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The Seasonal Cycle and the Business Cycle

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I. Introduction

Almost all recent research on macroeconomic fluctuations has worked with seasonally adjusted or annual data. The usual attitude toward seasonal fluctuations is typified by Sims (1974), who refers to the seasonal components of economic time series as "errors in variables" and analyses methods for treating series "contaminated by seasonal noise." Perhaps underlying this view is the notion that seasonal fluctuations are generated by a fundamentally different model than conventional business cycle fluctuations. Many economists would argue that seasonal fluctuations are entirely natural or even desirable while business cycle fluctuations are disturbing aberrations.

This paper takes a different approach by treating seasonal fluctuations as worthy of study in their own right. Instead of taking it for granted that seasonal fluctuations follow a different model from business cycle fluctuations, we consider the extent to which the two types of fluctuations display similarities. Our paper represents a return to an older tradition of NBER analysis of fluctuations, exemplified by Simon Kuznets (1933), in which fluctuations at both seasonal and business cycle frequencies were regarded as important topics of investigation.[1]

Seasonal fluctuations account for a large proportion of the non-trend variation in economic activity. Table 1 shows the result of regressing the logarithmic growth rate of real output[2] on four seasonal dummies.[3] The R^2 from this regression is .875, indicating that most of the variation in the dependent variable is due to deterministic seasonality. The standard deviation of the indeterministic component of this variable, as measured by the standard error of the regression, is less than half the size of a typical seasonal dummy fluctuation, as measured by the standard deviation of the fitted values of the regression (1.91 versus 5.06). The growth rate of output is typically 4.85% above average in the fourth quarter and 8.01% below average in the first quarter.[4]

Table 1: Regression of Log Growth Rate of Real GNP on Seasonal Dummies

$$\Delta \ln Y_t = \underset{(.32)}{-8.01 d_t^1} + \underset{(.31)}{3.72 d_t^2} - \underset{(.31)}{.49 d_t^3} + \underset{(.31)}{4.85 d_t^4} + \epsilon_t$$

$R^2 = .875$, DW = 2.00, s.e.e. = 1.91, Quarterly Data, 1948:2-1985:4

[1] Kuznets (1933) carries out a careful study of the seasonality of U.S. industries. Woytinsky (1939) and Bursk (1931) study the seasonality of employment fluctuations, while Kemmerer (1910) and Macaulay (1938) analyze the seasonality of interest rates.

[2] We have constructed seasonally unadjusted real GNP by dividing nominal seasonally unadjusted GNP, which is available from the Department of Commerce, by the seasonally unadjusted CPI, which is available from the Bureau of Labor Statistics. Appendix A describes the construction of seasonally unadjusted data in detail.

[3] The overall growth rate has been subtracted from both sides of the equation.

[4] We should emphasize that the growth rates have *not* been annualized.

In Section III below, we document the quantitative importance of seasonal fluctuations in more detail, and we present estimates of the seasonal patterns in a set of standard macroeconomic variables. Our results show that seasonal fluctuations are an important source of variation in all macroeconomic quantity variables, including consumption, investment, government purchases, employment, and the money stock. On the other hand, seasonal fluctuations tend to be small or entirely absent in both real and nominal price variables. The timing of the seasonal fluctuations in economic activity consists of increases in the second and fourth quarter, a large decrease in the first quarter, and a mild decrease in the third quarter. In the fourth quarter boom, output is on average 8.01% higher than in the "recession that occurs every winter."

There is a set of stylized facts about macroeconomic variables that collectively constitutes what is known as the business cycle. These facts include the tendency of output movements across broadly defined sectors to move together, the high correlation between nominal money and real output, the procyclical behavior of labor productivity ("Okun's Law"), the movement of consumption and leisure in opposite directions, the minimal variation in prices relative to the variation in quantities, and the mildly procyclical behavior of prices. Although there is not a consensus as to which model of business cycle fluctuations is responsible for these correlations in the data, it is agreed that they constitute the stylized facts to be explained.

We demonstrate in Section IV that, with respect to each of the major stylized facts about business cycles, the seasonal cycle displays the same characteristics as the business cycle, in some cases even more dramatically than the business cycle. That is, we find that at seasonal frequencies as well as at business cycle frequencies, output movements across broadly defined sectors move together, nominal money and real output are highly correlated, labor productivity is procyclical, consumption and leisure move in opposite directions, prices vary less than quantities, and prices fluctuate mildly procyclically. There is a "seasonal business cycle" in the United States economy, and its characteristics mirror closely those of the conventional business cycle.

The final purpose of the paper is to discuss alternative economic models that might generate the sorts of stylized facts we observe at both seasonal and business cycle frequencies. We attempt to draw out a number of the most interesting issues raised by our empirical results, and we interpret them in light of modern theories of aggregate fluctuations.

The remainder of the paper is organized as follows. Section II outlines an estimation strategy for presenting facts about the seasonal cycle and comparing the seasonal cycle to the business cycle. Section III uses this strategy to show that the seasonal cycle is a quantitatively important feature of the data and to document the seasonal patterns in major macroeconomic variables. In Section IV we compare the seasonal cycle with the business cycle and show that the seasonal cycle in the United States economy displays the important qualitative features of the business cycle. Section V concludes the paper by addressing the questions for further research raised by the results presented here.

II. Comparing the Seasonal Cycle and the Business Cycle

In this section we outline our statistical approach to quantifying and presenting seasonal patterns in quarterly macroeconomic time series. We follow Hylleberg (1986,Ch.2) and especially Pierce (1978) in considering a model that includes both deterministic and stochastic seasonal components. In contrast to the standard literature, however, we focus mainly on the deterministic seasonals – those which are representable by seasonal dummy factors, or, equivalently by a set of cosine waves with nonstochastic amplitudes and phase shifts.

Our emphasis on deterministic seasonality reflects three observations which, although logically distinct, cohere well. First, the empirical results presented in Section III suggest that deterministic seasonals go a long way toward accounting for the variation in the data, while models of stationary indeterministic seasonality play a secondary role. Second, as noted below, if deterministic seasonals are present but not accounted for (e.g., if the researcher maintains that the seasonal is a stationary ARMA process), inferences about seasonal comovements based on coherences are essentially incorrect. Finally, *a priori* reasoning about the economics of seasonality suggests the inadequacy of purely indeterministic models in capturing the key characteristics of seasonals in real world data. A stationary indeterministic model implies that the unconditional first quarter mean of a series is equal to the unconditional fourth quarter mean. This in turn implies that the long-run forecast of a series is independent of the quarter being forecast. Of course, a nonstationary indeterministic model - one with a unit root at the fourth lag - would allow seasonality to enter the long-run forecasts. However, that approach would still fail to use the information that Christmas falls in the same quarter every year.

Let X_t be a times series of interest. We wish to estimate the seasonal variation in the non-trend component of X_t. In order to insure that our conclusions about seasonality are not sensitive to the choice of detrending technique, we employ two alternative definitions of trend and estimate the seasonal variation in both detrended series. The first representation of trend that we consider is that of a unit root in the ARIMA representation of the indeterministic component of $\ln X_t$.

Recent work by Nelson and Plosser (1982), Campbell and Mankiw (1986), and others[5] indicates that this specification may be more consistent with observed data than the specification that $\ln X_t$ is stationary around a deterministic trend.[6] The second model that we employ is the one proposed in Hodrick and Prescott (1980).[7] Let τ_t be the trend component of $\ln X_t$. The τ_t are chosen to minimize

$$\sum_{t=1}^{T}(\ln X_t - \tau_t)^2 + 1600\sum_{t=2}^{T-1}((\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1}))^2$$

and the detrended series is defined to be the difference between the log of X_t and τ_t. This model allows the trend component of $\ln X_t$ to change slowly over time. Note that the interpretation of the detrended series is different for the two models. The first produces log growth rates, the second percentage deviations from trend.[8]

Now let x_t be the detrended series produced by one of the two procedures described above. We assume that x_t can be approximately described by the following model:

$$x_t = \sum_{s=1}^{4}\xi_s d_t^s + \beta(L)\epsilon_t \tag{1}$$

where $\beta(L)$ is a polynomial in the lag operator, d_t^s is a seasonal dummy for quarter s, ξ_s is a coefficient, and the polynomial $\beta(L)$ satisfies $\sum_{i=0}^{\infty}\beta_i^2 < \infty$. Thus, we model x_t as the sum of deterministic seasonal dummies and a stationary moving average process. This specification allows for both deterministic and stochastic seasonality in x_t. If the seasonal dummy coefficients are not all identical, then the series displays deterministic seasonality. If the polynomial $\beta(L)$ implies a quantitatively important *4th* order autocorrelation in the non-seasonal dummy component of x_t, then the series displays stochastic seasonality.[9] It is possible for a series to display both deterministic and stochastic seasonality (Pierce (1978)).

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[5] Clark (1986), Cochrane (1986), Evans (1986), Stock and Watson (1986), and Watson (1986) also find that one cannot reject the hypothesis of a unit root in the univariate ARIMA representation of real, seasonally adjusted GNP.

[6] The fact that one cannot reject the hypothesis of a unit root does not imply that it exists since the tests tend to have limited power (Shiller and Perron (1985)). We should also note that the existing analyses of deterministic trends versus unit roots have been carried out with annual and/or seasonally adjusted data, so the results of those analyses do not preclude the possibility that the unadjusted data are consistent with deterministic trends. Haza and Fuller (1982,pp.388-93) and Dickey, Haza, and Fuller (1984) address the issue of testing for unit roots (at the first and/or seasonal lag) in seasonally unadjusted data.

[7] This is also the detrending procedure employed in Kydland and Prescott (1982) and Prescott (1986).

[8] We have also estimated a third model, a second order polynomial function of time, with results extremely similar to those obtained using the procedure advocated by Hodrick and Prescott (1980).

[9] As long as $\beta(L)$ can be infinite order, the model in (1) is consistent with any stationary ARMA model for the stochastic seasonality in x_t. In practice, we find that most of the series we consider are well approximated by an AR(5) plus seasonal dummies, where the coefficients on lags one through three are small and insignificant and the coefficients on lags four and five are larger and more significant. For example, the coefficients on the first five AR terms in real output are .12,-.01, -.14, .36, and -.49. Only the last two are significantly different from zero.

As we emphasized earlier, it is important to allow for deterministic seasonality because a number of phenomena causing the seasonals in economic time series (holidays, school calendars, the weather) tend to produce seasonal peaks and troughs in the same season year after year. The magnitudes of the effects of these factors may change over time, so it might be desirable to allow for trend in the magnitude of the seasonal dummy coefficients.[10] As we report in Section III, however, the estimated seasonal dummy coefficients are surprisingly similar when estimated separately for the first and second half of the post-WWII sample period. We therefore do not find it important to allow for time variation in the seasonal dummy coefficients.

Given the model for x_t in (1), it is useful to apply two estimation procedures in order to examine the seasonal variation in economic times series. First, we examine the deterministic seasonals, i.e., the regular seasonal peaks and troughs in the series. For this purpose we estimate the equation

$$x_t = \sum_{s=1}^{4} \xi_s d_t^s + \eta_t \tag{2}$$

where η_t is the stochastic component of x_t. Ordinary Least Squares estimates of the seasonal dummy coefficients are consistent.[11] The error term in this equation, which is the stochastic component of x_t, need not be serially uncorrelated, however, so the OLS standard errors are not appropriate. We apply the Hansen and Hodrick (1980) technique, as modified by Newey and West (1987), to obtain consistent estimates of the standard errors of the seasonal dummy coefficients. We examine the correlation coefficients of the estimated seasonal dummies to determine the relations between the deterministic seasonal components of different series.

The second procedure we employ is to examine the spectrum of x_t. A series that displays purely indeterministic seasonality displays a peak in its spectrum in a neighborhood of the seasonal frequencies,[12] and this has been offered as a definition of seasonality (Nerlove (1964)). If some of the seasonality is due to seasonal dummies, then strictly speaking, the spectrum is not defined. The theoretical spectrum of a series displaying only deterministic seasonality consists of spikes of infinite height at the seasonal frequencies. The estimated spectrum of a series with deterministic seasonality has spikes of finite height, but the height of these spikes increases with sample size (Priestly (1981)). It is still informative to examine the estimated spectrum of such a series, however, because the estimated mass associated with a given set of frequencies is finite and independent of sample size.

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[10] See Stephenson and Farr (1972).

[11] OLS estimates of this model are also asymptotically efficient (Fuller (1976),pp.388-93), so for samples of the size we employ here there is probably little gain to estimating the model by Generalized Least Squares.

[12] By "seasonal frequency" we mean the principal seasonal frequency and its harmonics.

For the purpose of examining the relationships between different series at seasonal versus business cycle frequencies, we examine the coherence and gain of the cross spectrum. The coherence function between two series, x_t and y_t, is interpreted as the correlation coefficient by frequency, while the gain function from x_t to y_t is interpreted as the (absolute value of the) regression coefficient of y_t on x_t by frequency. The coherences that we present are those of the seasonal dummy adjusted series. We examine these, rather than the coherences of the seasonally unadjusted series, because the coherence of two series containing deterministic seasonality is always unity at the principal seasonal frequency. The gain functions reported are those relating the pure, seasonally unadjusted data. These are meaningful even in the presence of deterministic seasonality.

III. Basic Facts About the Seasonal Cycle

In this section we document the seasonal patterns in macroeconomic variables and demonstrate that seasonal fluctuations account for a significant share of the non-trend variation in these variables. We stop short of discussing the relations between the various seasonal patterns; that discussion is postponed until Section IV. We present results for both the log growth rates of the variables and for Hodrick-Prescott detrended data, although we focus more on the results for log growth rates. None of the results presented in this or the subsequent section of the paper is sensitive to the choice of detrending technique.

A. The Quantitative Importance of Seasonal Fluctuations

Tables 2a and 2b present three statistics for each of a set of key quarterly macroeconomic variables for the period 1948:2-1985:4.[13] Table 2a contains results for log growth rates while Table 2b contains results for detrended series.[14] Each statistic is computed from a regression of either log growth rates or deviations from trend on seasonal dummies. The first statistic is the standard deviation of the fitted values of the regression; this is an estimate the standard deviation of the deterministic seasonal component of the dependent variable. The second statistic is the standard error of the regression; this is an estimate of the standard deviation of the business cycle plus stochastic seasonal component of the dependent variable. The third statistic is the R^2 of the regression, which measures the percentage of the variation in the dependent variable due to deterministic seasonality.

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[13] The sample period is different for the following variables: Residential Non-Farm Structures, Farm Structures, and Producer's Durables (1948:2-1983:4); Employment (1951:2-1985:4); Monetary Base and Money Multiplier (1959:2-1985:4); and Hours, Nominal Wage and Real Wage (1964:2-1985:4).

[14] For some of the series we examine (unemployment and nominal interest rates), we detrend the level of the series rather the log level. For real interest rates, we do not detrend at all. For inventories, we work with the non-detrended values of the change in inventories divided by final sales. The results for these last two variables are reported in the tables for log growth rates.

Table 2a: Summary Statistics for Seasonal Dummies, Log Growth Rates, 1948-1985			
	Standard Deviation of Seasonal Dummies	*Standard Error of the Regression*	R^2
GNP	5.06	1.91	.875
Consumption	6.61	1.93	.921
Durables	14.24	5.62	.865
Non-Durables	11.33	2.11	.967
Services	1.09	1.05	.518
Fixed Investment	8.72	3.77	.843
Non-Residential	6.54	4.04	.724
Structures	9.98	3.79	.874
Producers Durables	7.07	5.87	.591
Residential	16.89	6.78	.861
Non-Farm Structures	17.51	6.79	.869
Farm Structures	21.46	38.92	.233
Producers Durables	14.76	22.26	.305
Government	3.79	3.50	.540
Federal	5.34	6.14	.431
Defense	3.91	5.97	.300
Other	18.13	17.88	.507
State and Local	4.89	2.31	.818
Exports	5.09	5.16	.493
Imports	3.08	5.14	.264
Change in Inventories	1.04	1.32	.384
Final Sales	6.19	1.81	.921
Unemployment Rate	.65	.51	.617
Labor Force	1.27	.53	.855
Employment	1.08	.74	.684
Hours	.87	.38	.841
Price Level	.21	1.19	.031
Nominal Interest Rate	.02	.21	.007
Real Interest Rate	.18	.74	.055
Nominal Wage	.13	.52	.059
Real Wage	.20	.70	.076
Nominal Money Stock	1.10	1.09	.506
Nominal Monetary Base	.76	.82	.462
Money Multiplier	.57	1.00	.243

The sample period is 1948:2-1985:4, except for the following variables: Residential Non-Farm Structures, Farm Structures, and Producer's Durables (1948:2-1983:4); Employment (1951:2-1985:4); Monetary Base and Money Multiplier (1959:2-1985:4); and Hours, Nominal Wage and Real Wage (1964:2-1985:4).

Table 2b: Summary Statistics for Seasonal Dummies, Deviations from Trend, 1948-1985			
	Standard Deviation of Seasonal Dummies	*Standard Error of the Regression*	R^2
GNP	2.87	2.51	.567
Consumption	3.73	1.98	.781
Durables	7.69	6.70	.571
Non-Durables	1.79	6.53	.930
Services	.66	1.61	.145
Fixed Investment	5.39	6.23	.428
Non-Residential	3.47	5.52	.283
Structures	6.56	5.38	.598
Producers Durables	3.67	6.77	.228
Residential	11.45	12.63	.451
Non-Farm Structures	12.00	12.78	.469
Farm Structures	14.39	26.36	.232
Producers Durables	8.83	14.52	.270
Government	2.33	5.00	.179
Federal	3.24	9.12	.112
Defense	2.02	10.00	.039
Other	13.18	16.09	.402
State and Local	3.38	2.47	.651
Exports	2.72	7.23	.124
Imports	2.20	6.20	.112
Change in Inventories	–	–	–
Final Sales	3.48	1.94	.763
Unemployment Rate	.41	.91	.168
Labor Force	.89	.53	.737
Employment	.74	1.09	.315
Hours	.61	.49	.601
Price Level	.11	1.67	.004
Nominal Interest Rate	.00	.00	.001
Real Interest Rate	–	–	–
Nominal Wage	.07	.79	.008
Real Wage	.16	1.43	.012
Nominal Money Stock	.73	1.10	.305
Nominal Monetary Base	.53	1.28	.147
Money Multiplier	.38	1.23	.085

The sample period is 1948:2-1985:4, except for the following variables: Residential Non-Farm Structures, Farm Structures, and Producer's Durables (1948:2-1983:4); Employment (1951:2-1985:4); Monetary Base and Money Multiplier (1959:2-1985:4); and Hours, Nominal Wage and Real Wage (1964:2-1985:4).

The standard deviation of the deterministic seasonal component in the log growth rate of real GNP is estimated to be 5.06%, while that of the deviations from trend is estimated to be 2.87%. Deterministic seasonal fluctuations account for more than 85% of the fluctuations in the rate of growth of real output and more than 55% of the (percentage) deviations from trend. Stochastic seasonal fluctuations and/or business cycle fluctuations represent a relatively small percentage of the fluctuations in real output. Plots of the log level of real output (Figure 1) and the log growth rate of real output (Figure 2) make this point even more clearly. The seasonal fluctuations in output are so large and regular that the timing of the peak or trough quarter for any year is rarely affected by the phase of the business cycle in which that year happens to fall.

Deterministic seasonal fluctuations are present in every major component of GNP, although the importance of these fluctuations in comparison to stochastic seasonal and/or business cycle fluctuations varies somewhat across components. The standard deviation of the seasonal dummies is particularly large in consumption purchases of durables and non-durables, residential fixed investment, and non-defense government purchases; it is smallest in consumption purchases of services and the change in inventories. The fraction of total variation explained by the seasonal dummies is largest for consumption purchases of durables and non-durables.

Seasonal dummies also explain a quantitatively important percentage of the fluctuations in the labor market variables, although the magnitude of the seasonal dummies is smaller than in many of the national income accounts. Looking at growth rates, the standard deviation of the seasonal dummy component is .65% for unemployment, 1.27% for the labor force, 1.08% for employment, and .87% for hours. The standard deviations of the deviations from trend are .41% for unemployment, .89% for the labor force, .74% for employment, and .61% for hours. The seasonal dummies are responsible for over two thirds of the variation in the log growth rates of all four labor market variables.

The standard deviations of the deterministic seasonal fluctuations in real and nominal price variables are noticeably smaller than those in the quantity variables. For example, the standard deviation of the seasonals in the growth rates of prices is .25%, and seasonal dummies explain only 3.1% of the total variation. The same conclusions hold qualitatively for real interest rates, nominal wages, and real wages. There appears to be no deterministic seasonality in nominal interest rates. These results mean that, unless there is considerable stochastic seasonal variation in prices, there is considerably more seasonality overall in quantity variables than in price variables.

There is substantial seasonal dummy variation in the money stock. There is somewhat less but non-negligible seasonal dummy variation in the monetary base and the money multiplier. Seasonal dummies account for approximately 50% of the variation in the log growth rate of money and the monetary base but only about 25% of the variation in the log growth rate of the money multiplier. The standard deviation of the seasonal dummies is 1.10% for money, .76% for the base, and .57% for the money multiplier.

In Figures 3 to 10 we present the (log) spectra of some of the series discussed above. For the quantity variables, the figures confirm the conclusions suggested by the seasonal dummy estimates of seasonality. For the price variables (the price level and nominal interest rates), the figures indicate that the absence of deterministic seasonality documented in Table 2 is accompanied by limited stochastic seasonality. Although there are peaks in the spectra of these two series at seasonal frequencies, they are not nearly as pronounced as those at the seasonal frequencies for the quantity variables. The results in Tables 2a and 2b combined with the results in the figures therefore indicate that quantity variables display much more seasonality than price variables.

B. The Seasonal Patterns in Macroeconomic Variables

The second step in our examination of the seasonal fluctuations in the economy is to display the estimated seasonal patterns in the macroeconomic variables considered above. These patterns are presented for log growth rates in Table 3a and for deviations from trend in Table 3b. The entries in the tables are the OLS estimates of the coefficients on the seasonal dummies from Equation (2). In each case we have subtracted the overall mean of the dependent variable from each dummy coefficient; the entries in the tables are therefore interpreted either as the difference between the average growth rate of the variable in that quarter and the overall growth rate, or, as the average percentage deviation of the variable from trend in that quarter. For ease of presentation, we have not included the standard errors on the coefficients.[15] For all variables other than the nominal interest rate, the data reject the null hypothesis of no deterministic seasonality at the 99% level of confidence.[16]

The coefficient estimates in Table 3a show that the growth rate of real output is strongly positive in the second and fourth quarters, strongly negative in the first quarter, and insignificantly negative in the third quarter. Looking at the deviations from trend in Table 3b, we see that output is, on average, well below trend in the first quarter, slightly below trend in the third quarter, and

[15] The standard errors are in general quite small, implying precise estimates of the seasonal dummy coefficients. For example, the OLS standard errors on the seasonal dummy coefficients in the log growth rate of output are .32, .31, .31, and .31., while the Hansen and Hodrick standard errors are .38, .30, .34, and .30.

[16] We have carried out these tests using the Hansen and Hodrick (1980) procedure, with the lag length set equal to 4. The variance-covariance matrix was computed using a damp factor of 1 to insure positive definiteness of the matrix (Doan and Litterman (1986), Newey and West (1987)).

Table 3a: Seasonal Patterns, Log Growth Rates, 1948-1985				
	Q1	Q2	Q3	Q4
GNP	-8.01	3.72	-.49	4.85
Consumption	-10.34	4.27	-.94	7.02
Durables	-21.30	12.73	-4.66	13.23
Non-Durables	-18.22	7.20	-.43	11.45
Services	1.80	-1.15	-.26	-.39
Fixed Investment	-12.33	12.33	.35	-.35
Non-Residential	-8.56	8.09	-3.77	4.23
Structures	-16.33	10.04	5.74	.55
Producers Durables	-4.02	7.29	-9.47	6.20
Residential	-21.50	22.65	8.45	-9.60
Non-Farm Structures	-22.22	23.50	8.78	-10.06
Farm Structures	-33.28	19.46	18.45	-4.63
Producers Durables	-24.61	7.95	2.48	14.18
Government	-6.47	3.23	1.31	1.93
Federal	-7.21	.31	-.93	7.82
Defense	-2.51	3.27	-5.04	4.28
Other	-21.26	-14.59	18.63	17.23
State and Local	-5.37	6.14	3.37	-4.15
Exports	-2.48	4.29	-7.08	5.27
Imports	-1.20	4.69	.24	-3.73
Change in Inventories	1.14	-.39	-.10	-.66
Final Sales	-9.83	5.24	-.81	5.40
Unemployment Rate	1.08	-.67	-.17	-.24
Labor Force	-1.27	1.55	.96	-1.23
Employment	-1.65	1.09	.84	-.27
Hours	-1.08	.74	.95	-.61
Price Level	-.19	.14	.19	-.14
Nominal Interest Rate	-.00	-.01	-.01	.02
Real Interest Rate	.18	-.16	-.20	.17
Nominal Wage	-.16	-.09	.13	.12
Real Wage	-.05	-.27	.03	.29
Nominal Money Stock	-1.05	-.82	.13	1.74
Nominal Monetary Base	-1.25	-.00	.55	.70
Money Multiplier	.04	-.37	-.52	.93

The sample period is 1948:2-1985:4, except for the following variables: Residential Non-Farm Structures, Farm Structures, and Producer's Durables (1948:2-1983:4); Employment (1951:2-1985:4); Monetary Base and Money Multiplier (1959:2-1985:4); and Hours, Nominal Wage and Real Wage (1964:2-1985:4).

Table 3b: Seasonal Patterns, Deviations from Trend, 1948-1985				
	Q1	Q2	Q3	Q4
GNP	-3.76	-.02	-.53	4.31
Consumption	-4.48	-.20	-1.16	5.84
Durables	-10.46	2.16	-2.48	10.77
Non-Durables	-8.07	-.79	-1.27	10.13
Services	1.09	-.08	-.32	-.69
Fixed Investment	-9.37	2.99	3.36	3.02
Non-Residential	-5.30	2.85	-.90	3.35
Structures	-10.56	-.48	5.25	5.79
Producers Durables	-2.36	5.00	-4.44	1.79
Residential	-18.81	3.86	12.29	2.66
Non-Farm Structures	-19.74	3.95	12.85	2.93
Farm Structures	-22.42	-2.84	15.15	10.10
Producers Durables	-10.75	-2.66	-.32	13.72
Government	-3.45	-.45	.94	2.97
Federal	-1.55	-1.59	-2.41	5.55
Defense	-.96	2.32	-2.80	1.44
Other	-2.21	-17.93	1.21	18.93
State and Local	-5.21	.79	4.24	.18
Exports	-1.14	3.44	-3.74	1.44
Imports	-2.80	2.03	2.26	-1.49
Change in Inventories	—	—	—	—
Final Sales	-4.87	.37	-.44	4.95
Unemployment Rate	.66	-.03	-.20	-.43
Labor Force	-1.32	.21	1.18	-.05
Employment	-1.17	-.07	.76	.47
Hours	-.87	-.14	.81	.20
Price Level	-.15	-.01	.16	-.00
Nominal Interest Rate	-.01	-.00	-.01	.02
Real Interest Rate	—	—	—	—
Nominal Wage	-.01	-.09	.01	.10
Real Wage	.13	-.17	-.13	.17
Nominal Money Stock	.06	-.66	-.55	1.16
Nominal Monetary Base	-.52	-.42	.13	.81
Money Multiplier	.32	-.07	-.59	.34

The sample period is 1948:2-1985:4, except for the following variables: Residential Non-Farm Structures, Farm Structures, and Producer's Durables (1948:2-1983:4); Employment (1951:2-1985:4); Monetary Base and Money Multiplier (1959:2-1985:4); and Hours, Nominal Wage and Real Wage (1964:2-1985:4).

well above trend in the second and fourth quarters. The growth rates from quarter to quarter implied by the deviations from trend are strikingly similar to the results in Table 3a on the growth rates themselves. For example, the implied growth rates in real GNP are -8.07%, 3.74%, -.51%, and 4.84%.

The seasonal patterns in the growth rates and deviations from trend in consumption purchases are essentially the same as those in output as a whole. The seasonal patterns in government purchases are also dominated by first quarter declines and fourth quarter peaks. Fixed investment behaves somewhat differently, however. It grows most strongly in the second quarter, grows slightly in the third quarter, declines weakly in the fourth quarter, and declines strongly in the first quarter. This implies, consistent with Table 3b, that the deviations from trend reach their peak in the third quarter and their trough in the first quarter.

There are of course some exceptions to these overall tendencies. The growth rate and deviation from trend of consumption purchases of services shows a first quarter peak rather than a fourth quarter peak. Residential investment shows strong growth in the third quarter as well as in the second quarter (implying that the deviations from trend are particularly high in the third quarter), and investment expenditures on producers' durables tend to be high in the fourth quarter. Federal non-defense purchases show a third quarter peak rather than a fourth quarter peak, and state and local government purchases are highest in the second and third quarters. None of these exceptions, however, is sufficiently strong to overturn the basic patterns described in the previous paragraph. In particular, the decline in output from the fourth quarter to the first quarter occurs in almost every component of economic activity.

The labor market variables are all procyclical during the first two quarters of the year, and the unemployment rate is procyclical over the entire year. In particular, all four variables show significant declines from the fourth quarter to the first quarter. Surprisingly, the labor force, employment and average hours all increase during the third quarter and decrease during the fourth quarter, contrary to the behavior of output.[17]

The seasonal dummy components of the price variables (although statistically significant for all variables other than the nominal interest rate) are far smaller than those in quantity variables. The growth rate of the price level is positive in the second and third quarters and negative in the first and fourth quarters. Nominal interest rates show no seasonal pattern whatsoever, while real

[17] Total employment as measured by the Establishment Survey, manufacturing employment, and production hours in manufacturing all increase slightly during the fourth quarter. Together with John Bound we are in the process of conducting a detailed investigation of the seasonality of monthly labor market variables.

rates are high in the first and fourth quarters. Nominal and real wages are low in the first half of the year and high in the second half.

The money stock and the monetary base are both procyclical, showing signficant peaks in the fourth quarter and significant troughs in the first quarter. The amplitude of the seasonal in the base is smaller than that in money, and the amplitude of the seasonal in money is smaller than that in output. The money multiplier shows a distinct fourth quarter peak.

We conclude this section by discussing the robustness of the results presented above with respect to choice of sample period. Tables 2c-2f and 3c-3f, presented in the Appendix, show the same information as in Tables 2a-2b and 3a-3b for two sub-samples of the 1948-1985 period (1948-1966, 1967-1985).[18] Although a few variables appear to display somewhat different seasonal patterns in the two periods, the magnitudes of the changes in the patterns are almost always small in comparison to the magnitudes of the seasonal patterns themselves. For example, the change in the amplitude of the seasonal dummy pattern in real GNP is only 2.48%, while the amplitude of the pattern is 14.17% in the first half of the sample and 11.69% in the second half.

IV. The Seasonal Cycle and the Business Cycle

The stylized facts about the economy that collectively constitute the business cycle phenomenon are, for the most part, facts about the correlations between various macroeconomic variables.[19] The purpose of this section is to examine whether these correlations are present at seasonal as well as at business cycle frequencies. After reviewing a number of specific stylized facts we note that, with respect to all of these correlations, the seasonal cycle is just like the business cycle. This result, that the seasonal cycle and the business cycle are so similar, is the most intriguing result of the paper. We discuss possible interpretations of this result in Section V.

A. The Behavior of Aggregate Output

The most basic feature of the business cycle is the first one discussed by Lucas (1977) in his now famous article on understanding business cycles: output movements across broadly defined sectors move together. We have demonstrated above that this phenomenon also exists at the seasonal frequencies, i.e., there is a quantitatively important aggregate seasonal cycle. Indeed, the seasonal cycle is more pronounced than the business cycle for most quantity variables. Although the timing of the seasonal peaks and troughs differs to some extent across different components of output, the

[18] The sample periods are different for the following variables: Residential Non-Farm Structures, Farm Structures, and Producer's Durables (1948:2-1966:4,1967:1-1983:4); Employment (1951:2-1966:4,1967:1-1985:4); Monetary Base and Money Multiplier (1959:2-1972:2,1972:3-1985:4); and Hours, Nominal Wage and Real Wage (1964:2-1974:4,1975:1-1985:4).

[19] See especially Burns and Mitchell (1946) Friedman and Schwartz (1963), and Zarnowitz (1985).

overall tendencies are sufficiently similar that a large seasonal cycle remains. In particular, Table 3 shows that the large decline from the fourth quarter to the first quarter occurs "across the board."

A priori reasoning leaves some doubt as to whether seasonal cycles of the magnitude documented above should be a characteristic of modern economies. Although an agricultural economy might be dominated by a weather induced cycle, it seems implausible that weather effects would be important enough to drive most sectors of, say, the post–WWII United States economy.[20] Some activities, such as residential construction, can proceed at least cost when the weather is "good." For many other activities, however, the temperature extremes associated with summer or winter are costly (high air conditioning/heating costs), so these activities should have spring or autumn peaks.

The large seasonal in activity is also surprising relative to standard neo-classical models that assume convex costs of production. If production functions are everywhere concave and there are no seasonals in production or preferences, then output should be produced evenly throughout the year. If there are seasonals in preferences, then there should be some seasonality in production, but inventories could moderate this substantially. If there are seasonals in technology, then of course production should be seasonal, *ceteris paribus*, even with concave within period production functions, but it is not obvious what these "aggregate" seasonals in technology might be.

It is striking (see Tables 3a and 3b) how closely the seasonal dummy pattern in final sales matches the seasonal dummy pattern in output. While it is true that inventory investment is on average positive in the first quarter, the amplitude of this seasonal is modest in comparison to the seasonals in production and sales. This coincidence of final sales and output is the essence of the message in Miron and Zeldes (1986), which finds that the seasonals in production in 2-digit manufacturing match almost precisely the seasonals in shipments.

B. The Relation Between Money and Output

As a result of the pioneering work of Friedman and Schwartz (1963a,1963b), all macroeconomists are acutely aware of the strong correlation between movements in the quantity of nominal money and movements in real output. Whether this correlation reflects a causal mechanism running from money to output, and if so which mechanism, is a matter of much dispute. In Keynesian models (e.g., Fischer (1977)), the correlation reflects causation that is the result of sticky prices. In the Rational Expectations with Misperceptions models (Lucas (1972,1977)), the correlation also

[20] Of course, it is possible that economies adopted seasonal patterns in earlier periods when, say, agriculture was more important, and have been slow to move away from these patterns because of the institutions that arose around these patterns (e.g., school years).

reflects causation from money to output, but it is the result of information imperfections. King and Plosser (1984) illustrate in a real, equilibrium business cycle model that the correlation may reflect reverse causality from output to money, a point made earlier by Keynesian opponents of monetarism (e.g., Tobin (1970)).

Figure 11 shows a plot of quarterly real GNP growth against the growth of the nominal money stock (M1). This plot provides for the seasonally unadjusted data an analogue to those in Friedman and Schwartz (1963a,1963b) which, using annual or seasonally adjusted data, demonstrate the tendency toward comovement of real output and the nominal money stock at the business cycle frequencies. The plot suggests that the money-output correlation is as impressive at seasonal frequencies as it is at business cycle frequencies. Interpretation of Figure 11 is facilitated by a joint examination with the seasonal factors presented in Table 3. Both money and output show strong growth between the third and fourth quarters. The levels of both peak in the fourth quarter and then fall markedly going into the first quarter. Money and output do not move together between the first and second quarters. In the early subsample the money stock actually falls 1.7% relative to trend, while real output grows by 3.2%. In the later subperiod, money is flat between the first and second quarters while output grows on average by 3.3%. Clearly the fourth quarter comovement dominates in both subsamples, giving correlations between the seasonal dummies of .39 in the first, .87 in second, and .62 in the combined samples, respectively. It is also noteworthy that the standard deviation of the seasonal fluctuations in output is consistently greater (by a factor of four) than that in money. Friedman and Schwartz (1963b) found that at the business cycle frequencies the magnitude of the fluctuations in output exceeds that in money by a factor of two.[21]

Figure 12 displays the coherence of the growth rates of money and output after removal of the deterministic seasonal components. This figure allows us to obtain some sense of the comovement of the stochastic seasonality in money and output. The coherence takes on values in the range of .8 at both the seasonal and the business cycle frequencies.

The work of Friedman and Schwartz was responsible for a strong revival of the much older view (e.g., Fisher (1920)) that largely exogenous fluctuations in the nominal money stock play a key causal role in the business cycle. It would seem quite implausible that seasonal fluctuations in output could be driven by monetary factors. Phenomena such as the weather and Christmas apparently play a crucial role in determining the seasonal cycle, and the money stock hardly plays a central part in determining these events. In particular, the fourth quarter peak in output seems

[21] Their results imply an income elasticity of money demand of one half. See Friedman and Schwartz (1963b, pp.57-58).

most plausibly attributable to the impulse to real spending associated with Christmas. In this sense, we have for the seasonal cycle an identifying restriction of a sort unavailable for the ordinary business cycle. It seems probable that most of the correlation between money and output at the seasonal frequencies reflects joint endogeneity, specifically an accommodative response of money to high real spending and output in the fourth quarter.

Since we have suggested that at the seasonal frequencies money is probably responding endogenously to the needs of trade, and since much of the literature about endogenous money concentrates on the role of the private banking system in providing transactions balances (King and Plosser (1984)), it is natural to decompose the correlation between money and output into the components due to inside and outside money, respectively. Figures 13-16 present results analogous to those in Figures 11-12 but for the monetary base and the money multiplier separately. Both inside and outside money growth show significant comovement with output growth at the seasonal frequencies. This is true both for the deterministic seasonal movements (see Tables 3a-3b) and, to a lesser extent, for the stochastic seasonality (Figures 14 and 16). However, neither inside nor outside money individually shows as high a coherence with output as does M1. It may be that inside and outside money are to some extent substitutes in the provision of liquidity or transaction services, and that both respond endogenously to real shocks that raise output.

King and Plosser (1984) treat high-powered money as exogenous and concentrate on the endogenous response of inside money to real business cycle movements. However, there is reason to believe that high-powered money is also responsive to the state of the real economy, for example, due to interest rate pegging by the central bank. More generally, a positive correlation between real output and outside money would arise whenever central bank policy is aimed at "maintaining an elastic currency," as the original charter of the Federal Reserve proposed.

Friedman and Schwartz (1963) did devote considerable energy and ingenuity to their attempts to argue against the view that money responds passively to the business cycle rather than exerting a causal force on it. They argue that the factors precipitating major changes in the nominal money stock were often events largely exogenous to the business cycle (gold discoveries, gold flows from abroad due to disturbances in other countries, and banking panics that were largely self-fulfilling prophecies rather than reflections of economic fundamentals), and could be regarded almost as "controlled experiments." However, there is reason to believe that none of these events was truly exogenous, and all could in principle be connected with disturbances of the sort that might be relevant in real business cycle models.[22]

C. The Procyclical Behavior of Productivity: Okun's Law

One of the better known stylized facts about business cycles is the procyclical behavior of labor productivity. This is often stated in the form of "Okun's Law" – a one percent increase in employment is associated with a two to three percent increase in real GNP. Figure 17 shows a plot of real GNP growth and employment growth against time.[23] At both seasonal and non seasonal frequencies, peaks in employment growth are associated with magnified peaks in the growth of real GNP, i.e., labor productivity is procyclical. To pin down the magnitude of this relationship at the seasonal as well as at the business cycle frequencies, we present the estimated gain function from employment growth to output growth in Figure 18. At both the seasonal and the conventional business cycle frequencies, the gain function takes on values in the neighborhood of two to three, indicating that Okun's Law holds for the seasonal cycle just as much as for the business cycle.[24]

An alternative way to examine the cyclicality of labor productivity is to compare the behavior of output with the behavior of total hours worked (employment times average weekly hours). When we compute the gain from total hours worked to output, we find that the coefficient decreases somewhat at the seasonal frequencies (to a value between one and one and a half) while dropping more noticeably at the business cycle frequencies (to a value of about one). Thus, we confirm the result in Prescott (1986) that measures of labor input based on hours imply less procyclicality of labor productivity at the business cycle frequencies than measures of labor input based on the number of persons employed. Measures of labor input based on hours, however, continue to exhibit procyclical labor productivity at the seasonal frequencies.

The procyclical behavior of labor productivity over the business cycle has recently been interpreted in two broadly different lights.[25] The older view (e.g., Dornbusch and Fischer (1984)) is that the relation reflects labor hoarding during recessions, perhaps coupled with variations in the utilization of capital services over the cycle. More recently, Prescott (1986) has argued that procyclical labor productivity reflects shocks to the underlying technology. The issue of which of these two mechanisms is mainly responsible for the observed procyclical labor productivity at seasonal

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[22] For an interpretation of the bank failures in the 1930's as real supply shocks, see Bernanke (1983).

[23] All the results discussed in this section refer to the same measure of employment used in Tables 2-3, namely total non-agricultural employment as measured by the Household Survey. We have also conducted the analysis with the Establishment measure of employment, with quite similar results.

[24] We have also computed analogues to Figures 17-18 using the (Hodrick-Prescott) detrended data. These figures are quite similar to those presented in the paper.

[25] Hall (1986) discusses some of the issues that arise in attempts to differentiate between the two approaches to the regularity.

frequencies is discussed in Section V.

D. The Joint Behavior of Consumption and Leisure

A key fact about the business cycle is that consumption moves procyclically while leisure moves countercyclically. This fact cannot easily be reconciled with an equilibrium model of the determination of consumption and leisure. Barro and King (1984) demonstrate that if preferences are additively separable over time, there can be significant variation in consumption relative to leisure only if one of consumption or leisure is an inferior good, or if there is significant variation in the real wage. The first possibility seems so implausible that we rule it out *a priori*. Existing evidence on the cyclical behavior of the real wage is mixed; some studies do find a procyclical real wage, but the magnitude of this cyclicality is modest. Others studies find that the real wage is acyclical or even countercyclical.[26] If we weaken the assumption about the time separability of preferences, then it is still possible that the negative correlation between consumption and leisure can be reconciled with the acyclical real wage in an equilibrium model. Attempts to find a specification for preferences that is consistent with the data, however, have so far been unsuccessful.[27]

In light of this continuing discussion, it is interesting to note that the seasonal fluctuations in the consumption/leisure ratio and the real wage display exactly the same behavior as the business cycle fluctuations. We document this in Tables 4 and 5. Leisure is defined as total time endowment minus hours of work. Total time endowment is equal to population times the number of weeks in a quarter (13) times the number of non-sleep hours in a week (116). Hours of work is equal to average weekly hours times the number of weeks in a quarter times employment. We can see from the results in the tables that the consumption/leisure ratio is highly seasonal and highly procyclical at the seasonal frequencies. Real wages, on the other hand, are much less seasonal and do not display a consistent correlation with output growth at the seasonal frequencies. Perhaps the most natural reconciliation of these results is that there are seasonals in preferences for consumption relative to leisure, or that preferences are non-separable over periods of a year.

E. Prices and Output

The stylized facts about the relation between the price level and real output are that prices are procyclical, and the absolute magnitude of fluctuations in output is greater than that of fluctuations in prices. This characterization of the relation between prices and output also holds at the seasonal frequencies. Figure 19 presents the coherence between the (seasonal dummy adjusted) log growth rates of prices and real output. There is a clear peak at the seasonal frequencies, and the correlation

[26] Barsky and Solon (1987) provide a recent summary of the evidence.

[27] See Eichenbaum, Hansen and Singelton (1984).

Table 4: Summary Statistics for Seasonal Dummies, Log Growth Rates, Consumption/Leisure Ratio and the Real Wage			
	Standard Deviation of Seasonal Dummies	*Standard Error of the Regression*	R^2
Consumption/Leisure	6.02	1.47	.944
Real Wage	.20	.70	.076

The sample period is 1964:2-1985:4.

Table 5: Seasonal Patterns, Log Growth Rates, Consumption/Leisure Ratio and the Real Wage				
	Q1	Q2	Q3	Q4
Consumption/Leisure	-9.75	4.40	-.26	5.60
Real Wage	-.05	-.27	.03	.29

The sample period is 1964:2-1985:4.

between the seasonal dummy coefficients in output and prices is approximately 0.4. From Table 2 we see that the seasonal variation in prices is small relative to the seasonal variation in output (.17 vs 5.06). The non-seasonal variation is also smaller (.95 versus 1.91), although not as markedly.

There is an intimate relationship between the fact that prices do not move over the seasons and the fact that nominal money and real output covary closely. Although the comovement of nominal money and real output is a widely known stylized fact, it is by no means obvious from economic theory or first principles why this should be the case, even if money is responding passively or endogenously. First principles suggest that real money must move with real output, but this could as well come from movements of prices with constant money as from movements in nominal money. There is a continuum of possible equilibria with varying degrees of apparent "price rigidity." Why does the monetary authority choose to accommodate seasonal movements in real money demand with nominal money? This is the outcome that would arise if the authority, in addition to disliking price surprises (as in the models of Goodfriend (1986) and Barro (1987)) also has a distaste for anticipated movements in the price level.

V. Discussion

The results presented above establish a new set of stylized facts about macroeconomic fluctuations. The two crucial points are that seasonal fluctuations are a dominant source of short term variation in economic activity and that seasonal fluctuations display qualitatively the same characteristics as business cycle fluctuations. Both facts should be challenging to researchers aiming at a deeper understanding of macroeconomic fluctuations.

The similarity of the seasonal cycle and the business cycle presents a challenge because, to paraphrase Lucas (1977), "it suggests the possibility of a unified explanation" of both business cycles and seasonal cycles. This is not to say that the same forces must necessarily explain both phenomena. Many economists might readily agree, for example, that the seasonal cycle represents a real, equilibrium cycle that entails no welfare loss while steadfastly maintaining that the business cycle reflects disequilibrium and/or inefficient utilization of resources. By trying to understand precisely why the seasonal and the conventional business cycle are so similar, and whether they nonetheless reflect different mechanisms, we may be able to shed considerable light on all aggregate fluctuations.

The two most plausible proximate causes of seasonal fluctuations correspond to the two kinds of disturbances that are in some sense the basis for the main competing paradigms in modern business cycle analysis - to be blunt, supply shocks and demand shocks. Supply shocks - more properly, time-varying technological opportunities - are the basis for the stochastic equilibrium real business cycle models surveyed in Prescott (1986). Shocks to aggregate demand are at the heart of most traditional discussions of business cycles - most notably, but not exclusively, those in the Keynesian mode.[28] We discuss the supply-driven and the demand-driven approaches in turn. Of course, there is no reason that both forces can not be at work in aggregate economic fluctuations. We suspect this is the case with regard to the seasonal cycle, with the fourth quarter boom being demand driven (Christmas spending) and the recovery from the first quarter to the second quarter due to the improvement in the weather. An attempt to quantify the fraction of seasonal fluctuations due to technology rather than tastes is a component of our ongoing research program.[29]

One obvious paradigm for rationalizing the seasonal fluctuations in the economy is the time-varying technological opportunities approach exemplified in Prescott (1986). In a seasonal version of this kind of model, there would be seasonal shifts in the technology available for producing certain goods, possibly accompanied by a seasonal in preferences.[30] Within any period, both preferences and technology would exhibit standard diminishing returns properties; these schedules would simply undergo systematic shifts from season to season. Production would proceed seasonally in order to take advantage of improvements in the technology, and, depending on the storeability of goods and the seasonality of preferences, consumption might also be seasonal. Although production and consumption might both be quite "unsmooth," all of this variation would represent efficient responses to changes in technological opportunities.

This kind of model would appear to be consistent with some of the facts about the seasonal cycle. The large second and third quarter peaks in residential investment are presumably responses to the relative ease of construction during good weather. In order to have such a model explain the fourth quarter boom in consumption and output as a whole, it will presumably be necessary to include a shift in preferences for consumption relative to leisure in the fourth quarter. The question will then be whether the combination of a seasonal in preferences dominated by a fourth quarter increase and a seasonal in technology dominated by a second/third quarter increase can imply the first quarter trough in virtually all activity, as well as the relatively small amount of

[28] Note that even the analytical framework of Friedman and Schwartz (1982) is Keynesian in being aggregate demand-driven. However, Friedman and Schwartz treat exogenous changes in the nominal money stock as the principal disturbance to aggregate demand, which we argued earlier would not be appropriate with reference to seasonal fluctuations.

[29] For related work on seasonally adjusted data, see Shapiro (1987).

[30] One can, in this sort of representative agent framework, mechanically interpret a seasonal in preferences in terms of shifts in the household production function and thereby lump all seasonality into technology. This comes at the cost, however, of losing the intuitively appealing distinction between impulses coming from the preference side and those coming from the technological side

seasonal variation in price variables (particularly real interest rates).

In a series of recent papers, Hall (1984, 1986a, 1986b, 1986c) has interpreted traditional Keynesian theory in a somewhat new light. On the aggregate demand side (Hall, 1984), there are, in addition to presumably exogenous changes in government purchases (military spending), important shifts in the relationship between consumption and income – taste shocks, perhaps. Such demand shifts are met by relatively elastic aggregate supply responses because marginal cost is flat in the presence of substantial excess capacity (Hall, 1986b). More particularly, Hall (1986a) argues that much of American industry is well described by a Chamberlinian monopolistic competition model in which price is substantially above marginal cost (see also Hall, 1986c), but potential profits are dissipated by fixed costs. As Martin Weitzman (1984) has stressed, firms would always like to sell more output at the current price if only the demand were there. A monopolistic competition, excess capacity story captures the central Keynesian notion that the aggregate supply curve may be quite flat and output largely demand-determined without appealing to arbitrarily "sales-constrained" firms or other disequilibrium concepts.

The juxtaposition of taste shifts with an aggregate supply curve that is highly elastic due to excess capacity seems, at the broad brush level, to provide a natural interpretation of the large expansion of output that occurs in the fourth quarter of each year. Christmas acts as a "taste shifter" that raises desired consumption for given permanent income and real interest rate. Indeed, Christmas provides a more readily identifiable example of a consumption shift than those found by Hall (1986c), whose argument is based on residuals from a "consumption function" estimated using defense expenditures as an instrument. With excess capacity and price in excess of marginal cost, firms gladly meet the fourth-quarter demand increase.

While Hall (1986) attributes the excess capacity which is central to the above scenario to the standard Chamberlinian juxtaposition of market power and entry, it is intriguing to speculate about seasonality itself as a cause of excess capacity. If firms choose capacity to meet demand in the peak season(s), excess capacity will be present at all other times. It would, of course, then be necessary to explain why price is not bid down to marginal cost in the off season. One last implication of the emphasis on excess capacity in relation to the seasons that may be worth noting is that an aggregate demand shock around Christmas time, when capacity is more nearly fully utilized, will tend to have different implications than a shock realized during the slow seasons, e.g., the first quarter.

A final consideration in understanding the magnitude of aggregate fluctuations at seasonal frequencies involves issues of coordination and consumption externalities. Above, we treated Christmas (and implicitly other holidays) as an "exogenous" source of aggregate demand shifts. One might go deeper and note that holidays are suggestive of the coordination or synergies issues implicit in some recent neo-Keynesian business cycle models (e.g. Diamond (1982), Kiyotaki (1986), Startz (1986), Shleifer (1986)). It is the essence of holidays that they yield more utility if everyone celebrates them at the same time than if everyone celebrates them at different times. This leads to inherent multiple equilibria and strong non-smoothing tendencies in the economy, similar to the patterns generated in Shleifer (1986). To pin down precisely which seasons emerge as the peaks in activity would then require only small seasonal shifts in technology or preferences.

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Table 2c: Summary Statistics for Seasonal Dummies, Log Growth Rates, 1948-1966			
	Standard Deviation of Seasonal Dummies	*Standard Error of the Regression*	R^2
GNP	5.34	2.00	.877
Consumption	7.76	1.64	.957
Durables	14.98	6.45	.844
Non-Durables	12.33	2.08	.972
Services	.95	.83	.567
Fixed Investment	9.53	3.92	.856
Non-Residential	6.78	4.78	.667
Structures	9.71	4.38	.831
Producers Durables	7.24	7.33	.494
Residential	17.41	5.58	.907
Non-Farm Structures	17.92	5.62	.910
Farm Structures	13.58	33.38	.142
Producers Durables	16.59	26.36	.284
Government	5.01	4.23	.584
Federal	6.57	7.71	.420
Defense	5.30	7.35	.342
Other	26.33	20.55	.621
State and Local	6.43	1.72	.933
Exports	5.71	5.68	.503
Imports	3.20	5.01	.290
Change in Inventories	1.15	1.38	.409
Final Sales	7.21	1.57	.955
Unemployment Rate	.76	.55	.660
Labor Force	1.46	.52	.888
Employment	1.10	.70	.713
Hours	.86	.34	.867
Price Level	.19	.70	.072
Nominal Interest Rate	.02	.27	.004
Real Interest Rate	.21	.73	.076
Nominal Wage	.19	.42	.175
Real Wage	.11	.59	.037
Nominal Money Stock	1.39	1.69	.805
Nominal Monetary Base	.81	.86	.471
Money Multiplier	.85	.70	.590

The sample period is 1948:2-1966:4, except for the following variables: Employment (1951:2-1966:4); Monetary Base and Money Multiplier (1959:2-1972:2); and Hours, Nominal Wage and Real Wage (1964:2-1974:4).

Table 2d: Summary Statistics for Seasonal Dummies, Deviations from Trend, 1948-1966			
	Standard Deviation of Seasonal Dummies	*Standard Error of the Regression*	R^2
GNP	3.12	2.28	.651
Consumption	4.37	1.71	.866
Durables	8.00	7.08	.561
Non-Durables	7.12	1.66	.948
Services	1.21	.63	.215
Fixed Investment	6.00	5.31	.561
Non-Residential	3.74	5.75	.297
Structures	6.52	5.65	.572
Producers Durables	3.78	6.89	.232
Residential	11.58	9.35	.605
Non-Farm Structures	11.94	9.73	.601
Farm Structures	9.67	21.54	.168
Producers Durables	10.07	16.88	.262
Government	3.09	6.72	.154
Federal	4.01	12.31	.096
Defense	2.72	13.49	.039
Other	19.07	19.56	.487
State and Local	4.42	2.52	.754
Exports	3.02	7.79	.131
Imports	2.34	5.99	.132
Change in Inventories	–	–	–
Final Sales	4.08	1.56	.872
Unemployment Rate	.50	.88	.243
Labor Force	1.00	.61	.728
Employment	.75	1.02	.353
Hours	.58	.46	.614
Price Level	.14	1.39	.010
Nominal Interest Rate	.00	.00	.010
Real Interest Rate	–	–	–
Nominal Wage	.17	.51	.103
Real Wage	.05	1.16	.002
Nominal Money Stock	.93	.99	.468
Nominal Monetary Base	.55	1.12	.195
Money Multiplier	.60	.90	.308

The sample period is 1948:2-1966:4, except for the following variables: Employment (1951:2-1966:4); Monetary Base and Money Multiplier (1959:2-1972:2); and Hours, Nominal Wage and Real Wage (1964:2-1974:4).

Table 2e: Summary Statistics for Seasonal Dummies, Log Growth Rates, 1967-1985			
	Standard Deviation of Seasonal Dummies	*Standard Error of the Regression*	R^2
GNP	4.86	1.63	.899
Consumption	5.55	1.38	.942
Durables	13.66	4.39	.907
Non-Durables	10.47	1.24	.986
Services	1.12	1.31	.580
Fixed Investment	8.08	3.22	.863
Non-Residential	6.44	2.94	.827
Structures	10.33	3.00	.922
Producers Durables	7.11	3.68	.789
Residential	16.65	7.45	.833
Non-Farm Structures	17.36	7.54	.842
Farm Structures	30.64	42.58	.341
Producers Durables	13.06	16.43	.387
Government	2.62	1.64	.719
Federal	4.30	3.36	.621
Defense	2.63	3.51	.359
Other	11.52	7.86	.683
State and Local	3.40	1.49	.839
Exports	4.58	4.49	.510
Imports	3.14	5.19	.267
Change in Inventories	.26	.89	.078
Final Sales	5.23	1.37	.935
Unemployment Rate	.56	.45	.613
Labor Force	1.13	.34	.917
Employment	1.09	.74	.684
Hours	.91	.37	.858
Price Level	.16	.81	.039
Nominal Interest Rate	.03	.67	.002
Real Interest Rate	.17	.74	.048
Nominal Wage	.22	.56	.137
Real Wage	.43	.65	.306
Nominal Money Stock	1.03	.87	.582
Nominal Monetary Base	.73	.65	.556
Money Multiplier	.46	1.11	.144

The sample period is 1967:1-1985:4, except for the following variables: Residential Non-Farm Structures, Farm Structures, and Producer's Durables (1967:1-1983:4); Monetary Base and Money Multiplier (1972:3-1985:4); and Hours, Nominal Wage and Real Wage (1975:1-1985:4).

Table 2f: Summary Statistics for Seasonal Dummies, Deviations from Trend, 1967-1985			
	Standard Deviation of Seasonal Dummies	*Standard Error of the Regression*	$\bar{R}^2$ R^2
GNP	2.69	2.68	.502
Consumption	3.15	2.00	.712
Durables	7.48	6.21	.592
Non-Durables	6.03	1.59	.935
Services	.74	1.92	.130
Fixed Investment	4.88	6.96	.330
Non-Residential	3.31	5.25	.284
Structures	6.65	5.11	.628
Producers Durables	3.75	6.59	.245
Residential	11.47	15.19	.363
Non-Farm Structures	12.21	15.48	.383
Farm Structures	20.16	29.93	.312
Producers Durables	7.67	11.23	.318
Government	1.63	2.10	.375
Federal	2.58	3.90	.305
Defense	1.44	4.28	.101
Other	8.03	7.94	.505
State and Local	2.39	1.95	.601
Exports	2.51	6.63	.125
Imports	2.15	6.40	.101
Change in Inventories	–	–	-
Final Sales	2.93	2.11	.658
Unemployment Rate	.33	.93	.112
Labor Force	.80	.38	.812
Employment	.74	1.14	.300
Hours	.64	.51	.613
Price Level	.10	1.90	.003
Nominal Interest Rate	.00	.00	.003
Real Interest Rate	–	–	–
Nominal Wage	.17	.97	.030
Real Wage	.30	1.64	.033
Nominal Money Stock	.66	1.11	.260
Nominal Monetary Base	.53	1.43	.118
Money Multiplier	.25	1.45	.028

The sample period is 1967:1-1985:4, except for the following variables: Residential Non-Farm Structures, Farm Structures, and Producer's Durables (1967:1-1983:4); Monetary Base and Money Multiplier (1972:3-1985:4); and Hours, Nominal Wage and Real Wage (1975:1-1985:4).

Table 3c: Seasonal Patterns, Log Growth Rates, 1948-1966				
	Q1	Q2	Q3	Q4
GNP	-8.58	3.17	-.18	5.59
Consumption	-11.87	4.74	-1.58	8.71
Durables	-21.68	12.93	-6.20	14.96
Non-Durables	-19.49	6.97	-.98	13.51
Services	1.63	-.67	-.69	-.28
Fixed Investment	-13.76	13.02	1.95	-1.21
Non-Residential	-9.15	8.93	-3.03	3.25
Structures	-15.77	9.61	6.25	-.09
Producers Durables	-4.73	8.83	-9.00	4.90
Residential	-23.59	21.58	10.65	-8.65
Non-Farm Structures	-24.04	22.32	10.97	-9.25
Farm Structures	-18.75	14.75	10.94	-6.94
Producers Durables	-27.26	6.65	2.83	17.79
Government	-8.64	4.07	2.09	2.48
Federal	-9.73	1.02	-.09	8.79
Defense	-4.14	4.74	-6.24	5.65
Other	-28.79	-22.40	32.83	18.35
State and Local	-6.80	7.91	4.66	-5.77
Exports	-3.72	4.79	-7.26	6.19
Imports	-1.34	4.21	1.43	-4.29
Change in Inventories	1.92	-.79	-.14	-1.00
Final Sales	-11.52	5.89	-.82	6.45
Unemployment Rate	1.29	-.73	-.35	-.22
Labor Force	-1.54	1.98	.80	-1.23
Employment	-1.79	1.03	.78	-.26
Hours	-.90	.66	1.02	-.78
Price Level	-.25	.09	.26	-.11
Nominal Interest Rate	.01	-.02	-.01	.02
Real Interest Rate	.26	-.11	-.28	.13
Nominal Wage	-.29	.13	.22	-.05
Real Wage	-.16	.05	.15	-.04
Nominal Money Stock	-.60	-1.67	.16	2.10
Nominal Monetary Base	-1.26	-.17	.65	.78
Money Multiplier	.38	-.86	-.71	1.19

The sample period is 1948:2-1966:4, except for the following variables: Employment (1951:2-1966:4); Monetary Base and Money Multiplier (1959:2-1972:2); and Hours, Nominal Wage and Real Wage (1964:2-1974:4).

Table 3d: Seasonal Patterns, Deviations from Trend, 1948-1966				
	Q1	Q2	Q3	Q4
GNP	-3.73	-.48	-.68	4.90
Consumption	-4.97	-.17	-1.77	6.91
Durables	-10.25	2.48	-3.64	11.41
Non-Durables	-8.21	-1.03	-2.09	11.33
Services	.93	.22	-.45	-.70
Fixed Investment	-10.40	2.63	4.52	3.25
Non-Residential	-6.12	2.96	-.05	3.21
Structures	-10.44	-.69	5.59	5.54
Producers Durables	-3.46	5.50	-3.48	1.44
Residential	-18.94	2.38	12.74	3.82
Non-Farm Structures	-19.49	2.60	13.23	3.67
Farm Structures	-15.38	.15	11.08	4.15
Producers Durables	-10.97	-3.95	-1.32	16.23
Government	-4.47	-.85	1.35	3.97
Federal	-2.54	-2.20	-2.13	6.88
Defense	-1.94	2.97	-3.34	2.31
Other	-2.66	-27.72	5.71	24.67
State and Local	-6.71	.96	5.71	.04
Exports	-1.89	3.58	-3.84	2.15
Imports	-3.01	1.52	2.91	-1.42
Change in Inventories	–	–	–	–
Final Sales	-5.62	.30	-.55	5.87
Unemployment Rate	.80	.02	-.31	-.51
Labor Force	-1.56	.39	1.20	-.03
Employment	-1.19	-.11	.67	.63
Hours	-.77	-.17	.86	.08
Price Level	-.18	-.07	.18	.06
Nominal Interest Rate	.02	-.01	-.02	.01
Real Interest Rate	–	–	–	–
Nominal Wage	-.27	-.03	.19	.11
Real Wage	.00	-.07	.06	.01
Nominal Money Stock	.60	-.94	-.84	1.19
Nominal Monetary Base	-.47	-.49	.10	.85
Money Multiplier	.73	-.19	-.87	.33

The sample period is 1948:2-1966:4, except for the following variables: Employment (1951:2-1966:4); Monetary Base and Money Multiplier (1959:2-1972:2); and Hours, Nominal Wage and Real Wage (1964:2-1974:4).

Table 3e: Seasonal Patterns, Log Growth Rates, 1967-85				
	Q1	Q2	Q3	Q4
GNP	-7.58	4.27	-.80	4.11
Consumption	-8.87	3.81	-.29	5.34
Durables	-20.92	12.53	-3.12	11.51
Non-Durables	-17.00	7.45	.14	9.41
Services	1.97	-1.63	-.16	-.50
Fixed Investment	-10.96	11.66	-1.23	.53
Non-Residential	-7.98	7.25	-4.49	5.22
Structures	-16.84	10.45	5.21	1.18
Producers Durables	-3.33	5.76	-9.93	7.50
Residential	-19.51	23.75	6.28	-10.52
Non-Farm Structures	-20.27	24.85	6.36	-10.93
Farm Structures	-48.84	24.51	26.62	-2.28
Producers Durables	-21.77	9.44	2.13	10.20
Government	-4.36	2.41	.55	1.40
Federal	-4.76	-.38	-1.74	6.88
Defense	-.90	1.81	-3.83	2.91
Other	-14.02	-6.70	4.52	16.19
State and Local	-3.97	4.38	2.10	-2.51
Exports	-1.30	3.81	-6.89	4.38
Imports	-1.06	5.17	-.94	-3.17
Change in Inventories	.39	.00	-.07	-.33
Final Sales	-8.20	4.62	-.78	4.36
Unemployment Rate	.88	-.62	.01	-.27
Labor Force	-1.02	1.12	1.12	-1.22
Employment	-1.54	1.14	.88	-.48
Hours	-1.25	.82	.88	-.45
Price Level	-.15	.20	.12	-.17
Nominal Interest Rate	-.04	.00	.00	.03
Real Interest Rate	.11	-.20	-.12	.21
Nominal Wage	-.05	-.31	.05	.31
Real Wage	.06	-.58	-.09	.61
Nominal Money Stock	-1.51	.03	.09	1.38
Nominal Monetary Base	-1.23	.20	.44	.60
Money Multiplier	-.47	.15	-.35	.66

The sample period is 1967:1-1985:4, except for the following variables: Residential Non-Farm Structures, Farm Structures, and Producer's Durables (1967:1-1983:4); Monetary Base and Money Multiplier (1972:3-1985:4); and Hours, Nominal Wage and Real Wage (1975:1-1985:4).

Table 3f: Seasonal Patterns, Deviations from Trend, 1967-85				
	Q1	Q2	Q3	Q4
GNP	-3.79	.45	-.38	3.71
Consumption	-4.00	-.23	-.54	4.77
Durables	-10.64	1.84	-1.33	10.13
Non-Durables	-7.94	-.54	-.45	8.93
Services	1.24	-.37	-.19	-.67
Fixed Investment	-8.37	3.37	2.20	2.80
Non-Residential	-4.51	2.75	-1.74	3.50
Structures	-10.67	-.27	4.89	6.04
Producers Durables	-1.29	4.51	-5.38	2.16
Residential	-18.68	5.33	11.84	1.51
Non-Farm Structures	-19.97	5.46	12.41	2.10
Farm Structures	-29.99	-6.28	19.61	16.66
Producers Durables	-10.51	-1.21	.80	10.92
Government	-2.49	-.05	.55	1.99
Federal	-.62	-.95	-2.67	4.23
Defense	-.05	1.69	-2.23	.59
Other	-1.75	-8.14	-3.30	13.19
State and Local	-3.77	.64	2.79	.34
Exports	-.42	3.31	-3.62	.73
Imports	-2.61	2.55	1.61	-1.55
Change in Inventories	–	–	–	–
Final Sales	-4.15	.45	-.33	4.03
Unemployment Rate	.53	-.09	-.08	-.36
Labor Force	-1.09	.02	1.14	-.07
Employment	-1.15	-.03	.84	.34
Hours	-.95	-.12	.76	.31
Price Level	-.12	.05	.14	-.07
Nominal Interest Rate	-.03	.01	-.00	.02
Real Interest Rate	–	–	–	–
Nominal Wage	.23	-.15	-.17	.09
Real Wage	.26	-.27	-.32	.33
Nominal Money Stock	-.46	-.39	-.27	1.13
Nominal Monetary Base	-.57	-.35	.15	.78
Money Multiplier	-.08	.07	-.32	.34

The sample period is 1967:1-1985:4, except for the following variables: Residential Non-Farm Structures, Farm Structures, and Producer's Durables (1967:1-1983:4); Monetary Base and Money Multiplier (1972:3-1985:4); and Hours, Nominal Wage and Real Wage (1975:1-1985:4).

Appendix A: Sources of Seasonally Unadjusted Data

There are three government agencies that collect, process, and publish most of the major macroeconomic time series. The Federal Reserve Board (FRB) bears responsibility for interest rates, industrial production, and monetary aggregates. The Bureau of Labor Statistics (BLS) has responsibility for consumer and wholesale prices, employment, and unemployment. The Bureau of Economic Analysis of the Department of Commerce (BEA) constructs the National Income and Product Accounts (NIPA) using data collected by the Bureau of the Census. The FRB and BLS collect and publish both seasonally adjusted and unadjusted data. BEA publishes only a limited number of unadjusted series, and it publishes these only irregularly.

The seasonally unadjusted data produced by the FRB are published in complete detail in its regular statistical releases. Some of these unadjusted data are also available in the Federal Reserve Bulletin or in various books.[31] All of the data are available on tape by request from the FRB. The unadjusted data produced by BLS are published in its statistical releases, in the *Monthly Labor Review*, and in a few cases in the Federal Reserve Bulletin. Again, they are also available on tape from BLS. Some of the series from FRB and BLS are available on an unadjusted basis from on-line data retrieval services such as Citibase, Wharton Econometric Forecasting Associates, or Data Resources Incorporated.

Seasonally unadjusted for the NIPA are more difficult to obtain. BEA never publishes any real, seasonally unadjusted series. The reason is the order in which BEA produces its real, seasonally adjusted series. BEA starts with several hundred highly disaggregated nominal quantity series that add up to nominal GNP. It obtains from BLS price indices corresponding to each of these quantities. BEA then seasonally adjusts all the quantity series and all the price indices, deflates all the seasonally adjusted quantity series by the seasonally adjusted price indices, and then aggregates to produce a real, seasonally adjusted value for GNP. BEA also aggregates all the seasonally adjusted nominal quantity series, which produces a value for seasonally adjusted nominal GNP. From these two series, BEA can produce a seasonally adjusted implicit deflator. Given these procedures for calculating seasonally adjusted series, it is a time consuming task to recover the underlying seasonally unadjusted data or to compute a seasonally unadjusted implicit deflator.

Fortunately, BEA does compute and publish seasonally unadjusted nominal quantity series for GNP and most of its major components. It is therefore possible to create real seasonally unadjusted NIPA series by using one of two procedures. The first is to divide the nominal quantity series by

[31] See, for example, *The Industrial Production Book*, Board of Governors of the Federal Reserve.

a seasonally unadjusted price index such as the Consumer Price Index. This is the procedure we employ above, as well the one employed in Sargent (1976) and Miron (1986). A second procedure is to multiply the real, seasonally adjusted series by the ratio of the nominal unadjusted series to the nominal adjusted series; this is the procedure employed in Miron and Zeldes (1986), Reagan and Sheehan (1985), and West (1986).[32] So long as there is not much seasonality in prices, which appears to be the case, this second procedure should provide a good approximation to the first procedure. It is advisable and/or necessary to use the second procedure if there are not appropriate price indices available.[33]

The BEA publishes the seasonally unadjusted nominal quantity data on the major subcomponents of GNP in the *Survey of Current Business.* The quarterly numbers for each year appear irregularly but approximately annually, usually in the July issue. The data are also available on floppy disk from the authors.

[32] Since standard seasonal adjustment procedures are approximately equivalent to applying two sided filters, they alter the autocorrelation structure of the series. Series that have been "reseasonalized" by this second procedure may therefore have distorted autocorrelation structures.

[33] Miron and Zeldes (1986), Reagan and Sheehan, and West (1985) use the second procedure for precisely this reason. The accounting intricacies involved in calculating an inventory series make it difficult to know what price index is an appropriate deflator.

Appendix B: Description of the Data Series

National Income and Product Account: The definitions of the various components are the standard ones. Quarterly figures. Source: Survey of Current Business, various issues.

Price Level: Consumer Price Index for All Urban Consumers. Quarterly Figures are arithmetic averages of monthly numbers. Source: Citibank.

Nominal Interest Rate: Yield on Treasury bills. Quarterly numbers are sums of monthly returns on 90 day bills with approximately 30 days to maturity. Source: Ibbotson and Sinqufield.

Nominal Wage: Average hourly earnings of private, non-agricultural production workers. Quarterly numbers are averages of monthly numbers. Source: Citibank.

Unemployment Rate: Civilian unemployment rate, total. Quarterly numbers are averages of monthly numbers. Source: Citibank.

Employment: Non-agricultural employment, Household Survey. Quarterly numbers are averages of monthly numbers. Source: Citibank.

Labor Force: Civilian labor force, total. Quarterly numbers are averages of monthly numbers. Source: Citibank.

Hours: Average weekly hours of production workers, private non-agricultural. Quarterly numbers are averages of monthly numbers. Source: Citibank.

Money Stock: M1. Quarterly numbers are averages of monthly numbers. Source: Citibank.

Monetary Base: Quarterly numbers are averages of monthly numbers. Source: Citibank.

Figure 1 Log Level of Real Output

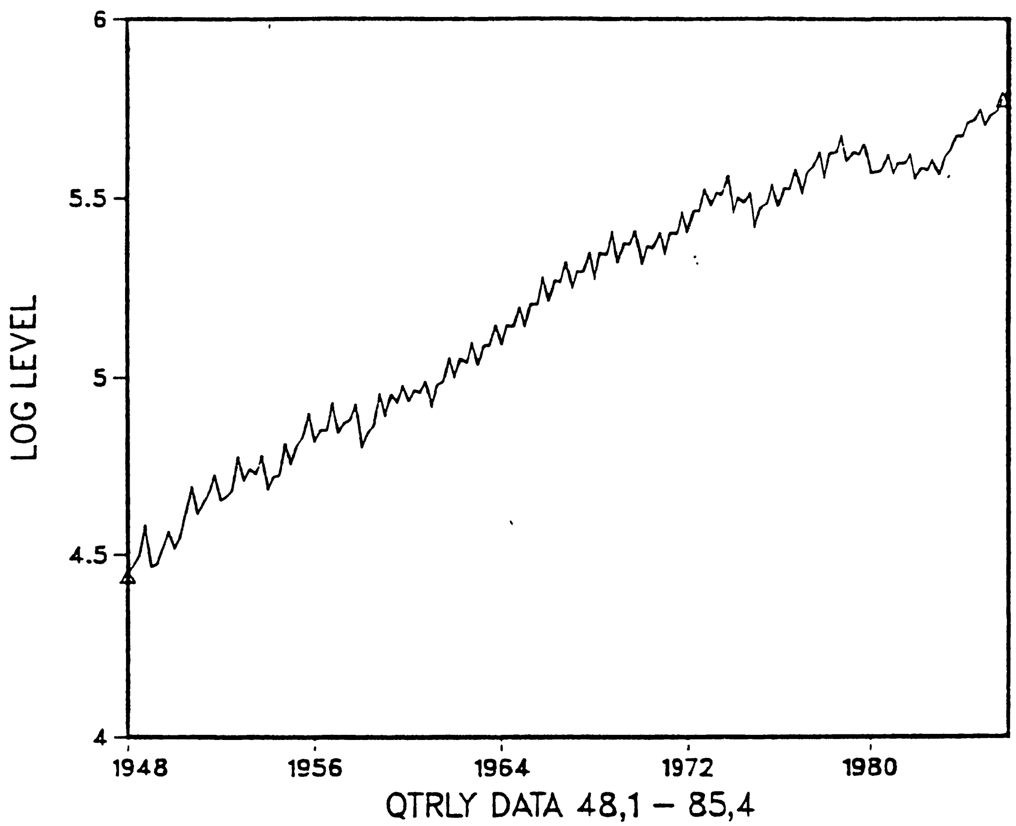
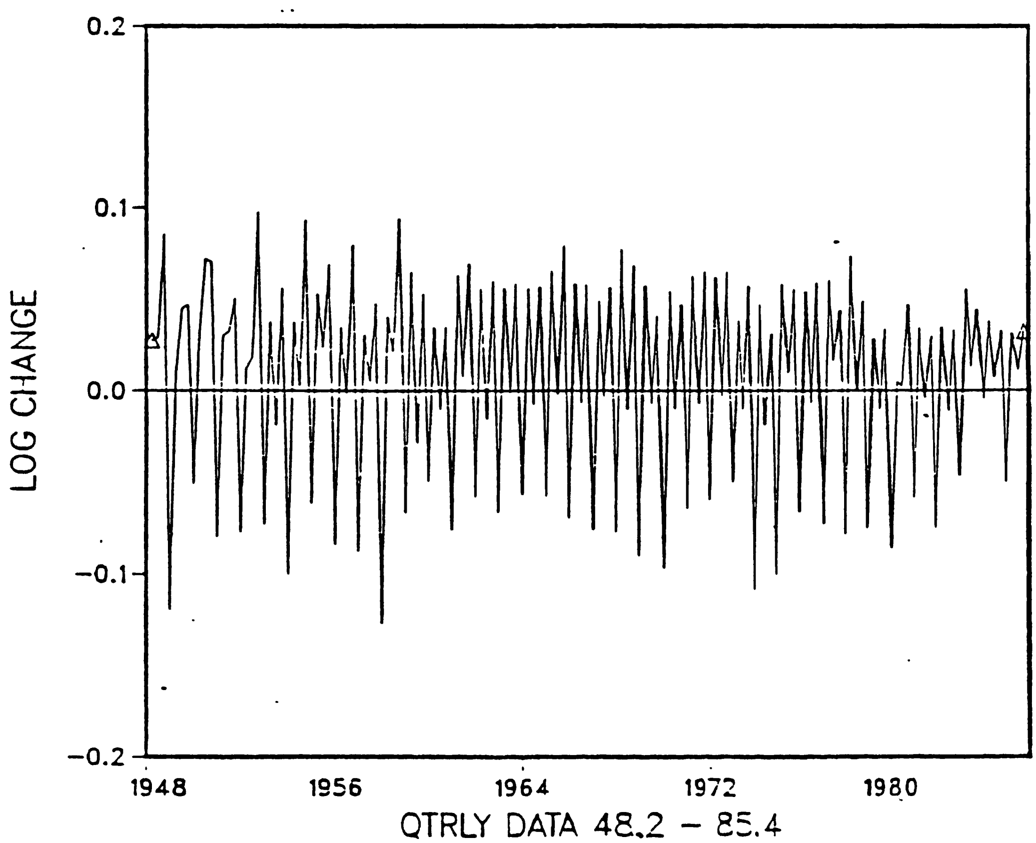


Figure 2 Log Growth Rate of Real Output



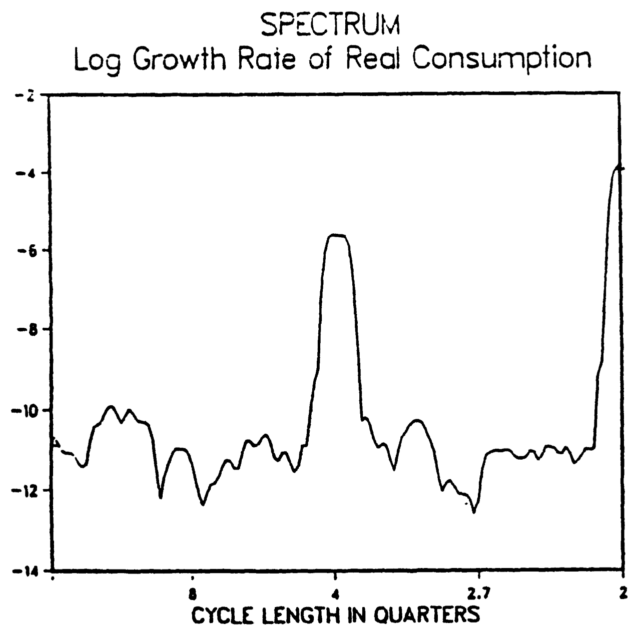
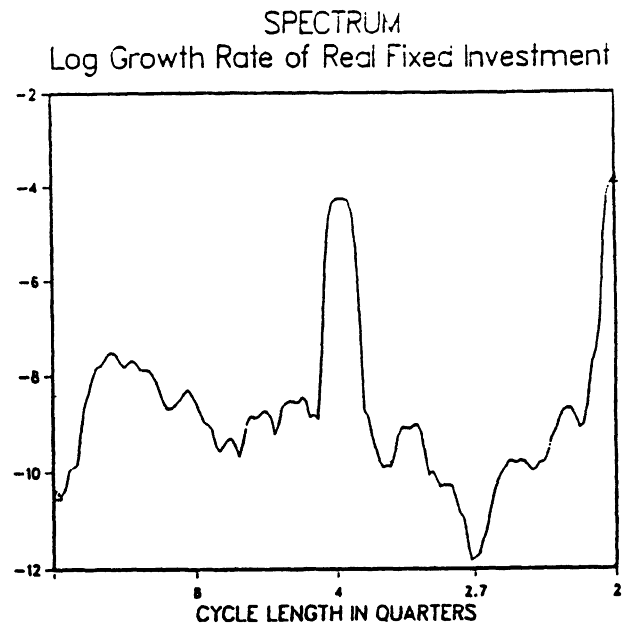


Figure 3



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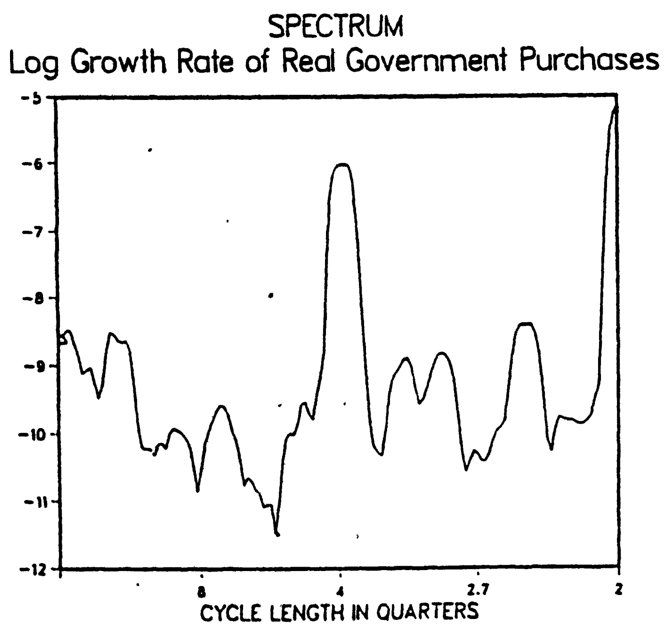

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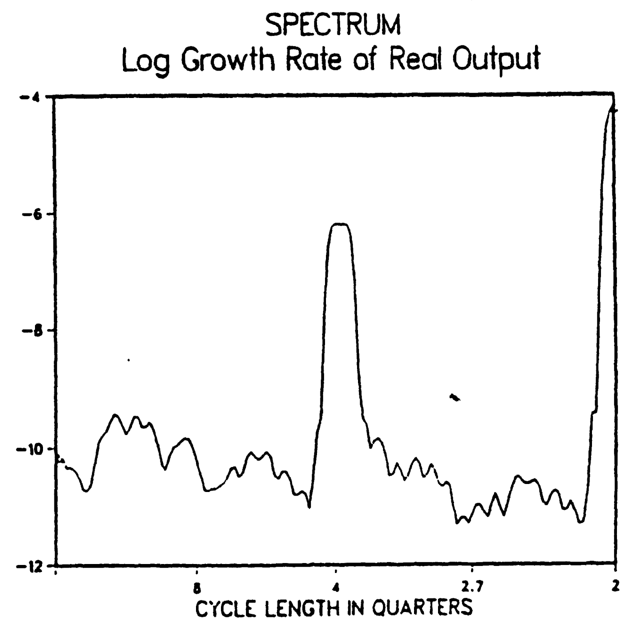

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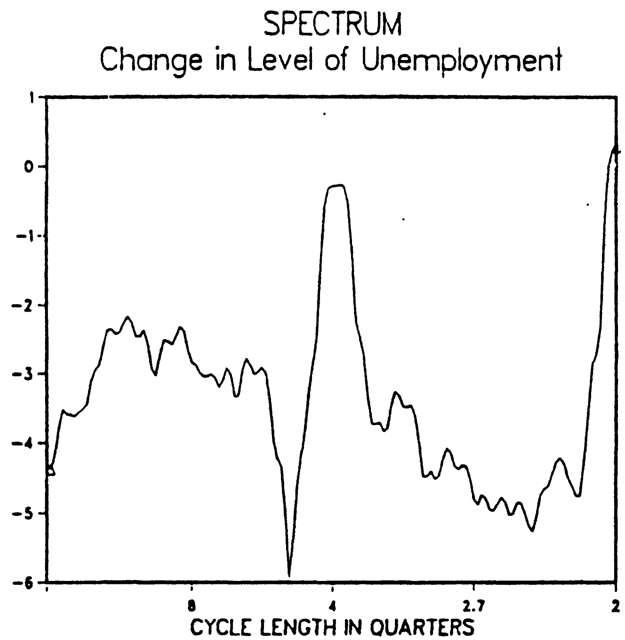

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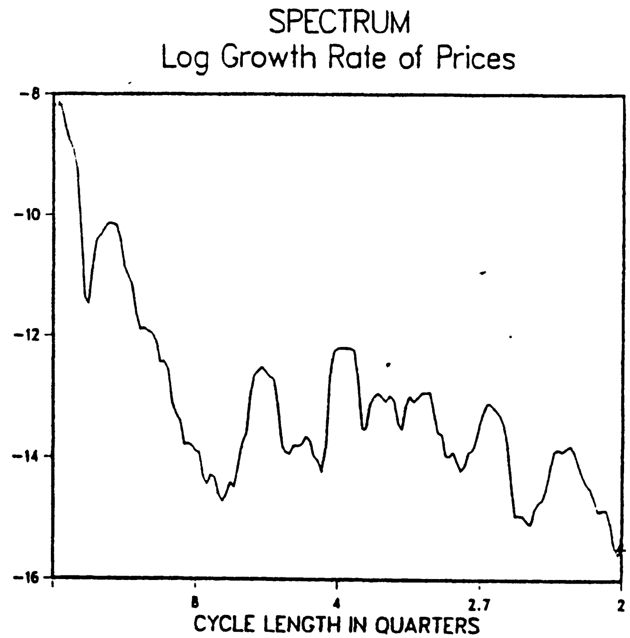

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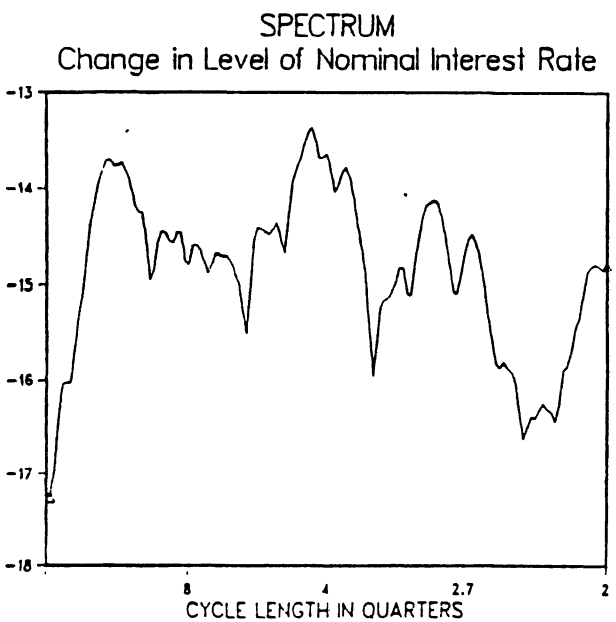

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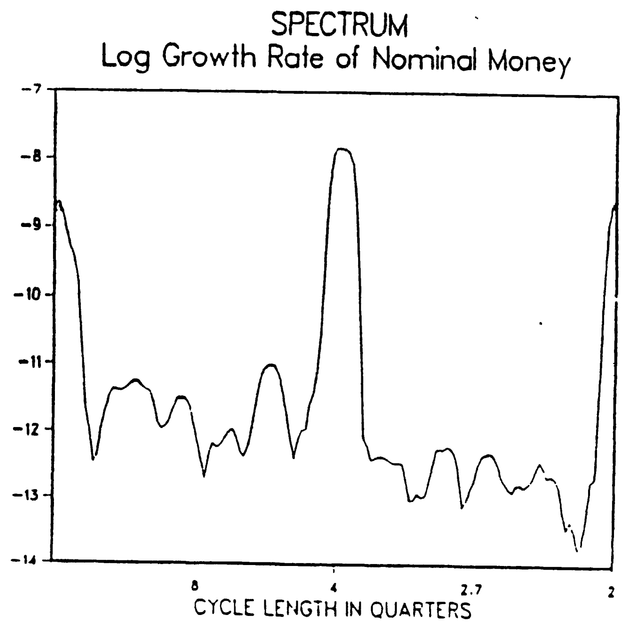


Figure 10

Log Growth Rates of Real Output & Nominal Money

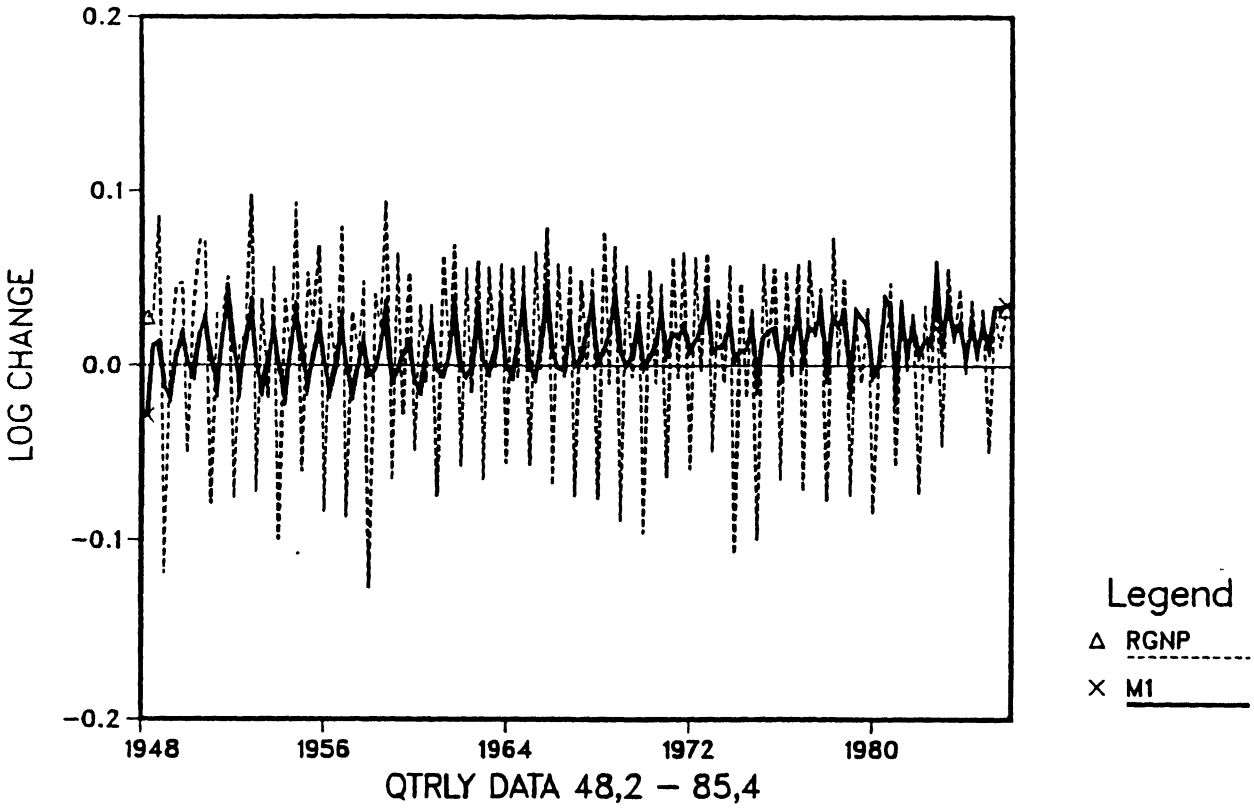


Figure 12

COHERENCE: Seasonal Dummy Adjusted
Log Growth Rates of Real Output & Nominal Money

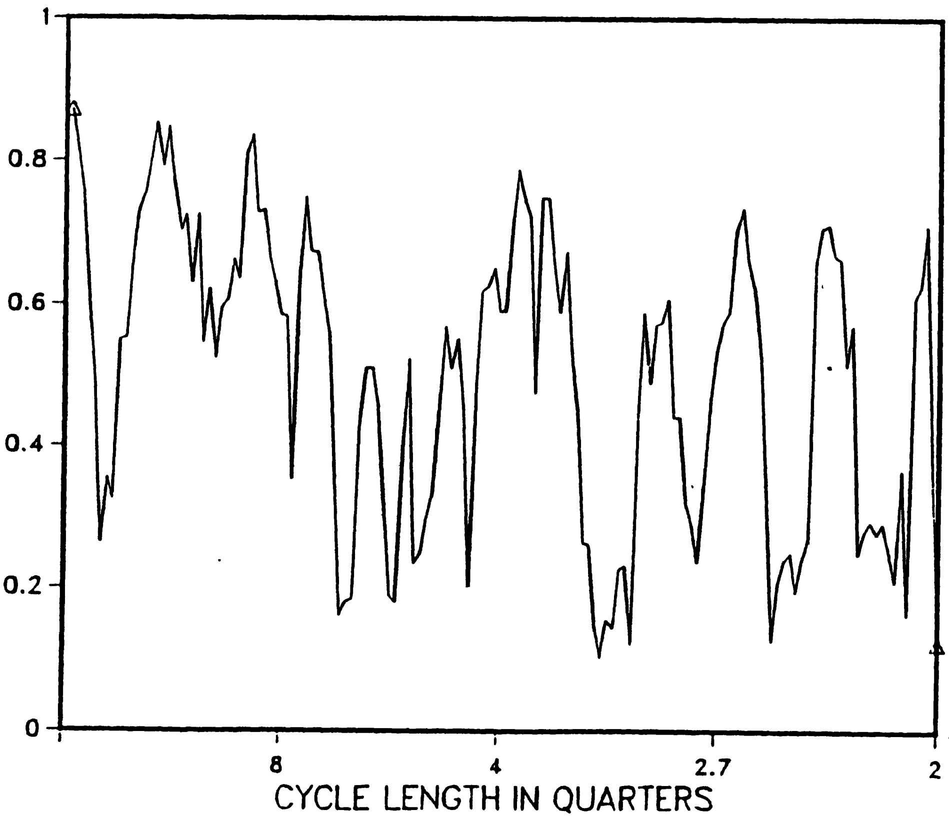


Figure 13

Log Growth Rates of Real Output & Nominal Monetary Base

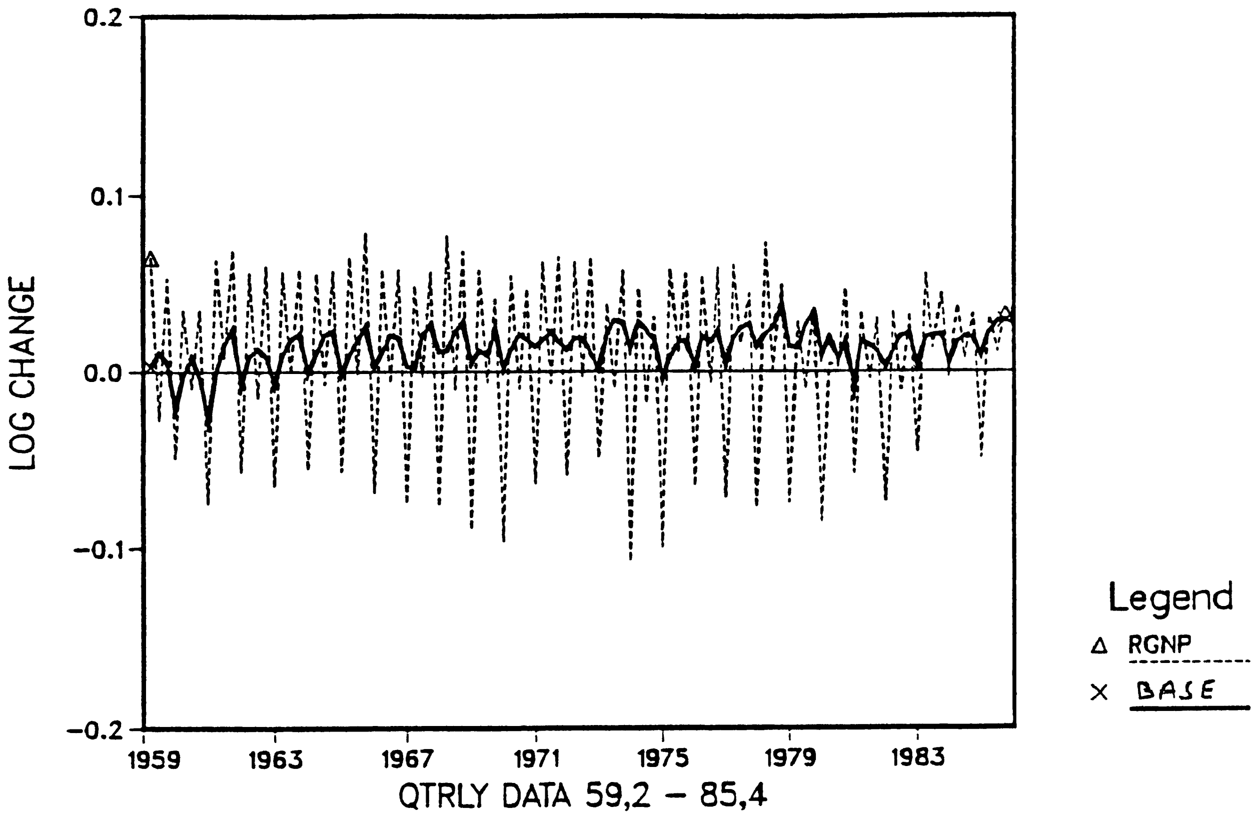
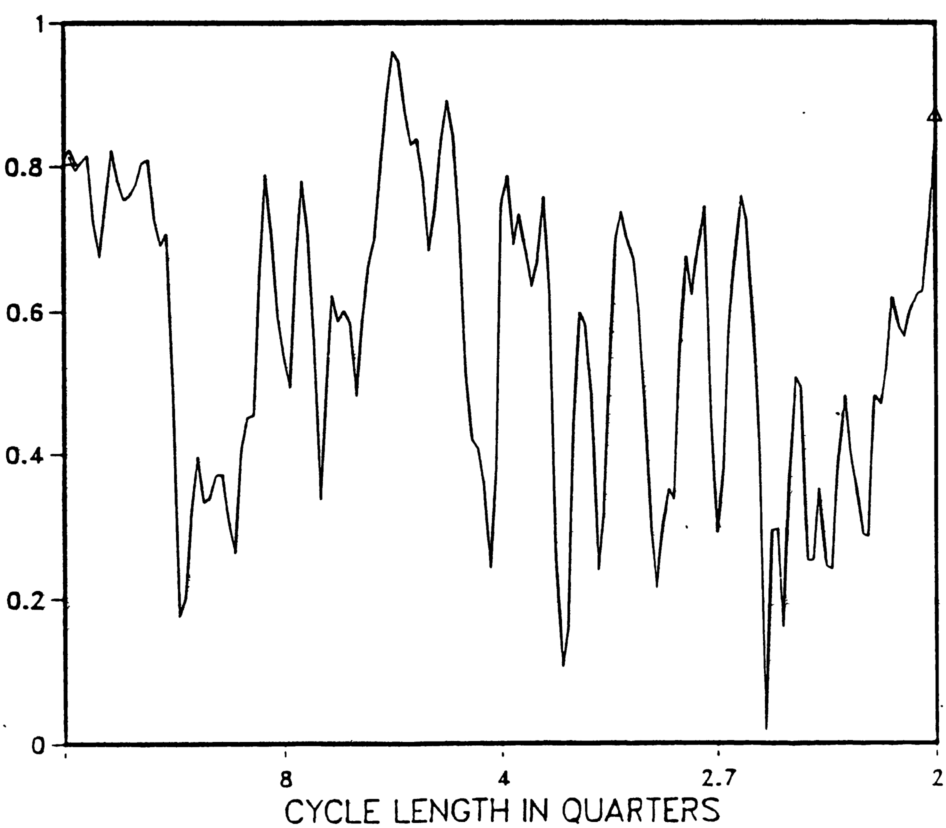
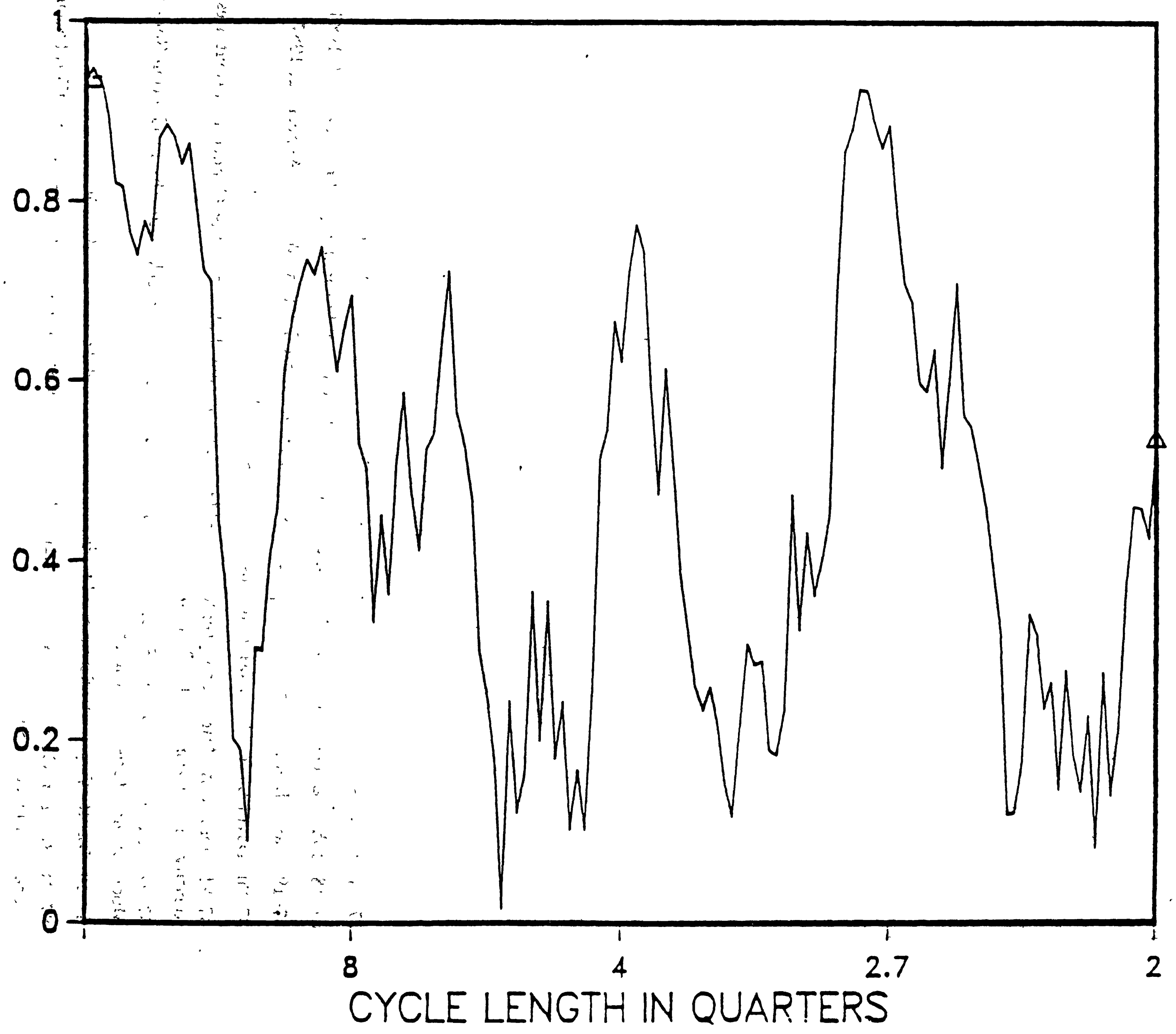


Figure 14 COHERENCE: Seasonal Dummy Adjusted
Log Growth Rates of Real Output & Nominal Monetary Base



COHERENCE: Seasonal Dummy Adjusted Log Growth Rates of Real Output & Prices



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