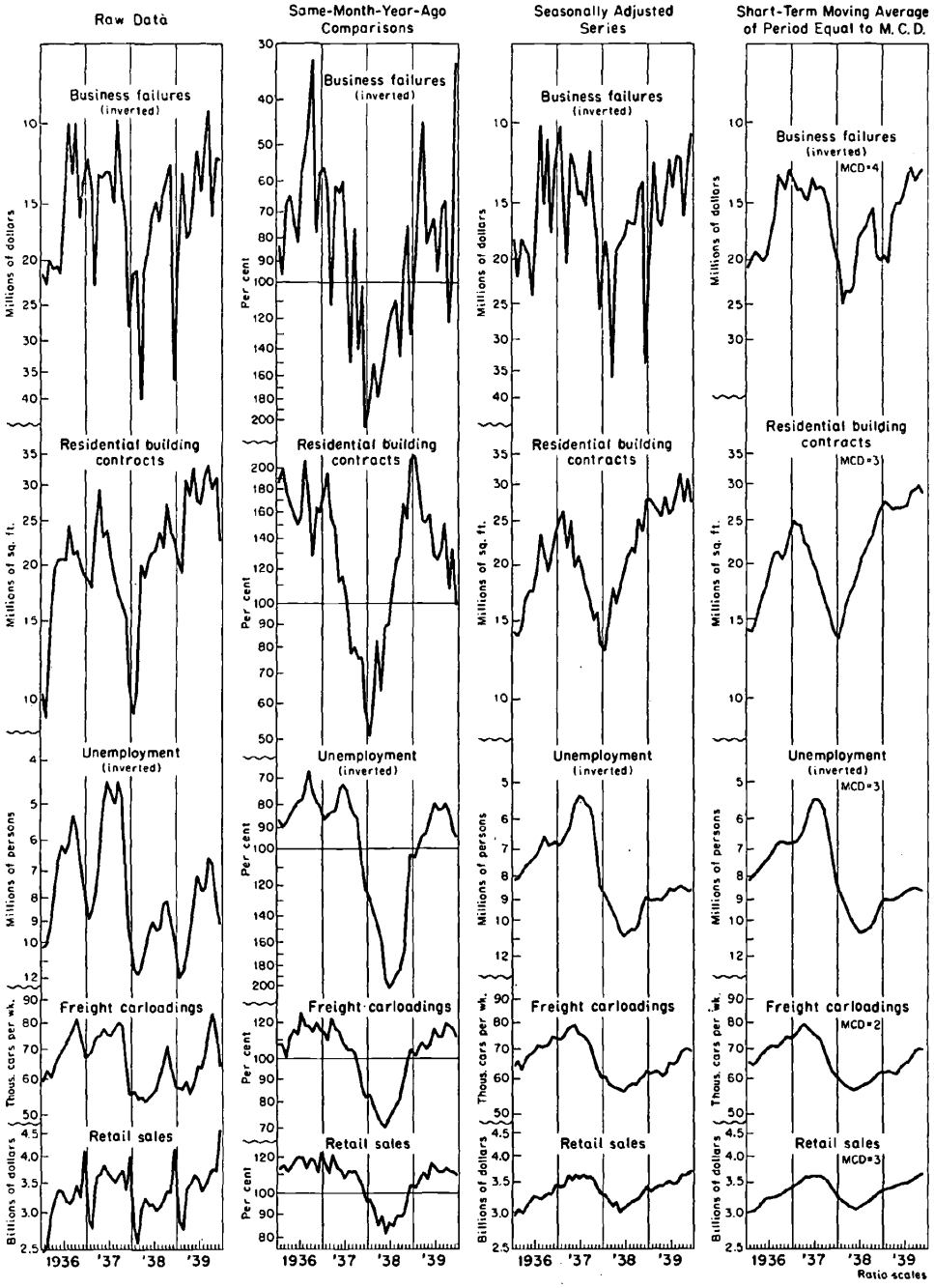
## IV. SAME-MONTH-YEAR-AGO COMPARISONS

The simple device of same-month-year-ago comparisons is frequently used to eliminate seasonal fluctuations. Same-month-year-ago comparisons involve dividing the figure for a given month by the figure for the same month of the pre-

[2] All seasonal adjustments in this paper are by the electronic computer method. The corresponding 1956 official seasonal factors are given, for comparative purposes, in Appendix B.

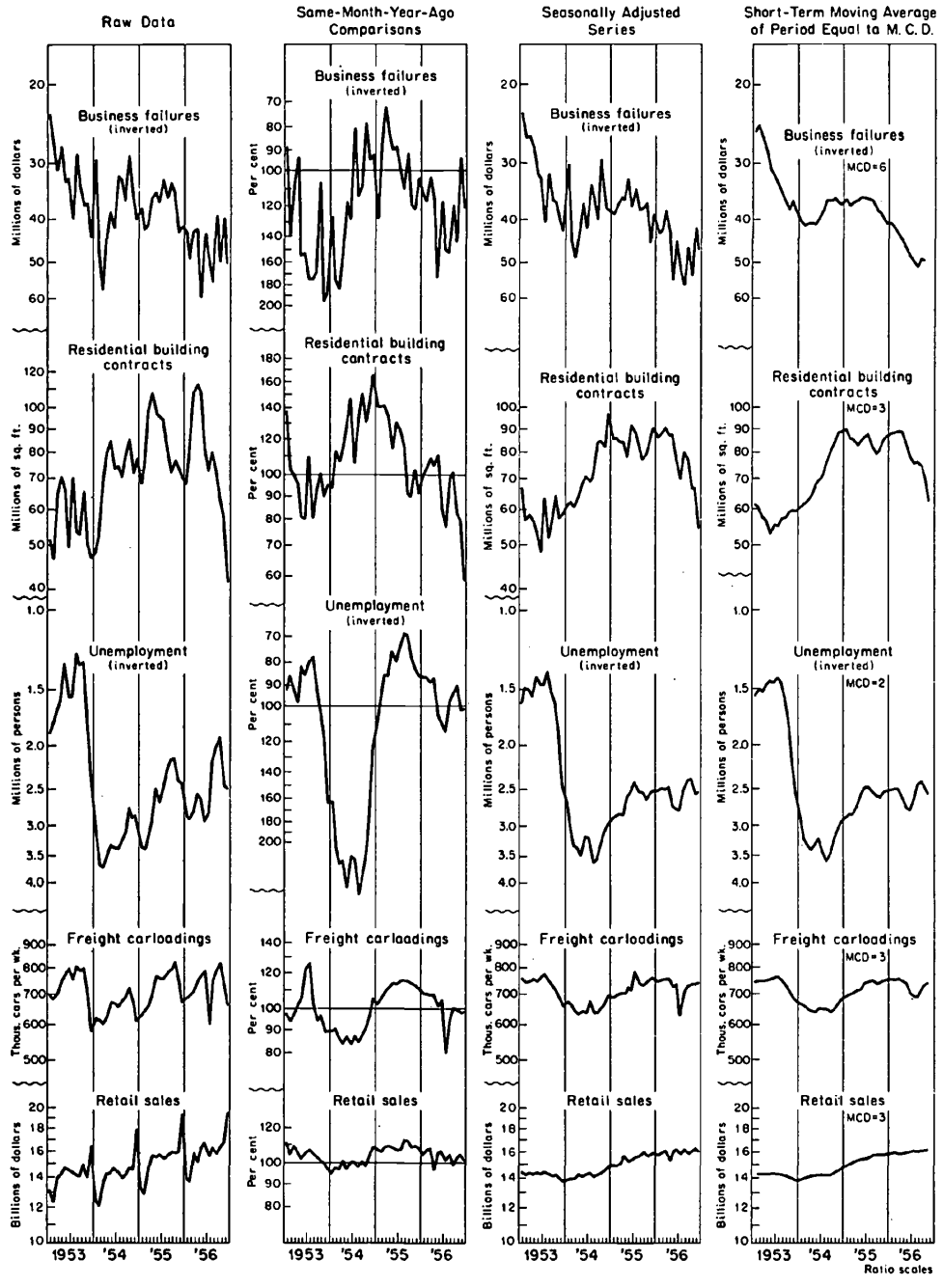
## CHART IV*A*

STATISTICAL ADJUSTMENTS OF RAW ECONOMIC SERIES TO IMPROVE THEIR USEFULNESS AS ECONOMIC INDICATORS, 1936–39



## CHART IV*B*

STATISTICAL ADJUSTMENTS OF RAW ECONOMIC SERIES TO IMPROVE THEIR USEFULNESS AS ECONOMIC INDICATORS, 1953–56



ceding year. This practice is widespread among financial writers and businessmen and is occasionally followed by professional economists and statisticians.

The simplicity of same-month-year-ago comparisons is, unfortunately, offset by major drawbacks. These drawbacks are sometimes critical at cyclical turning points. When a cyclical decline occurs, it usually takes a continuation of the tendency for several months before a decline below the same month of the year before becomes apparent. In using raw data for current analysis, same-month-year-ago comparisons tell broadly what has happened over the intervening twelve months, but not during that period. Such comparisons often will not indicate correctly the trend during the preceding six months, which is crucial in most current business analyses.

In same-month-year-ago comparisons a cycle-trend-seasonal-irregular composite for each month is divided by a similar composite for the same month one year back. In analyzing the results of such divisions, the trend factor can be disregarded on the ground that it is usually small from year to year; in any case, it affects all twelve monthly values in substantially the same way and therefore will not affect the cyclical pattern.

A constant seasonal factor will be eliminated by the division (any movement that recurs regularly every twelve months will be eliminated). If the seasonal factor changes, however, there will be a residual seasonal pattern, but on a year-to-year basis these changes are usually not very large.

The division of one set of irregular factors by another will yield still a third. Thus figures for a few months dominated by a strike may be divided by those for a few months dominated by abnormal weather, and the result could be almost anything. In general, if the irregular factors one year apart are uncorrelated with each other, as seems reasonable, their quotient can be expected to have a substantially larger relative variability than the irregular factor itself.[3]

The percentage change in the irregular factor is usually larger than that of the cyclical on a month-to-month basis, but not on a twelve-month basis, despite the effect just menioned. For this reason, the heart of the matter is the effect of the division of the cyclical component of a given year by the cyclical component of another. Only when data for the first year in a same-month-year-ago comparison follow a straight horizontal line will the cyclical pattern of the second year be unaffected. If the first year's pattern is the same as the second year's, a straight horizontal line will result; if it is the reverse, the cyclical pattern of the second year will be accentuated; if the first year has a curvature and the second year is a straight line, the inverted pattern of the first year will show up in the second.

The shape of the resulting curve is similarly affected by the rates of change in the two years. Thus when a year dominated by sharp cyclical movements follows a year of slow change, the imprint of the current year's cyclical pattern will show up fairly clearly in the same-month-year-ago curve. If the year of sharp cyclical change is then followed by a year of slow change, the same-month-year-ago curve for the third year will reflect, primarily, what happened a year ago, in inverted fashion. Thus the principal result

[3] See Morris H. Hansen, William N. Hurwitz, and William Madow, *Sample Survey Methods and Theory* (New York: John Wiley & Sons, Inc., 1953), I, 163, eq. 18.2 with $f = 0$ when the expected values of $X_t$ and $X_{t-12}$ are positive; also see Vol. II, chap. iv, Secs. 11, 13, 15, and 21.

of a same-month-year-ago comparison is the arbitrary replacement of one cyclical pattern by another.

Same-month-year-ago comparisons are often used by considering only the direction of change shown by the comparison (the changes between the figures for the same months one year apart are inspected to see whether they are plus or minus). For this method of analysis the 100 per cent lines drawn in the second panel of Chart IV provide a convenient comparison base. Points falling above this line indicate a rise (the figure for the second year is higher than that for the first), while points falling below the line indicate a decline. This approach will often lead to a very substantial delay in recognizing cyclical upturns or downturns. This can readily be seen from the graphs in Chart IV, which show same-month-year-ago comparisons for five economic indicators in the second panel and the corresponding seasonally adjusted series in the third panel. (The same-month-year-ago curves are dated at the end of the period of comparison; for example, the percentage ratio of January, 1956, to January, 1955, is plotted in January, 1956.) Thus residential building contracts, seasonally adjusted, began to rise in February, 1938, but the same-month-year-ago comparison did not show an increase (did not get above the 100 line) until five months later, in July. Similarly, unemployment began to decline in September, 1954, according to the seasonally adjusted series, but the same-month-year-ago comparisons did not show a decline until February, 1955.

A series will usually start to decline several months before the percentage change from the same month a year ago becomes negative. Consider, for example, the case of a smooth symmetrical cycle (such as a sine curve). Same-month-year-ago comparisons made on the ascending side of such a cycle will, of course, show increases. But increases will also be shown for the first, second, third, fourth, and fifth months after a decline starts, because the levels of the second year will be higher than those of the first year. The first decline will be indicated only in the sixth month after the contraction begins. Similarly, the first sign of a revival will be indicated only in the sixth month after the revival begins. Thus in the case of a smooth symmetrical cycle, same-month-year-ago comparisons treated on the above plan will show turning points six months late. In other, asymmetrical, types of cycles, the timing can be as much as eleven months too late. Only when a series drops off very sharply after a peak (the first month after the peak falling to a lower level than the eleventh month prior to the peak) or rises very sharply after a trough will this type of comparison show turning dates accurately.

In addition, when the same-month-year-ago comparisons are viewed as a time series, a downturn may merely reflect a retardation in the advance of a seasonally adjusted series rather than an actual decline. A retardation in the rate of advance will show up as a smaller absolute percentage change in same-month-year-ago comparisons. Since we know that retardations do not always precede contractions, such declines indicated by same-month-year-ago comparisons may be misleading. For example, the sharp decline during 1939 in the same-month-year-ago comparisons for residential building contracts (Chart IV, Part A) were quite as dramatic as the decline during the first half of 1937; but in 1939 this reflected only a retardation in

growth, whereas in 1937 the same pattern reflected a sharp decline in the level of activity. The difference is evident in the seasonally adjusted data.

Further troubles arising from same-month-year-ago comparisons are also illustrated in Chart IV. Note that the sharp decline in late 1937 and early 1938 is preserved in the same-month-year-ago comparisons, but the earlier cyclical patterns are sometimes distorted (e.g., residential building contracts) and the subsequent cyclical expansion almost always misrepresented. Similarly, the high level of the unemployment ratios in 1955 is misleading, as is the sharp decline in the residential building contracts ratios during 1955. Perhaps the most striking illustration, however, is provided by the 1953 figures for freight carloadings. They show a short pronounced rise, followed by a similar decline; these movements reflect in reverse those produced by the steel strike in 1952. They are entirely absent in the seasonally adjusted series in 1953.

TABLE 1*

AVERAGE MONTH-TO-MONTH PERCENTAGE CHANGES (WITHOUT REGARD TO SIGN), SEASONALLY ADJUSTED SERIES, AND SAME-MONTH-YEAR-AGO SERIES, 1936–39 AND 1953–56

| | Seasonally Adjusted | Same Month Year Ago |
|---|---|---|
| *Business failures:* | | |
| 1936–Aug., 1938 | 15.2 | 33.5 |
| 1953–56 | 12.7 | 22.0 |
| *Residential building contracts:* | | |
| 1936–39 | 9.1 | 15.0 |
| 1953–56 | 7.7 | 12.0 |
| *Retail sales:* | | |
| 1936–39 | 2.1 | 3.8 |
| 1953–56 | 1.6 | 2.9 |
| *Freight carloadings:* | | |
| 1936–39 | 2.2 | 4.5 |
| 1953–56 | 2.8 | 4.5 |
| *Unemployment:* | | |
| 1936–39 | 3.5 | 6.3 |
| 1953–56 | 5.5 | 9.6 |

* The data in this table are not strictly comparable because the same-month-year-ago comparisons implicitly involve an additional year—that prior to the period specified. Thus the 1953–56 same-month-year-ago figures involve 1952, a year in which there were major changes in series affected by the steel strike.

These charts also point up the fact that month-to-month irregular movements in the same-month-year-ago series are substantially larger than in the seasonally adjusted series and thus further obscure the underlying cyclical movements. This observation is supported by the statistics shown in Table 1, where the average month-to-month percentage changes (without regard to sign) in the seasonally adjusted and the same-month-year-ago series are compared for the five series plotted in Chart IV and for both periods (1936–39 and 1953–56). In every case the average month-to-month percentage change in the same-month-year-ago series is much larger. An increase in the variability of the irregular factor must have been the cause of this increase, since it is so much larger than the cyclical. Special computations for business failures, 1953–56, provide empirical support for this conclusion. The average percentage changes for the seasonally adjusted and same-month-year-ago series are, respectively, irregular, 12.2 and 20.4; cyclical, 2.7 and 3.8. The irregular movements are 4.5 times as large as the cyclical in the seasonally adjusted data; they are 5.4 times as large as the cyclical in the same-month-year-ago comparisons.

This leads to the conclusion that same-month-year-ago comparisons of raw data do not provide a satisfactory short cut to seasonal adjustments. We must look for other ways of improving raw economic series for the analysis of current economic conditions.[4]

[4] Economists have long been critical of same-month-year-ago comparisons. Thus in 1931 Frederick R. Macaulay wrote: "There is a simple and enlightening way to describe the operation of *subtracting* the quotation for the same month last year from the quotation for the present month and using the resulting figure instead of the raw data. It amounts