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American Business Cycles since World War II:
Historical Behaviour and Statistical Representation

Christina Romer, in her 1994 paper *Remeasuring Business Cycles*, emphasizes the decisive role played by dates of peaks and troughs in the 'reference cycle' in 'forming impressions about macroeconomic fluctuations'. They are usually thought of 'as the turning points of business cycles', but in the sense of a 'consensus of turning points in many specific series' rather than 'extremes in any one aggregate'. The reference cycle, 'a much used tool of macroeconomic analysis', is the result of an 'extremely impressive' research programme carried out by Arthur Burns and Wesley Mitchell at the National Bureau of Economic Research between the wars, described and summarized in *Measuring Business Cycles* (1946). Romer considers the latter to be 'one of the most respected books in American macroeconomics', and the work of Burns and Mitchell in dating business cycles to be 'monumental'.[1]

The reference cycle is normally represented by single aggregates or indicator variables, examples of which are the composite indicators published monthly in the US Department of Commerce *Survey of Current Business*. It is usual for commentators on current business conditions to talk of activities which tend to 'lead the cycle', like stock market indices, or which 'lag', like employment rates. For many years it has been assumed that most indicators, and the sectors they represent, behave in the same manner from cycle to cycle — stock markets always 'lead' and employment always 'lags'. This is based not on observation of contemporary behaviour, but rather on the orthodox interpretation of the interwar NBER programme that business–cycle behaviour is alike in all historical episodes and that expansions and contractions in the various sectors of the economy happen more or less simultaneously.

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[1]Romer (1994), pp. 573–576.

There is, however, much evidence to the contrary in NBER statistical results. It is the purpose of this paper to extend the NBER approach to the analysis of economic fluctuations in the postwar US economy in order to assess the extent of conformity of sectoral fluctuations.

I. Introduction

Burns and Mitchell defined business cycles as 'recurrent but not periodic' expansions and contractions, occurring 'at about the same time in many economic activities', lasting from one to about 12 years.[2] The expansions and contractions in each of the 'many activities' — known as 'specific cycles' — were, in this view, well–behaved; that is, the relative timings of their peaks and troughs were invariant from one episode to the next. It has thus been assumed since the definition was published that specific–cycle 'comovements' can be represented by the 'reference cycle'.

The influence of Measuring Business Cycles and its reference chronology cannot be over–emphasized. There are numerous examples in the macroeconomic literature. Lucas, in his theoretical ('real business cycle') analysis of comovements, cites Burns and Mitchell's 'documentation' as the authoritative empirical description of short–run economic behaviour. He argues that 'although there is no theoretical reason to anticipate it, one is led by the facts to conclude that...*business cycles are all alike* [emphasis in original]', that is, 'output movements across broadly defined sectors move together', although possibly with differential amplitudes.[3] Cooley and Prescott follow this approach in a 1995 real business cycle paper, citing as the relevant 'business cycle facts' the 'comovements of variables that Burns and Mitchell worked so hard to document and that

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[2]*Measuring Business Cycles*, p. 3.

[3](1977) p. 10. On p. 9: 'production of...durables exhibits much greater amplitude than...nondurables'.

Robert Lucas emphasized as the defining features of the business cycle'.[4] Blanchard and Fischer, in their advanced textbook *Lectures on Macroeconomics*, argue that the interwar NBER statistical evidence was 'the most systematic collection of business cycle facts', which, 'using a reference chronology of business cycles...documented the existence of regular cycles' as well as the dynamic properties of 'a large number of [time] series relative to the stages of the cycle...'[5]

Applications of the reference cycle are also found in the econometrics literature. King and Plosser's 1994 study of the stochastic properties of a real business cycle model directly follows the statistical measures of conformity and of average patterns of fluctuation developed by Burns and Mitchell.[6] Stock and Watson's work on coincident and leading indicators, published between 1989 and 1992, takes as 'primitive' the page–three definition.[7] These authors ask 'what do the leading indicators lead?' The answer is the reference cycle, which they distinguish from fluctuations in GNP; although no single aggregate can be a proxy for the dynamic behaviour of the 'many activities', the reference dates accurately capture 'comovements in a broad range of macroeconomic aggregates'.[8]

This tends to be the consensus view in applied research. In her 1994 study of economic stabilization Romer relies on a comparison of pre– and postwar reference dates to identify changes in US 'business–cycle' durations over time; and cites examples of other authors using the reference cycle for such comparisons.[9] Romer's object is to determine whether, as the original NBER reference dates suggest, pre–1939 'recessions' were more severe

[4](1995) p. 26.

[5](1989) p. 275.

[6](1994) Sections 2.2 and 2.3.

[7](1989) p. 353.

[8]*Ibid.*, pp. 352–353.

[9](1994) p. 573, note 1.

and protracted than those since the war. Her approach is to re–compute the prewar reference cycle using an industrial production series whose postwar turning points occur at about the same time as the NBER reference turns. The new prewar dates give reference contractions which are shorter and hence less severe than those identified by the original chronology, from which she concludes that postwar stabilization is illusory.

Watson (1994), in another stabilization study, compares reference measures derived by different methods, and demonstrates how sensitive are their observed cyclical durations to the volatility of the time series on which they are based. He constructs a postwar chronology using series similar to those employed by Burns and Mitchell, and then compares it to the NBER dates. Because his industrial production indices contain specific cycles not corresponding to 'movements in other series', Watson ignores these 'extra' cycles in fixing reference dates.[10] He concludes that apparent changes in durations in the postwar period are the artifact of his time series, which are more volatile than those used by the NBER.[11]

Reference measures are the basis for the identification of peaks and troughs in the 'business cycle' in the US economy. Romer argues that the procedures followed by the reference–cycle dating committee of the NBER for the US economy 'were laid down in more or less final form' in *Measuring Business Cycles*.[12] This appears to be the case, especially the requirement that an episode have sufficient *duration, diffusion* and *depth* to count as a reference/business cycle movement. These '3–D' criteria, as they have become known, are first discussed on page 72.

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[10](1994) p. 39.

[11]*Ibid.*, pp. 41–42.

[12](1994) p. 576.

Postwar NBER business–cycle research has been conditioned by *Measuring Business Cycles*. For example, as late as 1986 Moore and Zarnowitz endorsed the page–three definition with certain modifications, recognizing in particular that as a consequence of postwar economic growth specific cycles are usually 'asymmetric in that expansions typically exceed contractions in size and duration.'[13] The influence of growth rates on specific–cycle dynamics had earlier been recognized by Mitchell. In his 1927 volume, he appeared to equate them, speculating that cyclical fluctuations might really be 'alternating accelerations and retardations in the pace of a more fundamental process' (i.e., growth).[14] Recognition of growth asymmetries is thus not a significant departure from interwar NBER thinking.

Contrary to the conventional postwar interpretation of their statistical evidence, however, Burns and Mitchell actually found historical behaviour very complex. There is no clear evidence in *Measuring Business Cycles* of any 'documentation' of comovements. Mitchell himself always stressed the unique features of each historical episode, that the sequence of specific–cycle turning points was not well–behaved, and that consequently no single reference measure could adequately represent the complexities of short–run macroeconomic fluctuations.[15]

On the contrary, the page–three 'definition' was intended as a 'tool of research', analogous to other such definitions in the 'observational sciences', rather than as an accurate description of historical behaviour. It was 'subject to revision or abandonment' if not supported empirically.[16] On page four the authors argued that in order to observe empirical business cycles a specification that tells the observer 'where to look and what

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[13](1986) p. 735.

[14](1927) p. 224.

[15]*Measuring Business Cycles*, pp. 3–8.

[16]*Ibid.*, p. 3.

to look for' was required. Although by that time they claimed to have found 'considerable' evidence to support 'every clause...an intensive study...is necessary if we are to ascertain conclusively whether the many economic activities really fluctuate in unison as the definition states'.[17] It was thus not apparent in 1946 how 'general' was the 'consensus' of 'cyclical' phases in the 'many activities'. The issue could only be addressed by obtaining and analysing a great deal more data.[18]

In fact *Measuring Business Cycles* contains as many questions as answers for the student of historical fluctuations. For example, the occurrence of 'cyclical' movements at 'about the same time' allowed the possibility of 'leads' and 'lags' among the variables in relation to the 'general cycle'. This, however, contradicts Burns and Mitchell's stipulation that 'cyclical turns are concentrated around certain points in time; *for if there were no bunching of cyclical turns, there would be no business cycles answering to our definition* [emphasis added]'.[19] Of course there might even be 'several sets of general cycles running concurrently', all of different periodicity but 'combining to produce the variability our definition admits.' The turning points themselves raised questions of identification: for expansions and contractions 'seem to be interrupted by movements in the opposite direction, and some cycles apparently have double or triple peaks or troughs...attaining considerable proportions.'[20]

As a consequence of these complexities, the procedure for identifying specific cycles was not straightforward. Burns and Mitchell defined these as fluctuations lasting 'at least 15 months' and at most about 12 years in individual time series. Although elaborate rules for 'matching' specific–cycle peaks and troughs to reference turns were developed, these

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[17]*Ibid.*, p. 5.

[18]*Ibid.*, p. 6.

[19]*Ibid.*

[20]*Ibid.*, pp. 7–8.

required considerable judgment in their application; for the authors could find 'no mechanical [i.e., objective] device that insures sensible results'. The rules were designed to 'weed out "extra" specific cycles, that is, specific–cycle movements unrelated to business [or synonymously, reference] cycles' (thereby ensuring the 'sensible results').[21] In his final volume Mitchell conceded that such an approach was 'argument in a circle'.[22]

Setting the reference dates presented a greater problem because the dynamics of the 'many activities' appeared so divergent. It was difficult to 'determine how they fit together'. Burns and Mitchell found it impractical to parameterize the criteria for reference peaks and troughs in the same way as for specific cycles. They gave as an example ten employment series showing both 'extra' and 'skipped' cycles; and 'turning zones' rather than tight clusters of peaks and troughs.[23]

Burns later found a 'wide dispersion of specific–cycle peaks and troughs' in 600 interwar US time series. In a 1961 paper he argued that it was 'naïve' to suppose that most economic activities reached turning points at the same time. Only if all series were 'rising and falling in unison' could business cycles be represented 'exclusively [by] aggregate activity'. His solution to the dispersion problem was to propose two cycles: the first, 'seen', in the aggregate itself; and the second, 'unseen', in the 'distribution of expansions and contractions within the aggregate'. In the latter there should be an increase in turning–point numbers month by month until a reference turn is reached; yet he found that in interwar data the maximum percentage of turns in any month was only about 15, and that the 'clusters' of specific–cycle peaks and troughs could be spread by as much as two years around reference turns.[24]

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[21] *Ibid.*, p. 118.

[22] *What Happens during Business Cycles* (1951), p.77.

[23] (1946) Table 14, pp. 68–69.

[24] (1961) p. 17 and Chart 2.1, p. 15.

Owing to these complexities, leading indicators have had mixed success. As early as 1958 Alexander pointed out that 'diffusion' indices (which record the percentage of series in a given data set which show increases in levels in any one time period) often gave false signals.[25] Although the Stock and Watson coincident index performed well, their leading indicator failed to predict the US reference peak in 1990. They relied on a previously stable historical relationship between financial markets and the real sector which in this instance, according to Robert E. Hall, experienced a 'remarkable...breakdown'.[26] Hall, chairman of the NBER dating committee, gives all the 'recessions' since 1967 as examples of reference episodes which have been difficult to identify.

II. Breaking the Circle of Argument: an Algorithm for the Identification of Specific Cycles

The previous research thus leaves unanswered the most important questions about the reliability of the reference dates, their ability to summarize the dynamics of the 'many activities', and by implication the degree of historical comovement. Burns and Mitchell, on whom all this research relies for 'documentation', produced evidence which points more to divergences than to comovements. Their analyses were, of course, carried out before national income accounts were available for the United States on a quarterly or monthly basis, which led them to question the reliability of their own data. In any case the NBER has itself always been aware of the complexities of specific–cycle behaviour, as the comments of Moore and Zarnowitz indicate. Although these authors argue that specific–cycle peaks and troughs show 'rather definite points of concentration', the evidence they adduce is from the period up to 1939.[27]

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[25](1958) p. 636.

[26]Stock and Watson (1989); Hall (1991/2) p. 2.

[27](1986) p. 747. The evidence is from Moore (1961) Chart 7.3, pp. 198–201.

The reference–dating process, as described by Hall, considers a large volume of time–series data in fixing turning points, but focuses on a few variables as indicators of 'general conditions'. In identifying the 1990 peak, for example, the data that 'most strongly influenced the committee' were the real national income, real sales, industrial production and nonagricultural employment series.[28] However important these time series may be, they are not representations of the whole of economic activity. Hall moreover describes each reference date as a 'compromise' rather than as a well–defined turning point.

The question raised by the reference cycle can thus be framed as a variant of Stock and Watson's leading–indicator question: *viz.* with what do these dates actually coincide? That is, do the many activities conform in their specific cycles to any single set of dates, however powerful may be the technique of fixing them? From this a broader question arises: do postwar historical 'business cycles' really display the empirical regularities — comovements, stable leads and lags, predictable differences in amplitudes, and growth–induced asymmetries — assumed in the literature?

These issues can only properly be addressed by an examination of historical data for 'broadly defined output sectors' to determine the timing of specific–cycle peaks and troughs. Operationally this means direct observation of peaks and troughs in each time series. The presence of comovements implies the following behavioural characteristics:

(1) that turning point in most series are 'bunched', or 'clustered'; i.e., they reach their peaks and trough at about the same time;

(2) that, in addition, approximately the same number of specific cycles is found in each of the series; and

(3) that, for those series whose turning points are not found within the cluster, their leads or lags are comparatively stable and predictable.

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[28]Hall (1991/2) p. 1 and Figure 1.

The approach advocated here is similar to Burns and Mitchell's identification criteria for specific cycles, but free of an *a priori* reference chronology, which thus avoids the circularity and inconsistencies of arbitrary 'weeding'. That is, peaks and troughs are directly–observable, local time–series maxima or minima which are identified by applying the same quantitative algorithm to all series.

Therefore a peak is identified if within a specified number of time–periods preceding and succeeding it there is no other observation with an equal or higher value; and a trough occurs if there is none of equal or lower value. Formally, a 'peak' is a local maximum X_t in a time series $\{X_t\}$ whenever $X_t > \max\{X_{t-k}, \dots, X_{t-1}\}$ *and* $X_t > \max\{X_{t+1}, \dots, X_{t+k}\}$; a local minimum ('trough') is as above, but with $> \max\{\dots\}$ replaced by $< \min\{\dots\}$.[29] The parameter k determines the 'window length', or number of time–periods over which the algorithm searches before and after the current observation. Multiple turning points are also allowed for in the implementation. This comparatively simple criterion will presently be shown as sufficient to allow direct comparisons of specific–cycle durations and timing relations.

Burns and Mitchell claimed to have evaluated more than 800 time series. They did not, of course, have available the comprehensive macroeconomic time–series data reported monthly and quarterly from 1947. Prewar NBER analysis was thus forced to rely on large numbers of series as proxies for the 'broadly based output sectors'.[30] It was in response to such statistical deficiencies that the national income and product accounts were developed by Simon Kuznets and his team. Any study of the postwar US economy can therefore be based on the summary NIPA Table 1.2 time series — real quarterly GNP and

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[29]The implementation is by computer program. Source code and output tables are available from the author on request.

[30]Romer, however, believes that Burns and Mitchell fixed their reference cycle from only two composite, 'detrended' indices. See (1994) p. 580.

its sectoral components (as published periodically in *Survey of Current Business*). This was the approach advocated by Mitchell throughout the 1930s, and is the one he would have followed had the data been available. As such, the use of national income accounting data follows NBER methods in both letter and spirit.

As it happens, the data are accessible in a convenient form from 1947 to 1983 in the historical appendix to the 1986 NBER conference volume *The American Business Cycle* compiled by Nathan Balke. The present analysis uses Balke's variables, extended to the end of 1994:

Gross national product	Producers durable equipment
Durable goods	Changes in business inventories
Nondurable goods and services	Exports
Residential structures	Imports
Nonresidential structures	Government purchases of goods and services

In addition, the Table 1.2 sectoral totals for personal consumption expenditure and private domestic investment are included. Consumption is the total of durable and nondurable goods and services; investment is the aggregate of the two structures series, durable equipment and inventories.

This data set gives a balance between detail and generality, and enables an economical, 'top down', strategy to be implemented. As an initial step these variables will be examined for conformity with GNP. The latter, representing total output, can be interpreted as a reference measure. That is, if comovements are present in the postwar US economy then specific cycles in most series should conform to those in GNP. If the required conformity is found, then the components of these Table 1.2 series can in turn be examined; if not, then no further investigation is required. Eight hundred series are hence unnecessary *ab initio*.

Table 1 shows the specific cycles in real quarterly postwar GNP found by the algorithm, and also the NBER and Romer reference dates. Setting the window–length parameter $k=3$ identifies a peak/trough if there are no observations of higher/lower value within ±three quarters. Turning points in GNP (columns 5 and 6) are very close to those of the NBER's and Romer's reference cycles (columns 1–4). The latter are slightly closer to those of the NBER than are turns in GNP, as measured by mean absolute deviations from NBER dates. These are 0.33 and 0.78 quarters respectively for Romer and GNP. Such a result is not surprising: Romer's dates were constructed to reproduce those of the NBER; turning points in GNP have been identified without a prior reference measure. What is surprising, however, is how closely these sets of reference dates track GNP peaks and troughs: both have the same number of turning points; none is adrift by more than three quarters, and then on only one occasion — the NBER trough of 1970.

Given the difficulties encountered by the NBER dating committee in fixing turning points since the 1960s, such discrepancies are to be expected. In fact the largest deviation of the NBER reference turns from those of GNP, apart from 1970, is only one quarter; and in four cases they coincide. The reference measures therefore appear accurately to be tracking fluctuations in aggregate output. Whether this is the same as comovements in the 'many activities' cannot be determined without further statistical analysis, results of which are given in the next section.

If the turning–point algorithm is to follow Burns and Mitchell's methods closely, then the minimum specific–cycle duration should be 15 months (five quarters), and the maximum 12 years (48 quarters). Application to the 11 other NIPA variables produces a small number of instances outside these limits. Table 2 shows three occurrences below the minimum, all of four quarters' duration. Of the 120 complete specific cycles in the sample, only 2½ percent of specific cycles are hence below Burns and Mitchell's minimum. There are two above the maximum: one of 151 quarters in nondurable goods and services; and another of 81 quarters, in personal consumption expenditure. These are again proportionately minimal, at 1.7 percent of the total of specific cycles. Both are too long in duration to qualify as specific cycles. Nondurables have no specific cycles at all according to Burns and Mitchell's criteria; yet ignoring these series would not improve matters. A 'skipped' specific cycle cannot be 'weeded out'. Discarding the series altogether would defeat the object of the analysis, which is to determine whether comovements occur naturally in many activities when a consistent turning–point algorithm is applied. The six instances falling outside the limits are hence included because they highlight the difficulties inherent in the dating of 'business cycles', and because they are too few in number materially to alter the statistical results.

Much has been made of 'growth cycles' in the postwar literature. These are defined as sequences of turning points in series from which a deterministic time trend has been subtracted. Romer argues that trend–adjusted series were probably employed by the NBER in the identification of pre–World War II reference dates. The former can yield turning points very different from those of the unadjusted series if the data have pronounced secular tendencies.[31] As an illustration of this property the algorithm has been applied to the residuals from the regression of GNP on a linear time trend and constant term: i.e., $GNP_t = \alpha + \beta t + \epsilon_t$. The result is given in Table 1, columns 7 and 8. There are more turning points in the regression residuals than in the original series; none of the former coincides with any in the latter. Moreover the residuals are found to be highly autocorrelated, indicating that the regression is misspecified.[32] This confirms Romer's view that trend–adjustment is not a sensible approach to the identification of specific cycles.

III. Results

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[31](1994) pp. 574–575.

[32]Examples of autocorrelation coefficients are: first order, 0.98; sixth order, 0.78.

The comovement hypothesis requires that all series have the same number of specific cycles (and approximately the same number of turning points) and that the timing relations are stable and weighted in favour of coincidences. This section gives results from the application of the turning–point algorithm explained in the preceding section. Evidence of asymmetries and of differential amplitudes is also considered.

Comovements: the Evidence. Postwar turning points are listed in detail for the three principal components of GNP — government purchases, consumption and investment — in Table 3. These do not generally coincide: peaks and troughs in all four series are found only in 1953, 1973/5,1980 and 1989/91, equivalent to only half the total number of specific cycles in GNP. There are instances of turning points in component series having no equivalent in GNP and vice versa. Consumption had 'missing' turning points (i.e., specific cycles) in 1949/50, 1957/58, 1969/70 and 1981/82. Government purchases had 'extras' in the 1970s and 1980s, as did investment in the 1950s, 1960s and 1980s. All three series in Table 3 had at least one multiple turning point: i.e., extra peaks in the second quarters of 1971 and 1981 for government purchases; an extra peak at 1962:2 and a trough at 1967:2 for investment; and a peak at 1981:4 in consumption. In fact GNP is unique among the NIPA series under consideration in having no multiple turning points.

Even the 'weeding' of extraneous turning points, one of the main elements of Burns and Mitchell's approach, does not improve the fit of postwar specific cycles, as Table 4 shows. Here those peaks and troughs which do not have an 'equivalent' in GNP have been discarded — equivalent being in this case a turning point which is either closest to one in GNP, or else one which occupies the same position in the sequence. As an example, the peak in government purchases at 1949:3 is closest to the GNP peak at 1948:4; the peak at 1964:2 in the former occupies the same position as that in the latter at 1960:1, because there is none closer in time (see also Tables 1 and 3). Seven non–equivalent turning points in government purchases (32 percent of its total), 12 in investment (40 percent), and one in consumption (seven percent), shown in Table 4A, have been weeded according to these criteria.

To qualify as a comovement, a sectoral turning point ought to occur in the same quarter as one in GNP; but even when this criterion is relaxed slightly there is little evidence of conformity among these sectoral components. Those 'weeded' turning points in Table 4 occurring within ±two quarters of a GNP equivalent are marked with an asterisk. There are four in government purchases (i.e., 22 percent of the weeded total), nine in investment (half the total) and four in consumption (one–third). The only instance in which all four weeded series turn within ±two quarters of each other was the peak at 1953:2 which coincided with the end of the Korean War. Thus, even applying Burns and Mitchell's 'judgmental' criteria the evidence of turning–point conformity is weak.

In fact historical specific–cycle dynamics are divergent, as shown in Table 5. Only two series — residential and nonresidential structures — had the same number of cycles (12), and no component series had the same number as GNP (eight). The mean specific–cycle durations for the 12 series (column 3) emphasize the wide variations in behaviour — from 11 quarters (just under three years) to 96 quarters (24 years). The mean of the column 3 averages is 27 quarters, which is not very different from the mean of GNP specific–cycle durations, and which suggests that the latter is representative only of the average behaviour of the 'many activities'.

The consumption aggregate differs in its specific–cycle behaviour from both its components: durables had more than twice as many cycles and nondurables only half as many. The closest conformity to GNP was in durable goods and exports, each with only one 'extra' cycle. Investment–sector series were in general more volatile than consumption: the aggregate shows 13 cycles against four in the latter. However, the components of investment conformed more closely than those of consumption: four of the five series were similar but not identical in numbers; inventories was an outlier, with much more volatility than the others. Consumption had only half as many specific cycles as GNP; imports and exports slightly more; and investment and government purchases approximately half again as many. Nondurables, representing just over half of the value of GNP throughout the period, had only two completed cycles; and so cannot really be classified even loosely as 'cyclical'.[33]

The closer conformity of specific–cycle numbers shown for the investment–sector series (Table 5) does not guarantee conformity in their timings. Table 6 shows a comparison of turning points in the aggregate with those in the two construction series. There are 30 turning points in total investment; yet although 21 of these (70 percent) have equivalents in the two other series, the specific–cycle conformity is not as close as that figure suggests. There are 'missing' turning points in both component series. Those marked with a asterisk in the table fall within two quarters of each other in all three series: e.g., the first peaks in the table, at 1948:3, 1948:2 and 1948:4 respectively. There are seven such occurrences in each series: that is, about 23 percent of aggregate, 24 percent of residential and 26 percent of nonresidential turns. Those in the component series within two quarters of each other (but not of the investment aggregate) are marked with the symbol †. There are five in all, 17 and 19 percent of turns in residential and nonresidential structures respectively.

Table 7 shows measures of amplitude: that is, mean peak–to–trough decreases in levels and their variances for each series. Lucas' statement that durable goods is a more volatile series than nondurables is supported by these data: the mean peak–trough decrease in the former in the postwar period is 11.3, but in the latter only 1.9 percent. GNP, with a mean of 2.4 percent, is the least volatile of the aggregates; the others in ascending order are government purchases (3.1), consumption (3.2) and investment (18.2). Variances follow the same ordering. The most volatile in amplitude is the business–inventories series, with

[33]The proportions in Table 1.2 are 56 percent in 1950; 54 percent in 1970; and 58 percent in 1990.

negative as well as positive values and consequently with swings much greater than 100 percent; the least is nondurable goods and services. Investment is the most volatile sector both in aggregate and in its components. All series except nondurables have both greater mean and greater maximum amplitudes than GNP. Consumption, nondurables and government purchases have smaller minimums.

For the reference cycle to be an effective representation of comovements the necessary condition is that it should coincide with peaks and troughs in the majority of sectors. Table 8 shows the numbers of turning points in the 12 NIPA series occurring in the same quarters as NBER reference peaks and troughs. These indicate a lack of concentration of specific–cycle turning points at reference turns. There are two occasions, in 1958 and 1964, in which none of the turning points coincided with the reference turn; on four other occasions three or less turning points coincided; on only one occasion — the trough of 1991 — did the majority of series turn at the reference date. The mean number of specific–cycle peaks at reference peaks is just over three; and of troughs, about 3½ (that is, the means of columns 2 and 4); in both cases about one–quarter of the series in the sample. Average numbers increased after 1969/70: from 2.8 to 4.0 at peaks; and from 2.8 to 5.0 at troughs. The modal number of all turning points is four, which is only one–third of the series; the maximum, in 1991, is eight, or two–thirds.

The degree of clustering can be shown more generally by summarizing the number of turning–points occurring in each quarter as a frequency distribution. Figure 1 shows the histogram for perfectly clustered behaviour. The horizontal axis gives the number of turning points that may be observed in any single quarter, from zero to the maximum number of variables in the sample; the vertical axis shows the frequency, in quarters, of each observed number. The only non–zero frequencies are at the extremes — zero and the maximum number of turning points per quarter — because comovements imply that either all series or none should turn in a given quarter.

If such perfect clustering were observed then the relative frequencies of the zero and maximum classes would depend on the average length of the cycle. The zero–class would increase in frequency as the average cycle length increased, because fewer turning points would occur overall. For example, of the 192 quarters in the period 1947 to 1994, the first and final three quarters are excluded by the operation of the algorithm. Then, if the average cycle–length of GNP were, say, six years (24 quarters), then there would be 7½ specific cycles in the 186 quarters (since 186/24=7¾, or 7½ to the nearest complete half–cycle). Each cycle has exactly one peak and one trough, so that in 15 out of 186 quarters there would have been 12 turning points, and in all other quarters none. If the cycle length is only four years (16 quarters) then by this reckoning the maximum class would have had a frequency of 23 — i.e., reflecting turning points occurring every eight quarters. Such behaviour gives the U–shaped distribution shown in Figure 1.

Results already summarized in Tables 3, 5 and 8 suggest that clustering was not the case historically. The frequency–distribution for the NIPA data, plotted in Figure 2, confirms this: it is not U–shaped, but rather skew, with a peak at unit frequency. Its zero–class has a comparatively low frequency, and its maximum class has zero frequency. Such a distribution provides little evidence of clustering.

The Problem of Leads and Lags. Variations in specific–cycle numbers, shown in Table 5, pose a dilemma for the investigator of timing relations. In order to determine systematic leads or lags over GNP it is necessary to compare equivalent turning points, which means the weeding out of 'extra' cycles. Table 9 shows the result of such an analysis for the 11 component series. Following the same criteria as for Table 4, those turning points without an equivalent in GNP are discarded. The extent of weeding is in the range 22 to 57 percent of turning points, making the results difficult to interpret. In particular, consumption and nondurables present problems, since both series have fewer turning points than GNP, the 'reference' series in this analysis. The weeding of the latter, which strictly speaking should not be modified, is thus required.

Nevertheless, even after weeding the timings are volatile. All series but nondurables have substantial numbers of changes in timing (Table 9, column 8), that is from coincident to leading to lagging, etc. The range of these is from 13, or one every 3½ years on average, in residential structures, to two, or one every 24 years, in nondurables; the average number of changes is eight. All series but government purchases, which is principally a 'lagging indicator', show instances of coincident, leading and lagging relations, more or less evenly divided. Maximum leads and lags are also volatile (columns 6 and 7). Government purchases has the largest swings, with maxima of +7 and −17 quarters. Nondurables is much less volatile, and is the only series whose maximum leads and lags, +2 and −1 quarters (that is +6 and −3 months), are of the same magnitudes as those of official indicators published in *Survey of Current Business*.

Volatility of timing is also found within sectors. Table 10 shows the result of a comparison of two investment series in the same sector with similar numbers of specific cycles — residential and nonresidential structures. The latter is volatile in its leads and lags over the former, as can be seen in columns 3 and 4; and the number of changes in timing, shown at the bottom of the table, is still comparatively large. There were four leads and 18 lags, the maxima being +9 quarters, in 1984, and −7, in 1959 and 1978. There were four timing changes, occurring at irregular intervals in 1964, 1965, 1984 and 1990.

Asymmetries. Blanchard and Fischer point out that the dominant feature of macroeconomic history over the past two hundred years has been output growth.[34] As noted by Moore and Zarnowitz, growth gives rise to durational asymmetries between expansions and contractions. In the NBER reference cycle, for example, expansions on average lasted 17, and contractions 3½ quarters, in the period since 1947. The figures for GNP are 16½ and 2½ quarters respectively, and such durational asymmetries are found in all other series.

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[34](1989) p. 1.

There is also an asymmetry relating to the general economy. Figure 3 shows the percentage of variables with quarter–on–quarter increases since the beginning of 1947. This 'diffusion index' of expansions is a familiar measure: versions of it are published monthly in the *Survey of Current Business* 'Business Cycle Indicators' section. It has also been used as a criterion for identifying 'recessions', as periods in which fewer than 50 percent of variables show increases in levels.[35] The index shown in Figure 3 occupies the region above the 50–percent level in the majority of quarters since 1947, thus suggesting a 'diffusion asymmetry' in the US macroeconomy.

This feature can be seen in detail in Table 11, which gives the percent of quarters in which the level of each variable increased over the previous quarter. During the period 1947 to 1994, nine of the 12 NIPA series in the present study increased in more than 60 percent of quarters. The most persistent growth was in GNP, consumption and nondurables, all increasing in more than 80 percent of quarters. Only two, residential structures and business inventories, were close to the 50–percent level; and none was below 50 percent.

Table 12 shows the relative frequencies of each level of increase and decrease per quarter. Column 1 gives the number of series; column 2 shows the percentage of sample quarters in which each number of series increased; and column 3, the percentage of quarters in which each number decreased. Thus, for example, all 12 series increased in 6.3 percent of quarters (bottom row of table), but in no quarter did all 12 decrease (first row). At the other end of the scale the were no quarters in which none of the 12 series increased; but 7.9 percent in which none decreased. In 77.0 percent of quarters the majority of series (i.e., seven or more) increased; in only 14.1 percent did a majority decrease. The statistics thus concur with GNP and reference–cycle asymmetries, suggesting that episodes of general 'recession' have been less likely to occur and less prolonged since the War.

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[35]An example of such an application is in Simpkins (1994) p. 387.

V. Conclusion

Such is the prestige of Burns and Mitchell that their 'definition' of business cycles has always been assumed to be an accurate description of empirical behaviour. The practice of reference–dating has been justified by an appeal to prewar statistical evidence, which is interpreted as 'proof' that the 'many economic activities' always comove. Evidence of postwar fluctuations shows that such an assumption is far from legitimate, and that economic fluctuations are, in Romer's phrase, 'a very complex phenomenon'. When a consistent algorithm for the identification of specific cycles in the principal NIPA time series is applied, the following patterns of fluctuation are revealed.

1. NBER reference dates closely match the specific cycles in GNP rather than comovements in the 'many activities'. The principal NIPA (Table 1.2) aggregates show extensive variations in specific–cycle timing and duration: only four reference turns (or alternatively turns in GNP) coincide with peaks or troughs in consumption, investment and government purchases. On only one occasion since the war has the majority of these series reached turning points in the same quarter as a turn in the reference cycle. Compared to GNP, 'extra' specific cycles occurred in investment and government expenditure during the 1960s and 1980s; cycles in consumption were 'skipped' in the same periods. There are also instances of 'double' peaks and troughs, similar to those found by Burns and Mitchell. Moreover, fluctuations in nondurables and services, representing half the value of postwar US economic output, are so rare that it is questionable whether they are 'cyclical' in the sense of the 'definition'.

2. Divergences in timing occur even when 'extraneous' turning points are 'weeded' following interwar NBER practice: for example, only half the 'weeded' turns in investment occur within two quarters of equivalent GNP turns. There are also divergences among sectoral components: less than half the investment sector series reached peaks or troughs within two quarters of equivalents in their aggregate. Such behaviour suggests

that no aggregate is an accurate representation of the specific–cycle characteristics of its components in the US economy since World War II.

3. Leads and lags, even after 'weeding', are unstable and unpredictable. This is a function of the variability of specific–cycle duration and timing. However, the extent of weeding required for the lead/lag analysis is so great that the results are difficult to interpret.

4. Sectoral amplitudes also vary, consumption being less volatile than investment. In this case behaviour is closer to that assumed in theoretical models — for example, by Lucas (1977).

5. Postwar expansions and contractions in the macroeconomy have been asymmetric; the former are more diffused and persistent than the latter.

6. 'Detrending' produces markedly different specific–cycle dynamics from those of the original series. The analysis of 'growth cycles' relying on deviations from a smooth time–trend is therefore unsatisfactory.

Comovements are not found among US macroeconomic time series in the period since *Measuring Business Cycles* was published. It is unlikely that such a result would have surprised Burns and Mitchell, for it lends support to their view that each episode is 'unique', and that historical dynamics are behaviourally divergent. The stylization of the reference cycle has made it relevant to the formulation of a theory of business cycles rather than as a description of actual behaviour.

None of the 'business cycle facts' on which current research is based is therefore reliable. Although the reference cycle tracks turning points in GNP with great skill and consistency, it is not useful in tracking or predicting component fluctuations. Consumption, for example, had only half the number of specific cycles as GNP;

investment, half again as many. By using 'reference dates' obtained from an industrial production series to compare pre– and post–war 'business cycles', Romer's analysis is at best valid for one sectoral aggregate. As has been demonstrated, no 'general' state of business conditions can be inferred from any single time series or index in the postwar period. The historiography of postwar stabilization as mere statistical illusion is certainly not valid on the evidence of a modified reference chronology alone. Turning points in Romer's index series do not capture the behaviour of, say, consumption or the service sector, both of which have longer and gentler specific cycles than any production series.

On the contrary, the analysis of postwar 'stabilization' requires a multi–sectoral approach. This is implicit in Watson's conclusion that differences between pre– and postwar durations are the artifacts of the volatile series used to determine the prewar reference dates. On this basis he should perhaps have been more cautious about generalizing from univariate measures and about making 'reference', rather than sector–by–sector comparisons. His data nevertheless point to the conclusion of the present study, and could even have preempted it had he looked beyond reference measures. At all events there is nothing in the present results inconsistent with Watson's analysis of specific cycles.

Macroeconomists seem thoroughly to have misunderstood *Measuring Business Cycles*. Their theoretical models are invalidated by the assumption of comovements, justified by the supposed 'business cycle facts' of Burns and Mitchell. They fail to recognize that historical episodes are all different, that comovements are not found in empirical data, and hence that univariate measures cannot adequately represent the behaviour of the 'many activities'. Their models need thus to be recast to take account of sectoral divergences.

Diffusion asymmetries imply that, given a sufficient rate of economic growth, 'recessions' will always be more difficult to identify by the NBER '3–D' criteria than expansions. Hence the problems of 'recession'–dating noted by Hall are likely to be encountered normally rather than exceptionally. Given strong growth since the war, asymmetric behaviour in an epoch of strong growth may have been an effect of 'accelerations and retardations of a more fundamental process'.

In answer to the question posed earlier: the US reference cycle has coincided with specific cycles in GNP rather than with comovements in the 'many activities'. The statistical evidence of postwar economic fluctuations, when not biased to enforce conformity to a reference cycle, suggests that the former are 'largely unsystematic and unpredictable', and can only be measured by 'a vector of many diverse activities that are not reducible to any single aggregate' (*per* Moore and Zarnowitz).

The three criteria for comovements set out in Section II have not been met: turning points are not clustered; numbers of specific cycles diverge; and leads and lags are unstable. There are hence no 'general' business cycles in the postwar US economy answering to Burns and Mitchell's definition. It would appear that sectoral durations and timings, especially of consumption and investment, have few common features. Indeed, given the behaviour of the principal components of consumption, a good proportion of US economic activity may not have been cyclical at all in the sense commonly understood. The best that can be said is that there may be 'several sets of cycles running concurrently', as Burns and Mitchell speculated: i.e., in certain areas of industrial production, investment, government expenditure and international trade. On the other hand the distinction between stylized summary statistics and the actual history of business cycles, which was the essence of Burns and Mitchell's approach, is validated by the results of the present study.

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TABLE 1

US Reference Dates and Turning Points in GNP, 1948–1991 (Year: Quarter)

Reference Dates				GNP	
Romer		NBER			
(1)	(2)	(3)	(4)	(5)	(6)
Peaks	Troughs	Peaks	Troughs	Peaks	Troughs
1948:4	1949:4	1948:4	1949:4	1948:4	1949:2
1953:3	1954:3	1953:2	1954:2	1953:2	1954:4
1957:3	1958:2	1957:3	1958:2	1957:3	1958:1
1960:2	1961:1	1960:2	1961:1	1960:1	1960:4
1969:4	1970:4	1969:4	1970:4	1969:3	1970:1
1973:4	1975:3	1973:4	1975:1	1973:4	1975:1
1980:1	1980:3	1980:1	1980:3	1980:1	1980:2
1981:3	1983:2	1981:3	1982:4	1981:3	1982:3
1990:3	1991:1	1990:3	1991:1	1990:2	1991:1

TABLE 1 (continued)

Turning Point in GNP Regression Residuals (ϵ_t), 1948–1991

(Year: Quarter)

(7) Peaks	(8) Troughs
	1949:4
1951:3	1952:3
1953:1	1954:2
1955:3	1958:2
1959:2	1961:1
1962:2	1964:4
1966:1	1967:2
1968:3	1970:4
1973:1	1975:1
1978:4	1980:3
1981:1	1982:4
1984:1	1986:4
1988:3	1991:1
1992:3	

TABLE 2

Specific Cycles outside Burns and Mitchell's Durational Limits

Series	Dates (Year: Quarter)
a. Below Five Quarters	
Changes in business inventories	1970:4–1971:4
Imports	1969:2–1970:2
Private domestic investment	1988:3–1989:3
b. Above 48 Quarters	
Nondurable goods and services	1953:4–1992:3
Personal consumption expenditure	1953:2–1973:3

TABLE 3

Turning Points found by the Algorithm in Principal Components of GNP

Government Purchases		Private Domestic Investment		Personal Consumption Expenditures	
(1)	(2)	(3)	(4)	(5)	(6)
Peak	Trough	Peak	Trough	Peak	Trough
1949:3	1950:3	1948:3	1949:2	—	—
—	—	1950:4	1952:2	1950:3	1951:2
1953:4	1955:2	1953:2	1953:4	1953:2	1953:4
1958:4	1960:1	1955:4	1958:2	—	1958:1
—	—	1960:1	1960:4	1960:2	—
—	—	—	1962:4	—	—
1964:2	1965:1	1966:2	1967:2	—	—
1968:3	1970:2	1967:4	—	—	—
—	1971:2	1969:3	1970:4	—	—
1972:1	1973:2	—	—	—	—
1975:4	1976:3	1973:4	1975:1	1973:3	1974:4
1980:2	1980:4	1978:4	1980:3	1979:4	1980:2
—	1982:2	1981:3	1982:4	—	1981:4
1982:4	1983:4	1984:3	1985:3	—	—
1987:4	1988:3	1986:1	1986:4	—	—
—	—	1988:3	1988:4	—	—
1991:3	1992:3	1989:3	1991:1	1990:3	1991:1
1992:4	—	—	—	—	—

TABLE 4

Principal NIPA Aggregates: Turning Points Equivalent to those in GNP after 'Weeding'

(Year: Quarter)

GNP		Government Purchases		Private Domestic Investment		Personal Consumption Expenditures	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough
1948:4	1949:2	1949:3	1950:3	1948:3	1949:2*	1950:3	1951:2
1953:2	1954:2	1953:4*	1955:2	1953:2*	1953:4	1953:2*	1953:4
1957:3	1958:1	1958:4	1960:1	1955:4	1958:2	—	1958:1*
1960:1	1960:4	1964:2	1965:1	1960:1*	1960:4*	1960:2	—
1969:3	1970:1	1968:3	1970:2*	1969:3*	1970:4	—	—
1973:4	1975:1	1972:1	1976:3	1973:4*	1975:1*	1973:3	1974:4
1980:1	1980:2	1980:2*	1980:4*	1978:4	1980:3	1979:4	1980:2*
1981:3	1982:3	1982:4	1983:4	1981:3*	1982:4	—	—
1990:2	1991:1	1991:3	1992:3	1989:3	1991:1*	1990:3	1991:1*

*Turning points within ±two quarters of an equivalent in GNP

TABLE 4A

'Weeded' Turning Points in Principal Components of GNP

(Year: Quarter)

Government Purchases		Investment		Consumption	
(1)	(2)	(3)	(4)	(5)	(6)
Peak	Trough	Peak	Trough	Peak	Trough
		1950:4	1952:2		
			1962:4		
		1966:2	1967:2		
		1967:4			
	1971:2				
	1973:2				
1975:4	1982:2				1981:4
		1984:3	1985:3		
		1986:1	1986:4		
1987:4	1988:3	1988:3	1988:4		
1992:4					

TABLE 5

Completed Postwar Specific Cycles in 12 NIPA Series:

Numbers and Average Lengths

Series	Number	Average Duration (quarters)
GNP	8	24
Personal consumption expenditures	4	48
Durable goods	9	21
Nondurable goods and services	2	96
Private domestic investment	13	15
Residential structures	12	16
Nonresidential structures	12	16
Producers durable equipment	11	17
Changes in business inventories	18	11
Imports	11	17
Exports	9	21
Government purchases	11	17

TABLE 6

Turning Points in Two Construction Series: Comparison with Aggregate Investment

		Construction Sector			
Private Domestic Investment		Residential Structures		Nonresidential Structures	
Peak	Trough	Peak	Trough	Peak	Trough
	—			—	1947:4
1948:3*	1949:2*	1948:2*	1949:2*	1948:4*	1949:4*
1950:4	1952:2	1950:3	1951:3†	1951:2	1951:4†
1953:2	1953:4	1953:2	1953:4	—	—
1955:4	1958:2*	1955:2	1958:2*	1956:4	1958:3*
1960:1	1960:4	1959:2	1961:1†	1961:1	1961:3†
	1962:4	1964:1	1964:4	1962:3	1963:1
1966:2	1967:2*	1965:2	1967:1*	1966:3	1967:2*
1967:4		—		—	
1969:3*	1970:4	1969:1*	1970:2	1969:3*	1971:4
1973:4	1975:1*	1973:1†	1975:1*	1973:3†	1975:1*
1978:4		—	1978:1	—	1977:1

(TABLE 6: Continuation)

Private Domestic Investment		Residential Structures		Nonresidential Structures	
Peak	Trough	Peak	Trough	Peak	Trough
	1980:3*	1978:2	1980:2*	1980:1	1980:3*
1981:3	1982:4	—	1982:1	—	—
1984:3	1985:3	1984:2	1984:4	1982:1	1983:2
1986:1		1986:3		1985:2	
	1986:4		—	1987:4	—
1988:3	1988:4	—	1988:1	—	—
1989:3		—	1989:4†	—	1989:2†
	1991:1	1990:2†	1991:1	1990:1†	1994:1

*Turning points within ±two quarters of an equivalent in the aggregate

†Additional turning points in the two construction series occurring within ±two quarters of each other

TABLE 7

Peak–to–Trough Amplitude Measures in 12 NIPA Series

Series	Mean Percentage Decrease in Levels	Variance	Maximum Percentage Decrease	Minimum Percentage Decrease
GNP	2.4	1.4	4.9	1.0
Personal consumption expenditure	3.2	12.7	10.1	0.5
Durable goods	11.3	37.7	26.9	3.7
Nondurables and services	1.9	1.1	2.8	0.8
Private domestic investment	18.2	76.7	34.1	3.7
Residential structures	19.2	126.4	34.7	2.8
Nonresidential structures	9.8	37.5	21.8	2.2
Producers durable equipment	10.6	25.2	18.9	4.0
Changes in inventories	102.2	3411.5	240.6	31.3
Imports	7.4	50.2	28.6	1.2
Exports	10.4	37.9	18.5	1.6
Government purchases	3.1	9.1	12.2	0.6

TABLE 8

Numbers of Specific–Cycle Peaks and Troughs in 12 NIPA Series Occurring Simultaneously with NBER Reference Dates

(Year: Quarter)

NBER Peak	Number of Peaks	NBER Trough	Number of Troughs
1948:4	2	1949:4	4
1953:2	5	1954:2	2
1957:3	2	1958:2	0
1960:2	3	1961:1	4
1969:4	0	1970:4	4
1973:4	3	1975:1	4
1980:1	5	1980:3	4
1981:3	4	1982:4	4
1990:3	4	1991:1	8

TABLE 9

Analysis of Timing relations in 11 Component Series against GNP Turning Points

Series	Percentage Weeded	Number of Leads	Number of Lags	Number of Coincidences	Maximum Lead (quarters)	Maximum Lag (quarters)	Number of Timing Changes
Consumption†	56	5	3	2	+2	–7	4
Private domestic investment	40	6	4	8	+7	–3	11
Government purchases	28	3	15	0	+7	–17	4
Durable goods	22	9	7	2	+5	–13	8
Nondurable goods and services†	43	2	1	1	+2	–1	2
Producers durable equipment	26	21	9	6	+3	–3	8
Residential structures	38	8	5	5	+9	–11	13
Nonresidential structures	33	5	9	4	+10	–12	11
Imports	41	6	7	3	+3	–3	11
Exports	28	5	11	2	+22	–10	9
Changes in business inventories*	57	6	4	8	+11	–3	11

*Inventories rise during 'recessions'. Timings of peaks have thus been measured against troughs in GNP, and vice versa.

†Series with fewer turning points than GNP; the latter is 'weeded' in these cases.

TABLE 10

Comparison of Timings in Two Investment Series

Residential Structures		Nonresidential Structures	
Peak (year: quarter)	Trough (year: quarter)	Lead(+)/Lag(–) over Residential Structures at Peak (in quarters)	Lead(+)/Lag(–) over Residential Structures at Trough (in quarters)
1948:2	1949:2	–2	–2
1950:3	1951:3	–3	–1
1953:2	1953:4	—	—
1955:2	1958:2	–6	–1
1959:2	1961:1	–7	–2
1964:1	1964:4	+2	+7
1965:2	1967:1	–5	–1
1969:1	1970:2	–2	–6
1973:1	1975:1	–2	–1
1978:2	1980:2	–7	–1
1984:2	1984:4	+9	+5
1990:1	1991:1	–2	–3
Number of changes in timing			4

TABLE 11

Increases in Levels, 12 NIPA Series, 1947–1994

Series	Percent of Quarters showing Increases
GNP	83.2
Personal consumption expenditure	86.4
Private direct investment	63.4
Government expenditure	67.5
Producers durable equipment	67.5
Durable goods	67.5
Nondurable goods	89.0
Exports	65.4
Imports	70.8
Nonresidential structures	59.2
Residential structures	53.4
Changes in business inventories	54.5

TABLE 12

Relative Frequencies of Increases and Decreases over Previous Quarter

Number of Series	Percent of Quarters with Increases	Percent of Quarters with Decreases
0	0	7.9
1	1.0	13.6
2	1.6	15.2
3	3.1	17.8
4	2.6	9.9
5	5.8	12.6
6	8.9	8.9
7	12.6	5.8
8	11.0	2.6
9	16.8	3.1
10	16.2	1.6
11	14.1	1.0
12	6.3	0

Figure 1. Frequency Distribution, Clustered Turning Points

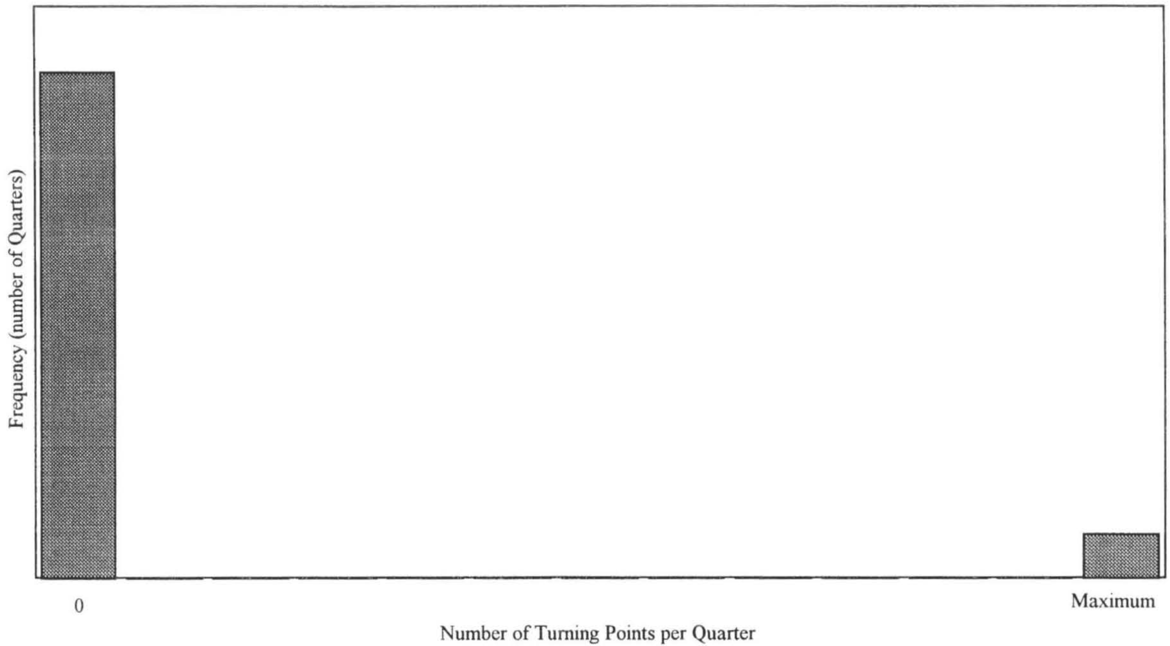


Figure 2. Turning–point Frequency Distributions, 12 NIPA Series, 1947–1994

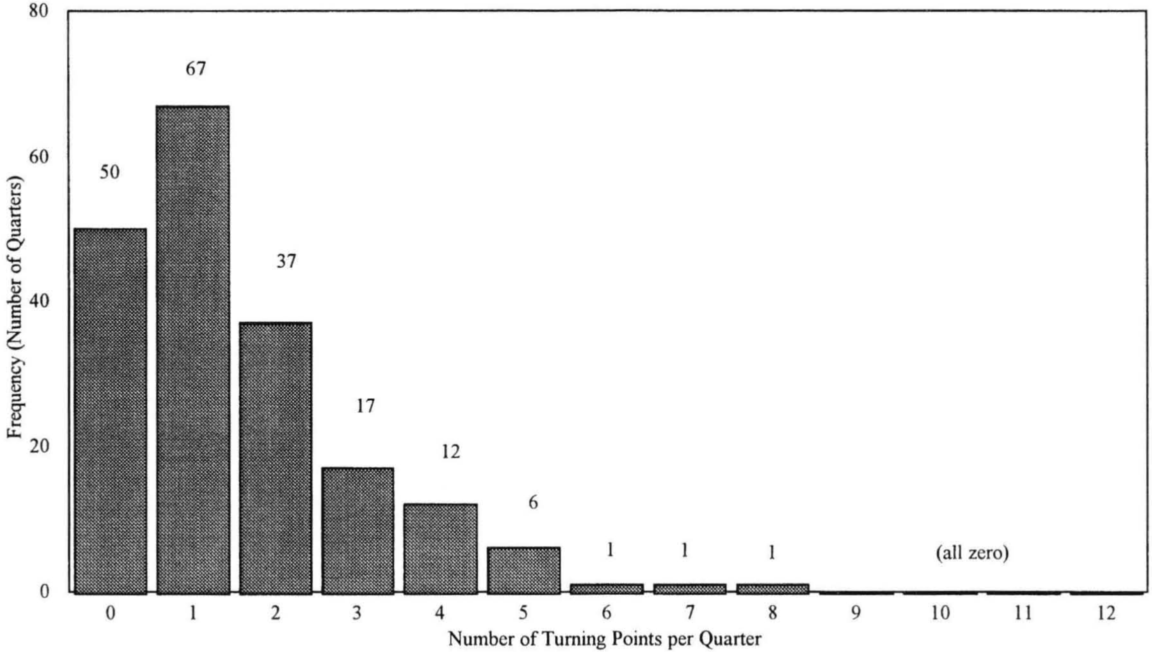
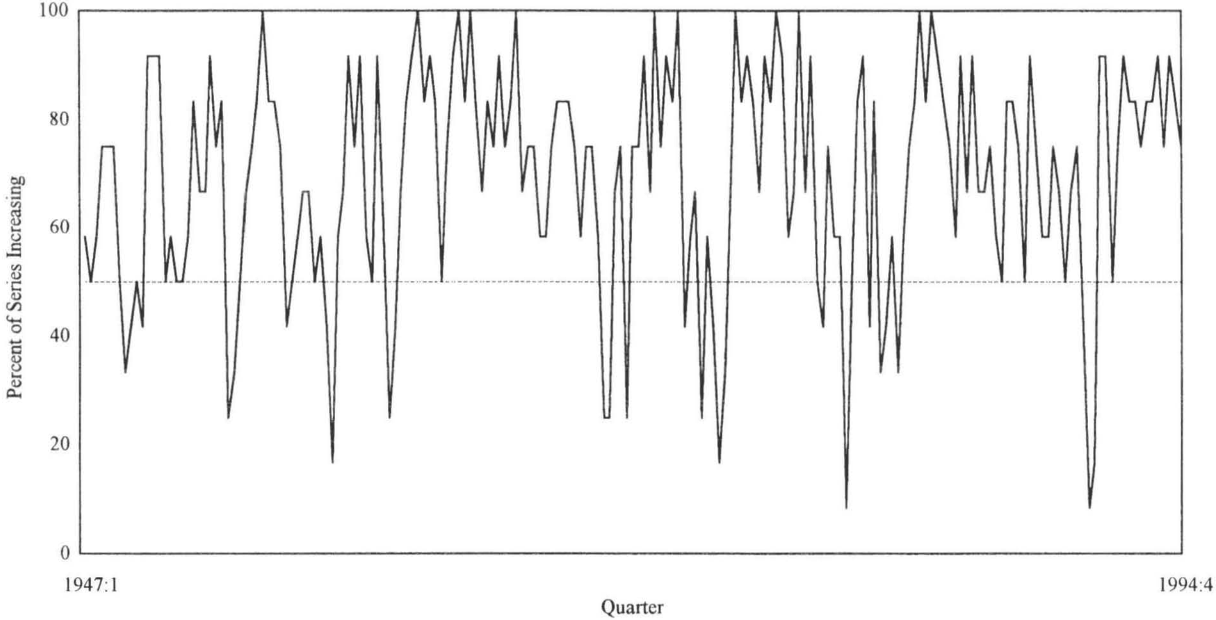


Figure 3. Diffusion of Quarterly Increases in Levels, 12 NIPA Series, 1947–1994



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