ARTICULATING THE TIME DIMENSION FOR ECONOMIC ANALYSIS

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I. The Need for Articulation

This paper deals with various ways in which the time variable can be handled in the statistical analysis of economic behavior. In our rapidly changing society, one thing is certain: at any point in time economic conditions are different from those at any other point. Similarities and regularities, not to speak of constancies, must be discovered and can rarely be presumed. It is true, of course, that the search for regularities and differences must not be blind. We have the right to expect peacetimes to differ from wartimes, inflations from deflations, fair deals from square deals, cyclical expansions from contractions, and so forth. Conversely we may hope that all contractions, all periods of steady growth--or perhaps some of them--have features that permit qualitative and quantitative generalizations as well as identification of unique experiences.

Analyses of individual time series are usually well attuned to the need for describing, and distinguishing between, the historically unique, the cycle specific, and the systematically pervasive.[1] They permit visual and quantitative distinction between early and late segments; long-term, cyclical, seasonal, and irregular behavior; and behavior during subperiods that may be homogeneous with regard to specified characteristics. Maintenance of historical integrity by unsummarized descriptions, as well as the summarization of like subperiods, is at least possible on the basis of the conventional Harvard technique of time series desegregation; it is a major concern of the various forms of business cycle analysis developed at the National Bureau of Economic Research.[2]

However, in describing economic relationships among several activities--whether by regression analysis, econometric model-building, or cross-spectra--we tend to proceed as if economic behavior were a basically stable process. This is reflected in the fact that most applications of these approaches describe economic behavior by a fixed selection of variables to which constant coefficients are attached and presumed to be valid over extended time periods without much regard to the characteristics of subperiods. The presence of an explicit time variable and the behavior of "residuals" reflect some aspects of changing dynamics. The time variable, however, veils rather than reveals the long-term functional relationships between the included variables. And the residuals do not, of course, describe changes in relationships.

It is the thesis of this paper that treating time summarily is neither desirable nor necessary, and that relationships should be described and tested for relevant subperiods, however they may be defined. Any specified segmentation of the time scale will be termed its articulation.

II. Articulations Currently in Use

The idea of subdividing the time period of analysis is certainly not new to theorists, econometricians, or others. Formulations are found in the literature that refer only to narrowly specified time periods, specified cycle phases, specified time series components, and so forth. A brief sampling of recent publications will show the wide variety of ways in which the time dimension has been handled in economic analysis.

At one extreme there is the undifferentiated treatment of time; parametric stability is assumed throughout the period of observation and frequently beyond. Many of the newer analyses that use econometric models are highly sophisticated with regard to inclusion of variables, degree of desegregation, statement of interdependencies, use of optimal or of distributed lags, expansion of strategic subsectors, analysis of residuals, and so on. But they tend to postulate the basic stability of the systematic relationships during the time period covered.

At the other extreme are formulations that stress the historical uniqueness of economic relationships during narrowly defined time periods. Economic historians can be expected to be most conscious of this uniqueness. The informal model

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Acknowledgment: It gives me pleasure to acknowledge my indebtedness to Charlotte Boschan, who prevented me from overestimating the justness of my cause; to Geoffrey H. Moore, who always makes me work a little more; to Judy Feins, whose assistance permitted me to work a little less; and to H. Irving Forman, who drew the charts. The electronic computer time needed for the calculations was provided by a grant from the International Business Machines Corporation.

constructed by Conrad and Meyer to investigate the profitability of the slave system before the Civil War is an example.[3] An obvious implication of their approach is the belief that analytical problems, strategic variables, and of course most parameters can differ vastly from period to period. Hence there is a need to construct models that mirror the conditions of the specific regime. Prices of slaves, costs of their sustenance and reproduction, yields per slave and per acre, prices of cotton--these are the variables necessary to understand the dynamics and test the viability of economic institutions during that particular period.

But it is not necessary to hark back that far in history to establish the need for restricting the validity of economic models to a small number of years. Rendigs Fels devised a special model to explain the 1948-49 recession. It is highly pertinent, for our purposes, to listen to his reasons: "Since the circumstances preceeding the 1948 downturn were unusual, none of the general-purpose models of the business cycle fits the facts adequately, and nobody has devised a model for this special purpose."[4] Fels's model is "special issue," both with regard to variables and, of course, to parameters. Arguments about the uniqueness of historical circumstances could of course be advanced for any contraction, expansion, or, for that matter, any other subdivision of economic history. Fels is quite aware of the broad methodological significance of his procedure, for, in writing about historically unique models in connection with business cycle research, he concludes that "it is surprising that this approach did not long ago become standard operating procedure for those like myself who study business cycles as historical individuals...it seems to me quite possible that we shall solve the riddle of the business cycle only by constructing tailor-made explanations for each one and then examining them for the common elements running through them all."[5] Fels asks for rigorous formulation of relationships during narrowly defined periods and for conclusions drawn from comparative analysis. In view of the theory-bound nature of models, this approach may lack the objectivity that is sometimes associated with induction. However, in the context of the present concern, his arguments for formulations during contiguous historically and cyclically defined time periods, with comparisons and summarizations thereafter, are of great relevance.

Theoretical and empirical justification for historical segmentation is not hard to find. Even basic mechanisms change their character--temporarily or permanently. Gardner Ackley writes: "Fixed investment has generally been viewed as the main source of instability in the economy. Theoreticians have devised several mechanisms which account for its unstable behavior. The experience of the mid-1950's reinforced our preconceptions on the subject.[6] Then why didn't it happen this time?" The implication is that other formulations of economic interrelations may be required for recent years than for the fifties.[7]

Between the extremes of undifferentiated and historically articulated treatment of time, there are attempts to combine what may be called dynamically related time segments. These may be groupings into short- or long-term movements, cyclical expansions and contractions, or other subdivisions. One of the oldest distinctions is that between long-term and short-term relationships.[8] Franco Modigliani, in his analysis of the saving-investment ratio, distinguishes a secular movement that "carries real income per capita above the highest level reached in any year," from a cyclical movement, up or down, that "leaves real income per capita below the highest previous peak." As a result of this distinction, he obtains a measure of cyclical marginal propensity to save of .23 which is strikingly different from a secular propensity of only about .10 or .11. Similarly, Paul Boschan,[9] in his analysis of steel production, shows that a crude correlation with industrial production for the period 1919-40 leads to a regression equation that describes neither cyclical nor trend relationships. Boschan distinguishes between a capacity-determined long-term relationship (represented by an associated function of capacity estimates) and an inventory-demand-determined short-run cyclical relationship (represented by capacity utilization rates). He also distinguishes between demand conditions during the twenties and thirties. These distinctions are not only analytically superior but they result in closer relationships and in improved projections, both for the short and the long term. Note that Modigliani and Boschan solved their problem of articulation not by explicit segmentation of the time scale but by a formulation that allows for differential responses depending on whether there is much slack or little slack in the economy. These time periods were delineated by the behavior of a specific variable.

More recently, Milton Friedman[10] differentiated between the consumption effect of permanent income and that of transitory income. This distinction is closely related to the problem of articulating the time dimension. Friedman not only measures the effects of the permanent income component by relating income to consumption over extended periods but also explains the systematic tendency of the income elasticity of consumption to rise with the extension of the measurement period. He stresses the different responses of consumers during extraordinary periods such as the two world wars and the Great Depression. The following observations are of particular relevance: "Human beings are more flexible than the particular mathematical equations we used to summarize their behavior; they recognized, as the equations could not, that the Great Depression was something exceptional and special to be taken into account in a different way than the run-of-the-mill up and down of economic activity."[11] This raises the

question whether such extraordinary periods should perhaps be excluded from the material that serves as the basis for broad generalizations and the economic mechanisms under such circumstances be described separately.

A cycle-phase oriented articulation was used in Duesenberry, Eckstein, and Fromm's[12] simulation of recession experiences for different mixes of automatic stabilizers. The experiment was conducted for a recession starting in the third quarter of 1957. The parameters were based on historical evidence for the postwar period, and sometimes for earlier years. A clear distinction between recession and nonrecession experiences was made: "For several of the equations... the system is assumed to behave differently in recessions than at other times. Data drawn only from recession periods were used to estimate these functions. As a consequence the model is appropriate only for recessions. It is not designed to explain the upper turning point in the business cycle, nor is it appropriate for periods of general prosperity....A model fitted to a wider range of business cycle conditions might not have been able to reflect the stability properties of the system."[13]

Several other authors distinguish between expansions (or early, late, and full expansions) and contractions. They present parameters separately for every cycle phase, for all corresponding cycle phases,[14] and for long-term relationships. A number of analyses differentiate time periods or single years by introducing dummy variables into the descriptive equations. This may well be used to characterize time periods and years as similar to others, as dissimilar from others, or as unique. The analysis may suggest the existence of differences in structural relationships during different time periods. However, the coefficients of the dummy variables do not describe the differential relationships themselves, if they exist.

Let us conclude our report with a particularly interesting instance, in which cyclical articulation did not only affect the parameters but also led to a radically dichotomous formulation of cyclical dynamics. Meyer and Glauber[15] hypothesize that under conditions of full capacity utilization, a type of accelerator mechanism determines investment behavior. By contrast, during slack periods in the utilization of existing capacity, investment is strategically influenced by cash inflows from current operations. Regardless of the validity of this hypothesis, its mere existence emphasizes the possibility of the dominance of different economic mechanisms at different times, and the loss of insight that may result from a failure to articulate the time dimension.

III. Some Experiments with Articulation

This section demonstrates the wide variation in statistical measures that may result from alternative articulations of the time dimension, and the benefits that may accrue from such articulation. First we shall experiment with alternative time segments, then with alternative time units and time spans.

In the first group of experiments, correlation and regression analysis is applied to various time segments of four variables--the dependent variable corporate profits, and the independent variables corporate product, unemployment rate, and time. Corporate product is meant to reflect industry growth and possibly the associated external and internal economies of scale; it is expected to vary positively with profits over the short and long run. The unemployment rate is introduced as a stand-in for capacity utilization. On a gross basis it should be inversely related to profits, particularly for cyclical movements. At very low unemployment rates (very high capacity utilization), the relationship may be expected to weaken. Finally, the time variable is introduced to relieve the other independent variables from explaining long-term relationships so that they may reflect shorter-term responses more effectively. Several combinations of the three independent variables are used, but no lags--mainly to avoid undue proliferation of alternatives. Let us begin our experiments with bivariate analysis.

Chart 1 shows corporate profits plotted against corporate product. The long line of average relationship, identified by its regression coefficient b = .13, is the least-squares approximation for the full period 1946/I-1966/I. Note that the line provides only a moderately good fit: it is steeper than the scatter configuration during the first five years, flatter than the configuration during the last four or five years, and it fails to represent either the long-term or the short-term responses during the middle period. Nevertheless, as column 2 of Table 1 shows, the correlation coefficient is as high as .93, the adjusted coefficient of determination .86. The reason for the high correlation is, of course, the pronounced upward trends in both series.[16] These create a huge total variance, of which the unexplained variance constitutes only a small fraction. For our purpose, this means that the correlation coefficients may be unsatisfactory criteria for comparing the effectiveness of subdividing the period into major time segments. This will become apparent shortly.

Chart 1 also contains regression lines for three subperiods which are identified.[17] Obviously the fit for the early and late segments is very close, with correlation coefficients of .99 in both cases. The slope of the regression line for the middle segment expresses the long-term tendency of this segment better than the line for the full scatter. The correlation coefficient, however, is only .53, with an adjusted R-square of .27. This merely reflects the fact that the short-term fluctuations of profits are inadequately explained by the regression. Visual inspection of the scatter supports the contention that subdivision of the time period led to

markedly improved representation, particularly for the first and last segments. The difference between the regression coefficients (.33, .06, and .22 respectively) seems to indicate that responses were substantially different in the three segments.

It was noted that the short-term response patterns during the middle period are not well represented by its regression line. Let us see what further subdivision of the time variable will do.[18] Chart 2 reflects a subdivision of time into segments that show similar response patterns. The scatter suggests that early profit contractions are relatively mild and inversely correlated, uncorrelated, or perhaps positively correlated with the continuing rise in corporate product.[19] By contrast, during late profit contractions and the subsequent expansions, a sharp positive response pattern is found. The similarity among the responses is well described by regression coefficients within the narrow range of .34 to .42. These results are important, and suggest that proper articulation of the time dimension may permit discovery of homogeneous response patterns in a number of (cyclical or other) subperiods that lend themselves to common inquiry and effective generalizations.

It may be said that this periodization was "ex post" and thus subject to methodological objections. Although pragmatically discovered similarities are legitimate starting points for analytical inquiries, it is not necessary to depend on them. Systematic regularities in responses of corporate profits to corporate product can also be found within a predetermined framework of time periods. The following tabulation shows the regression coefficients (profits versus product) for expansion and contraction periods of general business activity, as delineated by the business cycle chronology of the National Bureau (shown in years and quarters).

Expansions	Regression Coefficients
1946/1 to 1948/4	+.34
1949/4 to 1953/3	+.14
1954/3 to 1957/3	+.09
1958/2 to 1960/2	+.26
1961/1 to 1966/1	+.22
Contractions	
1948/4 to 1949/4	+.55
1953/3 to 1954/3	+.21
1957/3 to 1958/2	+.56
1960/2 to 1961/1	+.67

A given change in corporate product seems to evoke a smaller change in corporate profits during business cycle expansions than during contractions. The observed difference may be largely due to the long leads of the profit variable at peaks. Whatever the reason, the systematic difference in response patterns is apparent after segmentation of the time period into business cycle phases.

So far the emphasis has been mainly on differences in the parameters of simple regressions during different time periods. Inclusion of proper additional variables would not only give a fuller explanation of the dependent variable but might also modify the parameters of a simple explanatory variable (say corporate product) in such a way that the sharp differences between the subperiods would disappear. However, this should not be taken for granted. Table 1 shows what happens if time and unemployment are added to the independent variable. The addition of time adds to the explanation and has indeed an equalizing effect on the regression coefficient of the product variable. In the bivariate analysis the regression coefficient for corporate product varies between .06 and .33 (see column 2); after addition of the time variable, the variation is confined within the narrow limits of .39 and .45 (column 3), which, incidentally, is close to the values of the short-term responses shown in Chart 2. In this sense, the addition of the time variable is highly effective. However, addition of variables does not necessarily have such homogenizing effects. Column 7 of the table shows the coefficients for the full system of four variables. Note the enormous variation of the regression coefficients, for any of the independent variables, from subperiod to subperiod. Perhaps a more circumspect selection of variables could bring about a degree of structural stability which would make periodization unnecessary. It might, if the structural changes of the system are caught by the variables and the expression of their functional relationships. But in order to demonstrate either that temporal subdivisions are necessary or that they are not, we must analyze the time segments--in short, we must articulate the time dimension.

There are obvious limitations to the disaggregation of time periods. If the time segments chosen are short and the independent variables numerous, multivariate analysis tends to break down. We run out of degrees of freedom, we increase multicollinearity, we lose significance--all aspects of the same problem.[20] The first variable introduced will tend to explain most of the explainable variance. Thus, if we wish to have separate measures for short subperiods, we may have to consolidate similar periods and handle the problem of time trends statistically (for instance, by expressing data for each subperiod as relatives of the average for that period;) alternatively, we may have to confine ourselves to bivariate analysis. As a basis for judging the homogeneity of subperiods and for related research purposes, a systematic investigation of bivariate relationships might prove to be of value. A multidimensional matrix showing gross relationships (in the form of simple regression functions or of elasticities) between the hundred or so strategic variables that are commonly included in macroeconomic systems would constitute a research tool to supplement similar systems of basic measures that exist or are being developed for single time series.[21] The cycle stages and cycle

averages of the National Bureau's business cycle analysis might provide a convenient chronological framework for the computation of such response patterns. I shall not elaborate on this suggestion with a discussion of details. Response measures for each variable to each of the others, for all conceivable time periods, would surely not be necessary. But a data bank and a program that would permit computing such measures for any specified combination of variables and periods might well be wanted. That is another possibility of articulating the time dimension in measuring economic relationships.

In the second group of experiments, concern is not with the segmentation of the time scale into subperiods but with the effects of modifying the time units and time spans used in the statistical analysis of economic data. Analytically it does not make much difference whether production of coal is measured in units of short tons or million tons, and whether prices are given in cents or dollars. But it may make a lot of difference whether the time units are months, years, or longer periods. The aggregation into longer units averages intraunit fluctuations, and this affects the measurement of these fluctuations as well as any statements of the relationship between fluctuations of several activities. Obviously, correlation between annual time series will not reflect seasonal and shorter-term covariation, and may reflect cyclical covariation to a limited degree only. Similar observations could be made about changes covering different time spans. Since all this is well known, it is puzzling why the effect of different units and different time spans is not more frequently determined in quantitative economic research.[22]

To dispel any possible thought that these effects are really negligible, correlation and regression analysis were made for the same set of variables, using different time units and time spans. Throughout this experimentation, the average work week, as the dependent variable, is related to employment, the unemployment rate, and time--singly or in combination, for the period 1929-65. Employment is here conceived as a measure of effective demand for labor input. It is expected to vary positively with the duration of the average workweek over the short run,[23] though not necessarily over the long run. The unemployment rate is introduced as a measure of the tightness of the labor market on the supply side. Over the short term, low unemployment (limited additional supply) tends to force employers to increase labor input by lengthening the workweek, which leads to the expectation of an inverse gross relationship between weekly hours and unemployment rate. Over the long run, the declining secular trends in the average workweek and in the unemployment rate contribute toward a positive relationship. The time variable is designed to relieve the labor market factors, at least in part, of the task of describing long-term relationships.

Table 2 shows the results of the analysis for monthly, quarterly, annual, quinquennial, and decennial data. There is not much point in recapitulating the information contained in the table. Suffice it to say that correlation coefficients as well as regression coefficients are sensitive to modifications in time units, smoothing terms, and time spans. Characteristically, the correlation increases gradually with increasing size of unit and span. In the case of employment (column 2), the increase is substantial. This is readily understood in view of the gradually decreasing importance of random elements and the increasing importance of long-term trends. On occasion, reversals in the direction of change of the correlation coefficients are observed. This usually occurs when the cyclical and long-term relationships are in opposite directions, so that first the cyclical but eventually the long-term forces dominate the relationship. Similar changes and reversals in direction are also observable for the various regression coefficients, sometimes accompanied by reversals of sign (column 7, smoothing terms, employment). In evaluating the sensitivity of the coefficients to changes in time definitions, it must be noted that smoothing terms and time spans vary only from one to sixteen quarters, while the time units include five-year, and sometimes even ten-year, nonoverlapping averages. Furthermore, the number of observations available differs from shorter to longer time periods. The difference is most radical for the upper panel, where 444 observations are available for the monthly correlations, but only three for the decennial ones.

Table 3 deals with variations in correlation and regression coefficients as different cycle stages and phases are used as input for analysis. Some of the differences are startling. (See particularly the differences between the coefficients of employment versus the average workweek at peaks and troughs of business cycles.) They may have been caused partly by extreme values at the 1929 peak and the 1933 trough of the Great Depression, particularly since the number of included cycles, and therefore of observations, is small (six or seven). These large variations, as well as those in the correlation coefficients for expansion and contraction amplitudes, deserve more analysis than can be afforded here. For the purposes of this paper, the decisive finding of these experimentations is that measures of relationships can vary considerably with alternative time periods and time measures. This has consequences for the design of economic research and analysis.

I do not suggest that research workers should go through all the versions of time partitioning for any combination of reasonable variables. But I suggest that they find out whether systematic similarities or differences exist during subperiods relevant to their research objective. I am sure that more attention to the articulation of the time dimension will generate valuable insights.

IV. Programmed Articulation

Experimentation with alternative articulations of the time dimension involves additional computational work. However, in the age of electronic computers, the additional costs are usually not prohibitive. Under certain conditions, it may be advantageous to make the choice of alternative time periods and time units a part of the computer program.

It might be said that the proposed disaggregation of the time dimension leads to increased subjectivity of research results. In addition to the discretion of chosing variables, functions, and over-all time coverage, there is now the discretion of choosing time segments. No doubt, any proliferation of options increases the opportunities for selectivity. However, this bane could be converted into a boon if it became an accepted rule to report the effects of relevant alternative selections of time periods, time units, time spans, etc., on research results. Programmed analysis makes this feasible.

In the regression analysis of profits, one articulation involved the determination of cyclical turning points in the profit variable (see Chart 2). It is desirable to facilitate this process and remove turning-point-determination, as far as possible, from the predilections of the research worker. Criteria for the determination of specific turning points have been available for a long time,[24] but the process of implementation left much to personal knowledge, experience, and judgment. Attempts to specify and program a process of turning-point-determination that meets the specified criteria are now under way. Chart 3 shows the turning points picked by a program under development at the National Bureau. There are still obstacles to be overcome and refinements to be made, but the goal is in sight. In the context of the present paper, the significance of such a program is that it would permit the partitioning of the time dimension in accordance with the cyclical behavior of any component variable of a system.

Notes

1. Analyses of periodicities, such as spectral analysis, do not fall into this category.

2. Measures for individual cycle fractions and summary measures for corresponding cycle fractions are part of the National Bureau's Standard Business Cycle Analysis. The Recession-Recovery Analysis is mainly designed to compare rather than summarize cyclically corresponding experiences, but the latest programmed version of Recession-Recovery Analysis also gives averages over several cycles.

3. Alfred H. Conrad and John R. Meyer, "The Economics of Slavery in the Ante-Bellum South," Journal of Political Economy, April 1958, pp. 95-130.

4. Rendigs Fels, "The U.S. Downturn of 1948," American Economic Review, December 1965, p. 1061.

5. Ibid., pp. 1072-73.

6. Business Economics, Winter 1965-66, p. 15.

7. Several of the "fixed-variable, fixed-parameter" models continue to be tolerably effective forecasting instruments, in spite of the change of environment. This raises highly interesting questions; however, they are beyond the scope of the present concern.

8. Franco Modigliani, "Fluctuations in the Saving-Investment Ratio: A Problem in Economic Forecasting," Studies in Income and Wealth," New York, National Bureau of Economic Research, 1949, pp. 379-382.

9. Paul Boschan, "Productive Capacity, Industrial Production, and Steel Requirements," Long-Range Economic Projection, Princeton University Press for NBER, 1954, pp. 233 ff.

10. Milton Friedman, A Theory of the Consumption Function, Princeton for NBER, 1957, pp. 125 ff.

11. Ibid., p. 152.

12. J. Duesenberry, O. Eckstein, and G. Fromm, "Simulation of the United States Economy in Recession," Econometrica, October 1960, pp. 749-809.

13. Ibid., pp. 752-753.

14. See, for example, Edwin Kuh, "Cyclical and Secular Labor Productivity in United States Manufacturing," Review of Economics and Statistics, February 1965; or Peter Eilbott, "The Effectiveness of Automatic Stabilizers," American Economic Review, June 1966 (also his bibliography reporting previous analyses that distinguish behavior during expansions and recessions).

15. John R. Meyer and Robert R. Glauber, Investment Decisions, Economic Forecasting, and Public Policy.

16. The correlation coefficient of profits against time is .88, that of product against time .99!

17. The little squares on Charts 1 and 2 designate the quarters at which the period is partitioned.

18. Computing regressions separately for "all expansions" or "all contractions" will not help, since the line of average relationship continues to reflect both cyclical and long-term changes.

19. The positive correlation during 1959 has, perhaps, elements of a fluke. The correlation is very low and is based on four quarters only. The terminal quarter is lower than the initial, but the intermediate quarters give the least-squares line a positive tilt.

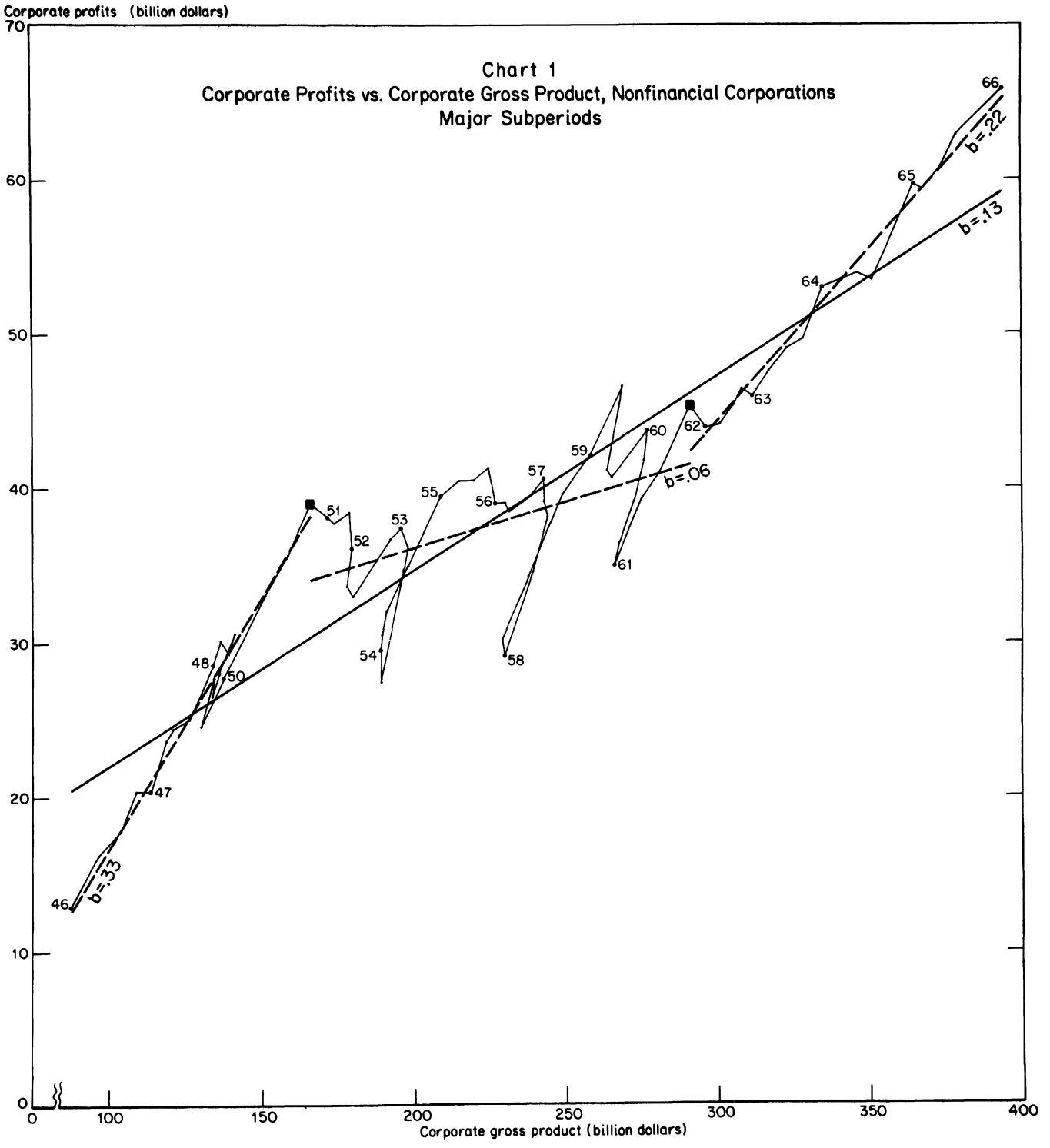
20. The problem may be seen in the top panel of Table 2. For the ten-year period there are as many variables as observations, but fewer degrees of freedom. Thus, multiple regressions could be provided only up to five-year periods.

21. See Julius Shiskin, "Long-Term Economic Growth, A Statistical Compendium," published in these Proceedings.

22. There are, of course, exceptions. For example, Arthur F. Burns and Wesley C. Mitchell, in Measuring Business Cycles, New York, NBER, 1946, deal in Chapter 6 with the effect of the time unit on cyclical measures, and in Chapter 8 with the effects of smoothing. Recently, Milton Friedman and Anna J. Schwartz measured differential rates of monetary growth over increasing time units and time spans. (See NBER, Forty-Sixth Annual Report, New York, 1966, pp. 47-48.) A forthcoming National Bureau study, "Variable Span Diffusion Indexes," by Geoffrey H. Moore and Julius Shiskin, explores the effects of varying the time span.

23. The leads of cyclical turning points in the workweek over those in employment require some qualification of this statement. See Gerhard Bry, The Average Workweek as an Economic Indicator, New York, NBER, 1959, p. 15.

24. See Burns and Mitchell, Measuring Business Cycles, Chapter 4.


Corporate profits (billion dollars)
Chart 1
Corporate Profits vs. Corporate Gross Product, Nonfinancial Corporations
Major Subperiods
b=.33
b=.06
b=.22
b=.13
46
47
48
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
0
10
20
30
40
50
60
70
0
100
150
200
250
300
350
400
Corporate gross product (billion dollars)

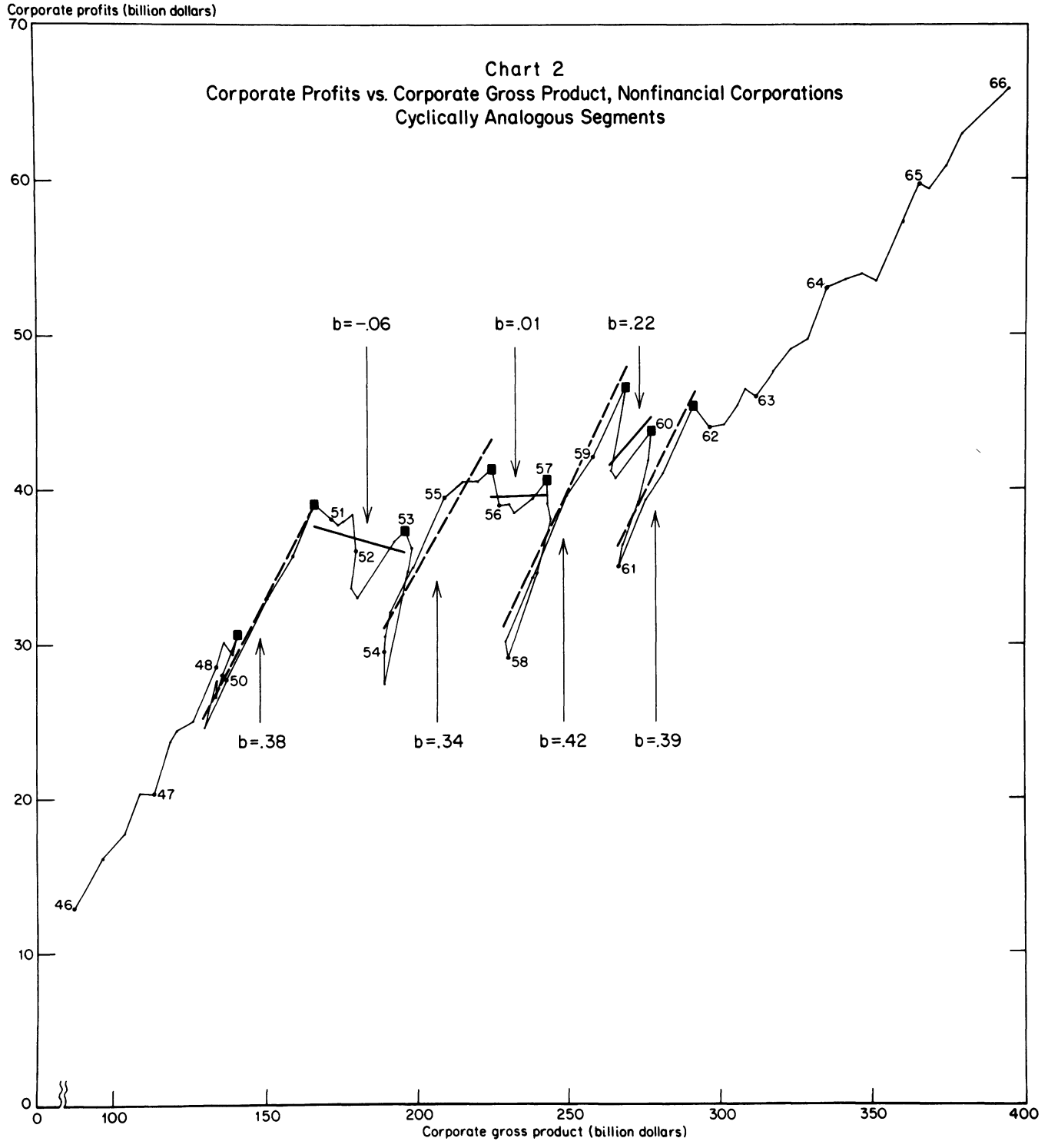
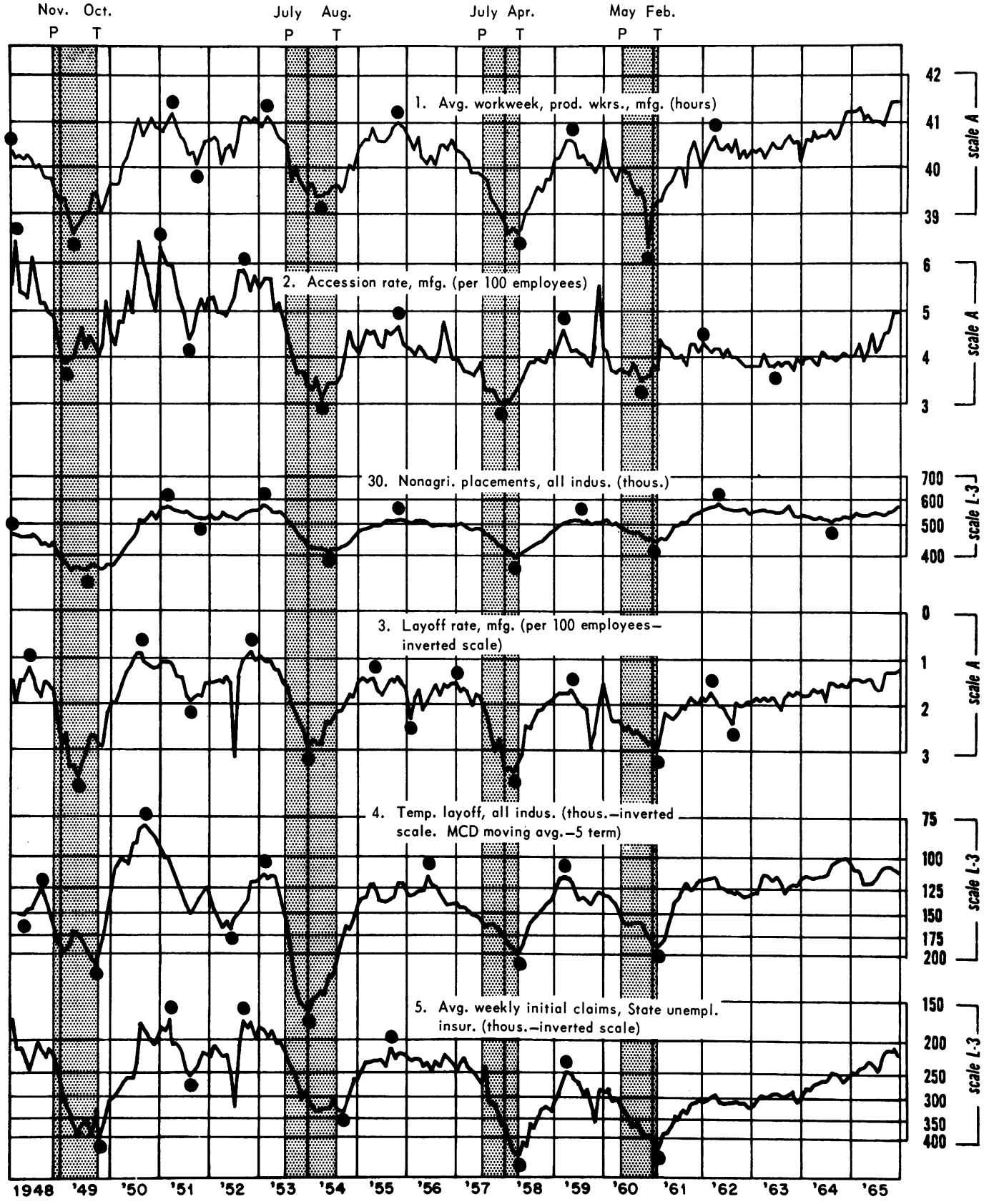

Corporate profits (billion dollars)
Chart 2
Corporate Profits vs. Corporate Gross Product, Nonfinancial Corporations
Cyclically Analogous Segments
b=-.06
b=.01
b=.22
b=.38
b=.34
b=.42
b=.39
46
47
48
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
0
10
20
30
40
50
60
70
0
100
150
200
250
300
350
400
Corporate gross product (billion dollars)

Chart 3
Programmed Turning-Point Determination



Source: chart, Business Cycle Developments, June 1966, P 10; turning points, program under development at NBER.

TABLE 1

Corporate Profits vs. Corporate Product, Unemployment Rate, and Time
Correlation Analysis, Major Periods, 1946/1 to 1966/1

Years and Quarters	Independent Variables						
	Time (1)	Product (2)	Product Time (3)	Unemplt. (4)	Unemplt. Time (5)	Product Unemplt. (6)	Product Unemplt. Time (7)
Full Period 1946/1 to 1966/1							
Correlation Coefficients	.8779	.9296	.9697	.0855	.9277	.9520	.9698
Adjusted R-Squares		.8624	.9388	-.0053	.8570	.9039	.9381
Y-Intercepts		9.4320	-12.4685	34.1309	33.5244	16.7912	-14.3688
Regression Coefficients							
Product		.1262	.3740			.1350	.3867
Unemployment				.7680	-2.9533	-1.9353	.1845
Time			-.8268		.4532		-.8720
Subperiod 1946/1 to 1950/4							
Correlation Coefficients	.8733	.9915	.9962	.0804		.9957	.9963
Adjusted R-Squares		.9821	.9916			.9903	.9911
Y-Intercepts		-15.6713	-22.3874			-13.6859	-23.9178
Regression Coefficients							
Product		.3253	.3997			.3305	.4114
Unemployment						-.5676	.1088
Time			-.2676				-.3135
Subperiod 1950/4 to 1961/4							
Correlation Coefficients	.3799	.5339	.8821	-.0021	.6072	.7080	.9512
Adjusted R-Squares		.2685	.7675	-.0232	.3386	.4775	.8779
Y-Intercepts		23.7450	-17.0148	37.5793	35.6776	22.4543	-55.5388
Regression Coefficients							
Product		.0615	.4507			.1079	.7610
Unemployment				-.0064	-2.3481	-1.9152	3.2400
Time			-1.1088		.3106		-2.2161
Subperiod 1961/4 to 1966/1							
Correlation Coefficients	.9679	.9881	.9930	-.7818		.9898	.9957
Adjusted R-Squares		.9749	.9842			.9770	.9895
Y-Intercepts		-21.6296	-5.8700			-33.6868	-19.5515
Regression Coefficients							
Product		.2203	.3925			.2390	.4359
Unemployment						1.1040	1.4150
Time			-1.0137				-1.1276

TABLE 2

Average Workweek vs. Employment, Unemployment Rate, and Time, 1929-65

Variation of Correlation and Regression Coefficients
Over Different Time Units, Smoothing Terms, and Time Spans

	Independent Variables						
	Time (1)	Emplt. (2)	Emplt. Time (3)	Unemplt. (4)	Unemplt. Time (5)	Emplt. Unemplt. (6)	Emplt. Unemplt. Time (7)
Time Units[a]							
Correlation Coefficients	.13 to .55	.55 to .83	.70 to .70[a] (.72)	-.78 to -.80 (-.71)	.87 to .87[b] (.91)	.82 to .78[b] (.86)	.87 to .87[b] (.90)
Regression Coefficients							
Employment		.578 to .387 (.333)	1.091 to .695[a] (1.096)			-.550 to -.598[b] (-.628)	-.053 to -.228[b]
Unemployment				-.322 to -.195	-.436 to -.368[b] (-.439)	-.512 to -.462[b] (-.537)	-.450 to -.450[b] (-.475)
Time	.003 to .189[a]		-.015 to -.541[a]		-.011 to -.585[b]		-.010 to -.517[b]
Smoothing Terms (Moving Averages)[a]							
Correlation Coefficients	.13 to .42	.56 to .82	.71 to .90	-.79 to -.85	.89 to .92	.84 to .85 (.86)	.89 to .92
Regression Coefficients							
Employment		.581 to .642	1.096 to .995			-.560 to -.118 (-.561)	-.061 to .249 (-.063)
Unemployment				-.323 to -.267	-.439 to -.398	-.517 to -.314	-.455 to -.307
Time	.009 to .022		-.044 to -.031		-.033 to -.029		-.031 to .030
Time Spans (Changes)[a]							
Correlation Coefficients	-.11 to -.13 (-.21)	.56 to .83	.57 to .90	-.46 to -.92	.46 to .93	.58 to .93	.58 to .95
Regression Coefficients							
Employment		1.487 to 1.559 (1.352)	1.491 to 1.719 (1.357)			1.202 to .400 (.398)	1.239 to .725 (.585)
Unemployment				-.355 to -.486 (-.491)	-.351 to -.484 (-.486)	-.127 to -.393 (-.401)	-.112 to -.314 (-.337)
Time	-.002 to -.014 (-.018)		-.003 to -.038		-.001 to -.010		-.002 to -.021

Note: The two top figures in each cell denote the extremes of a monotonic change, from first to last of the indicated alternatives. When there are reversals in direction of change, the value showing the largest deviation from the initial coefficient is given in parentheses.

[a]The time units considered are monthly, quarterly, yearly, five-yearly, and ten-yearly periods. The smoothing and the time spans considered are one, two, three, four, six, eight, twelve, and sixteen quarters.

[b]Up to five-year unit only.

TABLE 3

Average Workweek vs. Employment, Unemployment Rate, and Time, 1929-65

Variation of Correlation and Regression Coefficients
Over Different Cycle Stages, Cycle Phases, and Cycle Amplitudes

	Independent Variables						
	Time (1)	Emplt. (2)	Emplt. Time (3)	Unemplt. (4)	Unemplt. Time (5)	Emplt. Unemplt. (6)	Emplt. Unemplt. Time (7)
Expansion Stages							
(I,II,III,IV,V)							
Correlation Coefficients	.67 to -.68 (.74)	.92 to -.32 (.98)	.98 to .70 (.99)	-.98 to -.59 (-.99)	.999 to .91 (.81)	.99 to .86 (.85)	.999 to .93 (.98)
Regression Coefficients							
Employment		.969 to -.470 (.780)	1.635 to .339 (.902)			-.638 to -1.003 (4.207)	-.002 to -.419 (3.602)
Unemployment				-.314 to -.498 (-.226)	-.382 to -.515 (-.260)	-.502 to -.741 (1.760)	-.382 to -.612 (1.364)
Time	1.256 to -1.183		-.133 to -.154 (-.0312)		-.051 to -.121 (-.013)		-.050 to -.088 (-.026)
Contraction Stages							
(V, VI, VII, VIII, IX)							
Correlation Coefficients	-.68 to .64	-.32 to .92 (.93)	.70 to .96 (.62)	-.59 to -.98 (-.68)	.91 to .995 (.85)	.86 to .995 (.81)	.93 to .997 (.89)
Regression Coefficients							
Employment		-.470 to .951	.339 to 1.366			-1.003 to -.643 (-2.005)	-.419 to -.375 (-1.524)
Unemployment				-.498 to -.311 (-.295)	-.515 to -.362 (-.347)	-.741 to -.503 (-1.287)	-.612 to -.451 (-1.152)
Time	-.118 to .095		-.145 to -.072 (-.060)		-.121 to -.032 (-.032)		-.088 to -.018 (-.016)

(continued)

TABLE 3 (concluded)

	Independent Variables						
	Time (1)	Emplt. (2)	Emplt. Time (3)	Unemplt. (4)	Unemplt. Time (5)	Emplt. Unemplt. (6)	Emplt. Unemplt. Time (7)
Cycle Phases (Expansions, Contractions)							
Correlation Coefficients	.44 to .04	.88 to .50	.93 to .71	-.82 to -.71	.86 to .88	.92 to 92	.97 to .94
Regression Coefficients							
Employment		.588 to .399	.823 to .864			1.752 to -1.536	1.966 to -1.084
Unemployment				-.205 to -.276	-.270 to -.449	.437 to .985	.431 to -.867
Time	.355 to .045		-.380 to -.768		-.289 to -.695		.376 to -.363
Cycle Amplitudes (Expansions, Contractions)							
Correlation Coefficients	-.63 to .79	.90 to .81	.90 to .84	-.99 to -.97	.996 to .98	.993 to .994	.999 to .994
Regression Coefficients							
Employment		1.614 to 4.194	1.673 to 2.588			-.491 to 1.452	-.375 to 1.639
Unemployment				-.515 to -.565	-.582 to -.501	-.648 to -.454	-.676 to -.468
Time	-1.499 to 1.921		.108 to .940		.423 to .359		.372 to -.158

Note: The two top figures in each cell denote the extremes of a monotonic change, from first to last of the indicated alternatives. When there are reversals in direction of change, the value showing the largest deviation from the initial coefficient is given in parentheses.