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Appendix D

The Method [1]

Seasonal Movements

In their raw state, quarterly series of export quantities and values are extremely choppy, and their sawtooth contours defy interpretation. The first task is, therefore, to adjust them for seasonal movements. To do this properly is very difficult in some instances because, besides being large, the seasonal changes shift rapidly from one year to another. Occasionally, having tried several methods, we had to accept corrections with which we do not feel satisfied.[2]

This problem does not arise with export price series, which behave differently from values and quantities. Their movements are, in general, much milder; and they show only very slight seasonal variations or none at all.

U.S. Business Cycles

Business cycles are "expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions and revivals which merge into the expansion phase of the next cycle; . . . in duration business cycles vary from more than one year to ten or twelve years." [3] The business cycle chronology was determined by Burns and Mitchell after study of cycles in many economic activities and of descriptive evidence found in business annals. Since the publication of *Measuring Business Cycles,* two of the quarterly turning points there determined have been revised. Of these, the trough in 1919—shifted from the second to the first quarter of 1919—is not covered by this study. As for the second revision,

[1] The definitions of the Burns-Mitchell measures are adaptations from their *Measuring Business Cycles,* NBER, New York, 1947.

[2] For some comments on the seasonal variations in U.S. export values in the 1920's, see Simon Kuznets, *Seasonal Variations in Industry and Trade,* NBER, New York, 1933, pp. 264–267. Kuznets noted particularly the contrast between the large movements in exports of crude materials and foods and the milder ones in manufactures exports, and, further, the offsetting effect on the seasonals of total exports of the different time patterns of the various component classes.

[3] Burns and Mitchell, *Measuring Business Cycles,* p. 3.

the peak in 1929, the new date—the third quarter of 1929—has been used for timing comparisons, but the old date—the second quarter of 1929—is used otherwise.

Export Cycles and World Import Cycles

These cycles are wavelike movements in the seasonally adjusted series, corresponding in duration to business cycles. Their turning points have been set by the National Bureau in accordance with the rules worked out for this purpose. For quantity and value series which have, in most instances, sharply defined cyclical movements, this presented no particular difficulties. Nevertheless, inclusion and omission of some of these turns is problematical. Price turns were more of a problem since price cycles are not always sufficiently pronounced to be easily recognized.

Matching Turning Points

Once determined, the timing of peaks and troughs in exports is compared with that of turns in domestic business and in world imports. This matching of turns again proceeds by elaborate rules but leaves enough discretion to the investigator to make it a flexible tool yielding a great deal of information on the relation of exports to domestic and world import cycles and some other factors. Since there are turns in each of the reference series which are not accompanied by turns in the others, the impact of the different factors can be isolated to some extent. This permits some conclusions about the causes of export turns. If it was found, for instance, that an export quantity series always turned down when, and only when, domestic business turned up, this would be consistent with the hypothesis that business turns cause export turns.

Cycle Phases

The interval from a trough to the following peak in a series is the expansion phase; the interval from the peak to the following trough, the contraction phase.

Amplitude of Expansions, Contractions, and Full Cycles

The amplitude of expansions is measured by the difference between the standing of the series at the cycle peak and that at the preceding

trough, expressed as a percentage of the average value of the series over the full cycle. The corresponding measure is used for contractions. The full-cycle amplitude is the algebraic sum of the phase movements with the sign of the contraction movement reversed.

Export amplitudes are measured in export cycles, in U.S. business cycles, and in world import cycles.

Taking percentage deviations from the cycle average removes the intercycle trend, but preserves the intracycle trend. The method renders the different cycles in a series comparable, regardless of shifts in the average level of the data. In this way features common to most cycles are made to stand out clearly while features peculiar to single cycles tend to fade away. Furthermore, and most important, cycle amplitudes of different series can be related to each other since they are measured in the same units.

Weighted Averages of Annual Rates of Change in Expansions, Contractions, and Full Cycles

The sum of the amplitudes in all individual expansions covered divided by the total number of expansion years gives the weighted annual rate of change in expansions. Annual rates of change in contractions and in full cycles are derived in the same fashion.[4]

Such rates of change are computed for export changes during export cycles, world import cycles, and U.S. business cycles.

Ratios of Rates of Change of Exports in U.S. Business Cycles and in World Import Cycles to Their Rates of Change in Export Cycles

The rise and fall of each export series between its own peaks and troughs can be regarded as a measure of its total cyclical variability which is independent of the series' conformity to a reference cycle. Hence, the relation of the rate of change of exports during world import cycles, or during U.S. business cycles, to their rate of change in export cycles is an indicator of the degree to which the cyclical variation in exports can be attributed to domestic or world import cycles. These ratios of rates of change have proved very revealing in most instances.

[4] It is customary at the National Bureau to give monthly rather than annual rates of change. However, annual rates seem more immediately meaningful today in view of their constant use in discussions of economic change.

Conformity Indexes

The most important of these indexes, the one that measures conformity to full reference cycles, is based on a comparison of the rate of change of exports during reference contractions and rates during the preceding and succeeding reference expansions.

Each such comparison in which the rate of decline in contraction turns out to be smaller (or the rate of rise larger) than that in expansion is counted as an instance of inverse conformity. The number of such instances is deducted from the number of instances of positive conformity and the difference expressed as a percentage of the total number of comparisons.

The index of conformity to full cycles has the great merit of being unaffected by long-run trends. Also it is not sensitive to a single unusual movement, as the average amplitudes are. On the other hand, a series which rises barely more in expansion than in contraction will conform as well as one which rises vastly more.

The separate conformity indexes for expansions and contractions are based entirely on the series' direction of change.

The index of conformity to reference expansions is the difference between the number of expansions in which the series rises and the number in which it declines, expressed as a percentage of the total number of expansions covered. The index of conformity to reference contractions is the difference between the number of contractions in which the series falls and the number in which it rises, expressed as a percentage of the total number of contractions covered.

Ranking of U.S. Business Expansions and Contractions for Correlation Analysis

The methods described so far compare the paths of exports during business expansions with their paths during contractions. They do not distinguish between vigorous and weak expansions, or between severe and mild contractions. Such distinctions are obviously desirable. But they require quarterly measures of the amplitude of expansions and contractions in U.S. business at large in 1879–1961. Such measures are not available, and we have to rely instead on two indicators of cyclical amplitudes which have been used for similar purposes and found fairly satisfactory by Friedman and Schwartz in

their work on money.[5] One of these indicators is an average of three trend-adjusted indexes of general business, prepared by Burns and Mitchell and revised and extended by Geoffrey H. Moore (Moore index). The second is a series representing bank clearings or bank debits outside New York. This series is highly correlated with, and the best available substitute for, quarterly national income, which is not available for the earlier years.[6]

Certain aspects of these indicators should be borne in mind in evaluating the findings. The average of the three business indexes is trend-adjusted and heavily weighted with physical volume series, particularly with physical volume of manufacturing. Bank clearings or debits are not trend-adjusted, measure economic activity in terms of value rather than physical volume, and also cover financial transactions outside New York City. Each of these indexes thus has its merits and its defects, and the results may be expected to vary depending on whether one or the other is used. The effect of trends on the correlations has been stressed in Chapters 2 and 7.[7]

An impression of the extent to which the two indicators arrive at a similar evaluation on the relative amplitudes of business cycles is given by the measures in Tables 40 and 41. Clearly the ranks they assign to individual business phases are by no means identical. The correlation of the amplitudes of the two indexes in expansions and contractions combined yields a Kendall coefficient of +.74 for the later period and +.79 for the earlier one, which denotes a close but far from perfect correspondence.

Friedman and Schwartz, referring to the entire period 1879–1961, find that the indicators come closer to agreeing about contractions than about expansions. They attribute this to the fact that there is wider dispersion about contraction than about expansion amplitudes which causes larger errors to be tolerated in the former than in the latter.

[5] See Milton Friedman and Anna Schwartz, *Trends and Cycles in the Stock of Money,* Chap. 3, a National Bureau Study in preparation. I have drawn heavily on this work.

[6] For the Moore index, see Geoffrey H. Moore, *Business Cycle Indicators,* Princeton for NBER, 1961, Vol. I, p. 104 and the evaluation of the index, p. 105. GNP data are not used because they are not available quarterly for the earlier years. Switching indicators would preclude the important comparisons between periods.

[7] One advantage of the Moore index is that its amplitudes are, on the average, much larger in contractions (20 per cent) and in full cycles (40 per cent) than those of clearings. The average decline of clearings in business contractions is only 3 per cent, against 20 per cent for the Moore index; the corresponding figures for full cycles are 26 against 40 per cent.

That this is not the whole story, however, emerges when the records before and after World War I are examined separately. Before World War I, it turns out, the two indicators agree quite well in either expansions (+.44), or contractions (+.71). In the later period, however, the ranks assigned by the two indicators to expansions show no similarity (the coefficient is −.07), while agreement in regard to contractions is even better than before (+.81). The explanation lies in the break in price trends and hence in value trends between the interwar and the post-World War II periods. The rising trend after 1948 raises the amplitudes of the clearings index in these later expansions above those of the interwar period, while the Moore index rises, on the whole, more in the earlier expansions. For instance, according to the Moore index, the ranks of the two first expansions of the 1920's are 1 (the largest) and 3; according to the clearings index, they are 4 and 6 (the smallest). The 1954–57 expansion, on the other hand, ranks second highest in clearings and lowest in the Moore index.

Certainly the two indicators are not ideal measures of the amplitudes of business cycles, but they are the best ones available for the period covered, as far as I know. We are using both and have computed two sets of coefficients for the main relationships investigated. Though this does not eliminate the weaknesses of the indicators, it does at least afford a certain check on them. Where results differ significantly, conclusions are based on whichever indicator seems more appropriate for the purpose at hand, e.g., on the Moore index for export quantities, on the clearings index for prices.

Partial Rank Correlations of Expansion and Contraction Amplitudes

The amplitudes of rise and fall in U.S. exports during U.S. business expansions and contractions are ranked in a single array from largest rise to largest fall. World imports and the two indicators of domestic business are treated in the same fashion. Correlating the ranks of each pair of variables, we obtain simple coefficients which serve to supplement and check the results based on conformity indexes and ratios of rates of change.[8]

[8] Quarterly rates of change during expansions and contractions have also been considered as a possible basis for this analysis. Experiments have shown, however, that the results are not sufficiently different from those obtained with amplitudes to warrant a second set of computations. Moreover, such rates cannot be obtained for one of our two indicators of domestic business cycles (the Moore index).

Moreover, the simple coefficients serve in the derivation of coefficients of partial correlation which enable us to bring out the net effects of domestic or world cycles on exports more sharply than with other measures.

Since partial correlation analysis has not been developed for the Spearman rank correlation coefficients which Friedman and Schwartz used but is available for Kendall coefficients, our analysis is based on the latter. It should be noted that Kendall and Spearman coefficients have different underlying scales though the range in both is from +1 to −1. Simple coefficients which are significant at the 5 or 1 per cent level are so designated in the tables. Unfortunately, no tests of significance are yet known for the partial coefficients.[9]

[9] Maurice G. Kendall, *Rank Correlation Methods,* London, 1948, and Sidney Siegel, *Nonparametric Statistics,* New York, 1956.