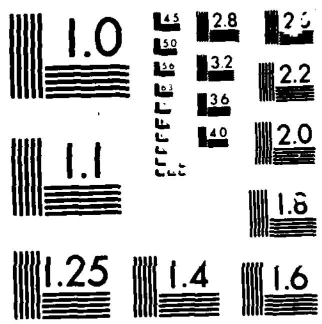
AD-A166 565 RECRUITMENT EARLY WARNING SYSTEM PHASE II TWELVE MONTH FORECASTS OF THE U..(U) ECONOMIC RESEARCH LAB INC RESTON VA R A HOLMES ET AL. MAR 85 ONR-85-02 1/1

UNCLASSIFIED N00014-85-C-0033 F/G 5/9 NL



MICROCOP' CHART

ECONOMIC RESEARCH LABORATORY, INC.

1914 ASSOCIATION DRIVE, RESTON, VA 22091
(703) 476-5500

RECRUITMENT EARLY WARNING SYSTEM
PHASE II

TWELVE MONTH FORECASTS OF THE UNITED STATES UNEMPLOYMENT RATE

A TECHNICAL REPORT

by

R. A. Holmes and Ross Neil
SIMON FRAZER UNIVERSITY

under the direction of
Dr. Peter Greenston
ECONOMIC RESEARCH LABORATORY, INC.

March 1985

This report was prepared under the Navy Manpower R&D Program of the Office of Naval Research under Contract N00014-85-C-0033. Reproduction in whole or in part is permitted for any purpose of the United States Government. This document is approved for public release; distribution unlimited.

ECONOMIC RESEARCH LABORATORY, INC.

1914 ASSOCIATION DRIVE, RESTON, VA 22091
(703) 476-5500

RECRUITMENT EARLY WARNING SYSTEM
PHASE II

TWELVE MONTH FORECASTS OF THE UNITED STATES UNEMPLOYMENT RATE

A TECHNICAL REPORT

by

R. A. Holmes and Ross Neil
SIMON FRAZER UNIVERSITY

under the direction of
Dr. Peter Greenston
ECONOMIC RESEARCH LABORATORY, INC.

March 1985

This report was prepared under the Navy Manpower R&D Program of the Office of Naval Research under Contract N00014-85-C-0033. Reproduction in whole or in part is permitted for any purpose of the United States Government. This document is approved for public release; distribution unlimited.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

AD-A166 565

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION: unclassified	1b. RESTRICTIVE MARKINGS: N/A
2a. SECURITY CLASSIFICATION AUTHORITY: N/A	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A	
4. PERFORMING ORGANIZATION REPORT NUMBER(S): ONR-85-	5. MONITORING ORGANIZATION REPORT NUMBER(S): N/A
6a. NAME OF PERFORMING ORGANIZATION: Economic Research Laboratory, Inc. — 6b. OFFICE SYMBOL (If applicable): ERL	7a. NAME OF MONITORING ORGANIZATION: Office of Naval Research, Department of the Navy
6c. ADDRESS (City, State, and ZIP Code): 1914 Association Drive, Reston, VA 22091	7b. ADDRESS (City, State, and ZIP Code): Arlington, VA 22217
8a. NAME OF FUNDING/SPONSORING ORGANIZATION: same as 7a — 8b. OFFICE SYMBOL (If applicable): ONR	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER: N00014-85-C-0033
8c. ADDRESS (City, State, and ZIP Code): same as 7b	10. SOURCE OF FUNDING NUMBERS

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
62763	411	RF 63521803	NR475-028

11. TITLE (Include Security Classification): Twelve Month Forecasts of the United States Unemployment Rate (unclassified)

12. PERSONAL AUTHOR(S): Holmes, R.A. and Neil, R.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
technical	FROM 84/10/1 TO 85/9/30	1985/9	63

16. SUPPLEMENTARY NOTATION: Supported by the Office of Naval Research Manpower R&D Program.

17. COSATI CODES

FIELD	GROUP	SUB-GROUP
N/A	N/A	N/A

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number): Unemployment forecasts; leading economic indicators; transfer functions; ARIMA models

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report describes the construction and performance of a forecasting model developed to forecast U.S. civilian unemployment. The model is based on a composite leading indicator, tailored to the unemployment rate, which consists of 15 component series on the U.S. economy. The components are weighted by an empirically derived weighting procedure, using bivariate regression analysis. As the objective is a 12 month forecast of unemployment, the weight of each of the component series is derived from its predictive power at a lead of 12 months. The weighted components are then combined to form a composite indicator, USULI12.

Within-sample testing indicates that the USULI12 leads turning points (both peaks and troughs) in U.S. unemployment by two to eleven months. Regression testing confirms the predictive power of the USULI12.

(continued on reverse)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION: unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL: Dr. Neil Glassman	22b. TELEPHONE (Include Area Code): (202) 696-4313 — 22c. OFFICE SYMBOL: ONR

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

Block 19 Continued

To forecast the U.S. unemployment rate, the USULI12 is used as the input variable in a transfer function model with an ARIMA noise structure. In a series of out-of-sample tests designed to examine forecasting accuracy near turning points, the mean absolute error is typically less than a 0.5 unemployment percentage point.

Accession For	
NTIS GRA&I	X
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

Acknowledgements

The authors wish to thank the Economic Research Laboratory, Inc., the Social Sciences and Humanities Research Council of Canada and Simon Fraser University for their generous financial assistance in the preparation and presentation of this paper. Previous studies providing the basis for this analysis were financed by the Social Sciences and Humanities Research Council of Canada and Simon Fraser University. Funding and data for the present study were provided by Economic Research Laboratory, Inc., Reston, Virgina.

<u>Disclaimer</u>

The authors guarantee only that the methodology described in this paper has been correctly applied. In other applications, this methodology has produced accurate forecasts but there is no guarantee that it will always do so. Unforeseen events may arise to invalidate any forecast, and the authors cannot guarantee that future events will not invalidate this forecast. Users of this forecast should recognize that any decisions based on this forecast are the responsibility of the users and incur no financial risk for the authors of this forecast.

INTRODUCTION

The purpose of this paper is to explain a forecasting model developed to forecast the United States unemployment rate (USU). The model is based on a leading indicator which is tailored to the unemployment rate being forecast. The components of the leading indicator, and the use of the leading indicator in our forecasting model are described below.

CONSTRUCTION OF THE TWELVE MONTH UNITED STATES LEADING INDICATOR (USULI12)

Component Series

The leading indicator (USULI12) that we develop to forecast USU consists of 15 component series on the U.S. economy. They are as follows:

1. Index of help-wanted advertising
2. Average work week, production workers manufacturing (hours)
3. Average weekly overtime, production workers manufacturing (hours)
4. Average weekly initial claims, state unemployment insurance
5. Contracts and orders, plant and equipment, in 1972 dollars
6. New orders, capital goods, non-defence, in 1972 dollars

7. Index of industrial production, nondurable manufactures (1967=100)
8. New private housing units started, total
9. Index of new private housing units authorized by local building permits (1967=100)
10. New orders, consumer goods, in 1972 dollars
11. Index of industrial production, consumer goods (1967=100)
12. New orders, durable goods, in 1972 dollars
13. Index of stock prices, 500 common stocks (1941-43=10)
14. Money supply, M2
15. U.S. leading indicator (USLI).

Massaging and Weighting the Component Series

Our 15 component series are combined into a twelve month leading indicator (USULI12) for the U.S. unemployment rate (USU) after some initial massaging of the data. This involves smoothing, deseasonalizing, and standardizing for variation (so that the more volatile series do not dominate the index). Once this initial massaging of the data is complete, the 15 component series are then combined into a leading indicator by an empirically derived weighting procedure.

The usual procedure for producing leading indicators involves the use of subjectively determined weights. The National Bureau of Economic Research, the institution which pioneered work on leading indicators, has long suggested weighting the components of a leading indicator by scoring them on the following:

1. Economic significance
2. Statistical adequacy
3. Historical conformity to business cycles
4. Cyclical timing record
5. Smoothness
6. Promptness of publication.

The average scores are used to weight the index, with the components having the highest scores receiving the largest weights.

In practice, this weighting procedure is very arbitrary with weights being subjectively rather than empirically determined, and often equal weights or a very coarse scale of weights, being employed. We propose an alternative approach to weighting the components of a leading indicator when it is being used to forecast a specific series. Our approach involves choosing the weights so as to maximize the expected accuracy of the forecasts being made. We employ regressions of the cyclical variation of the series being forecast on the cyclical variation in each of the component series using a lead of 12 months on the component series. Since our objective is to prepare a 12 month forecast of USU, we base our weights for the 15 component series in the U.S. unemployment indicator (USULI12) on their predictive power at a lead of 12 months. More precisely, our weighting scheme is based on the following regressions:

$$Y_t = \alpha + \beta X_{jt-12} + u_t$$

where,

Y_t = cyclical variation in USU

X_j = cyclical variation in the jth component of USU

j = 1, 2, 3, ... , 15 (the 15 component series)

α, β = regression parameters

u_t = disturbance term

The r^2 values in these regressions are then used to derive weights for the component of the leading indicator in the following manner:

$$W_{12j} = \frac{r^2_{12j}}{\sum_{i=1}^{20} r^2_{12j}}$$

where:

W_{12j} = weight assigned to the jth component of USU on a 12 month leading indicator

r^2_{12j} = coefficient of determination in the regression of Y on X with a lead of 12 months on X.

Weights of the Twelve Month Leading Indicator

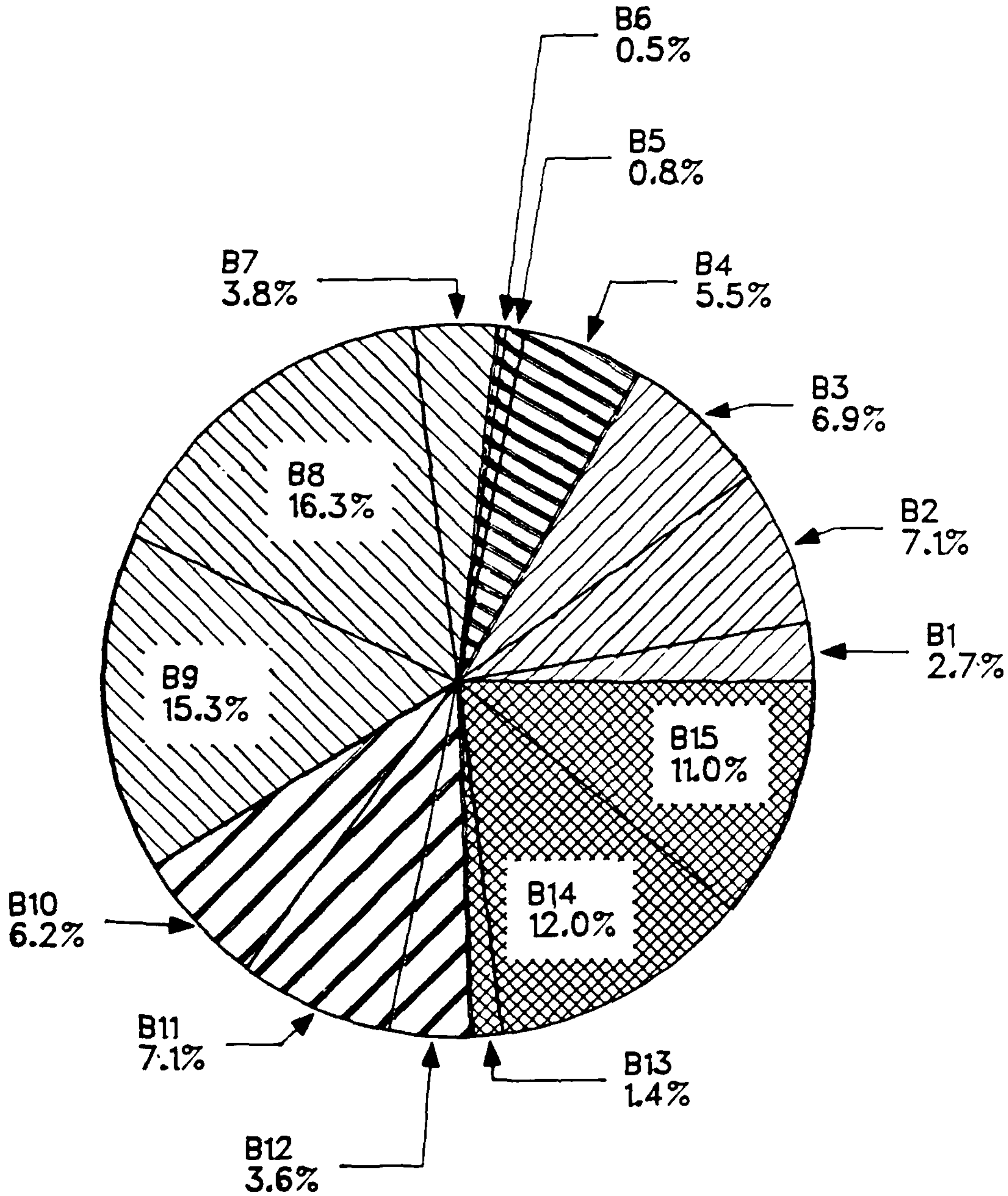
The weights obtained for USULI12 (i.e. with a lead of 12 months) on the 15 component series using data for the 1970-1 to 1984-10 period are as follows:

	Component Series	Weight	Cum Weight*
B8	New private housing units started, total	16.3%	16.3%
B9	Index of new private housing units authorized by local building permits	15.3%	31.6%
B14	Money supply, M2	12.0%	43.6%
B15	U.S. leading indicator	11.0%	54.6%
B11	Index of industrial production, con goods	7.1%	61.7%
B2	Average work week, production workers man	7.1%	68.7%
B3	Average weekly overtime, prdn workers man	6.9%	75.6%
B10	New orders, consumer goods	6.2%	81.8%
B4	Average weekly initial claims, state UI	5.5%	87.3%
B7	Index of industrial production, nondurable	3.8%	91.1%
B12	New orders, durable goods	3.6%	94.7%
B1	Index of help-wanted advertising	2.7%	97.3%
B13	Index of stock prices, 500 common stocks	1.4%	98.8%
B5	Contracts and orders, plant and equipment	0.8%	99.5%
B6	New orders, capital goods, non-defence	0.5%	100.0%

*Cumulative weights are rounded after calculations accurate to four decimal places.

The weights are plotted on Diagram 1, a pie chart on page 7. Note that the numbers 1 through 15 plotted on this pie chart refer to the 15 component series as numbered on pages 2 and 3 above. They are also the B numbers listed in the table above.

DIAGRAM 1
RELATIVE WEIGHTS OF THE COMPONENTS OF THE TWELVE MONTH U.S. UNEMPLOYMENT LEADING INDICATOR 1970-2 TO 1984-10



The previous table page 6 and the pie chart page 7 show that over 50% of the weight in USULI12 is contained in the following four series:

1. B8 New private housing units started, total
2. B9 Index of new private housing units authorized by local building permits
3. B14 Money supply, M2
4. B15 U.S. leading indicator

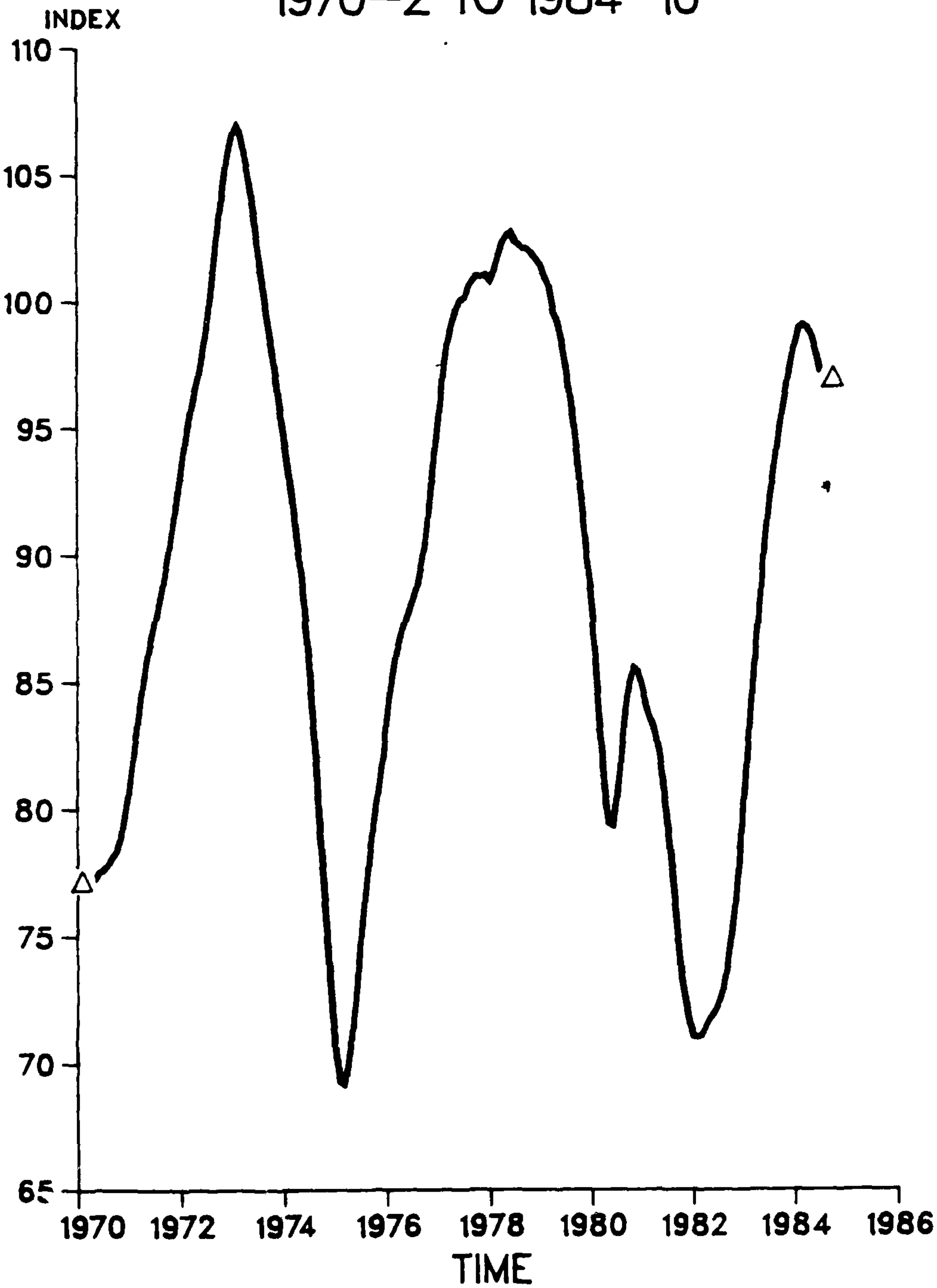
Moreover, the following three additional series provide an additional 25% of the total weight on USULI12:

1. B11 Index of industrial production, consumer goods
2. B2 Average work week, production workers manufacturing
3. B3 Average weekly overtime, production workers manufacturing

Thus, these 7 series provide a cumulative total of about 75% of the weight in USULI12, with the remaining 8 series accounting for only 25% of these weights.

The resulting leading indicator (USULI12) is shown on Diagram 2 page 9. The recent history of USULI12 shows a recovery in the economy between 1982-2 to 1984-3 with USULI12 rising from 71.1 to 99.0, but since 1984-3 the leading indicator has dropped to 96.9 in 1984 10. This slow down in economic activity from 1984 3 to 1984 10 may signal a rise in unemployment in the next 12 months.

DIAGRAM 2
TWELVE MONTH LEADING INDICATOR FOR U.S. UNEMPLOYMENT
1970-2 TO 1984-10



In the latest month (1984-10), USULI12 declined from 97.1 to 96.9. This decline reflects the weighted percentage changes in the 15 component series which are shown on the bar chart (Diagram 3), page 12. The declines result primarily from the negative effects of:

1. New private housing units started, total (8)
2. U.S. leading indicator (15).
3. Index of new private housing units authorized by local building permits (9)
4. Index of industrial production, nondurable manufactures (7)

It is interesting that two of the large negative impacts on USULI12 comes from the construction industry with new private housing starts having a particularly large negative effect. The other large negative impacts come from the U.S. leading indicator and the index of industrial production. These latter two components are signalling a general slowing down of the U.S. economy.

The component series producing a decline in the leading indicator are partially offset by the positive effects of the following:

1. Money supply, M2 (14)
2. Index of stock prices, 500 common stocks (1941-43=10) (13)

Of these two components Diagram 3, page 12 shows that the money supply (14) has by far the largest positive effect on USULI12, in October 1984.

The following remaining component series have had little effect on the leading indicator in the latest month:

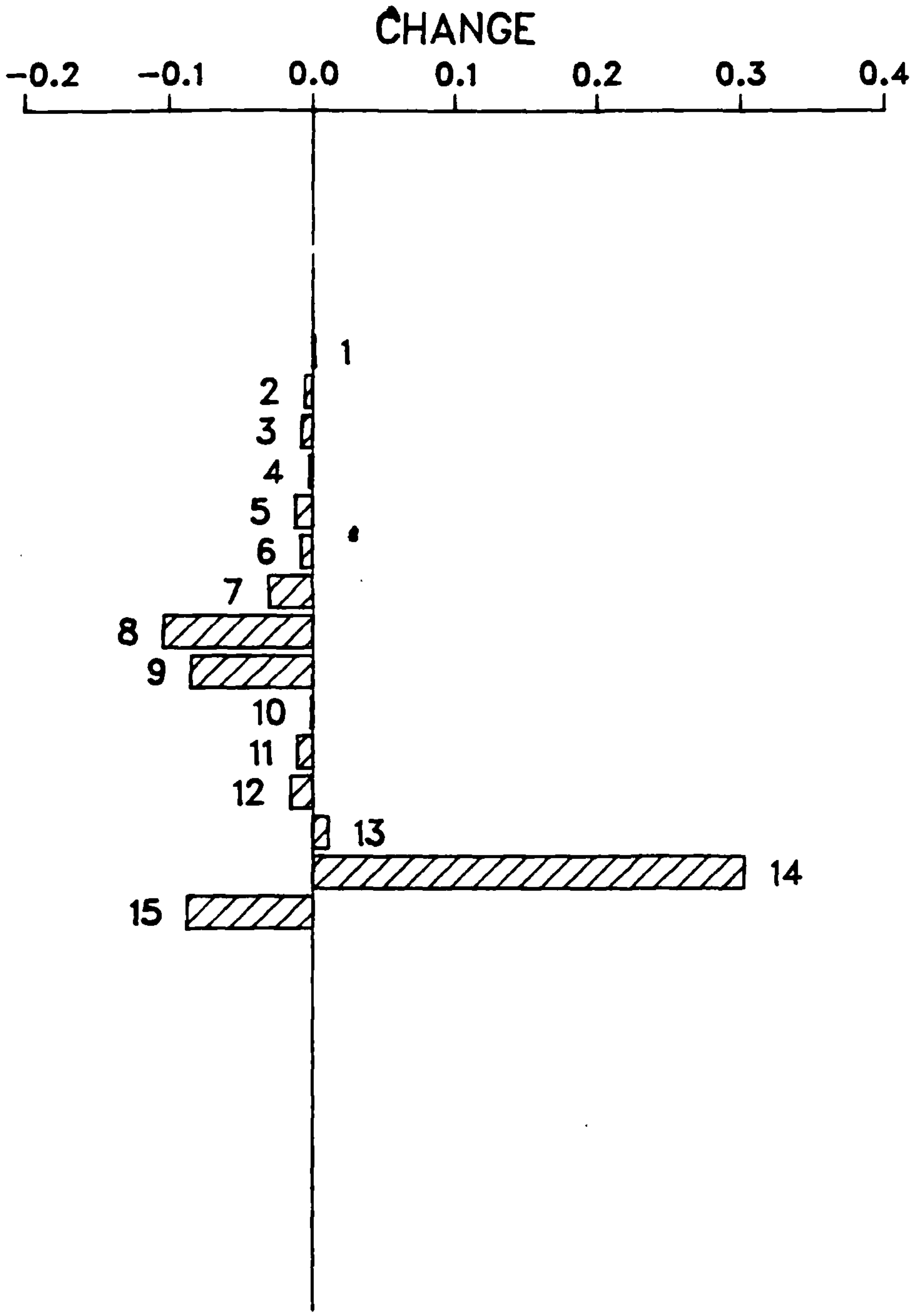
1. Index of help-wanted advertising (1)
2. Average work week, production workers manufacturing (hours) (2)
3. Average weekly overtime, production workers manufacturing (hours) (3)
4. Average weekly initial claims, state unemployment insurance (4)
5. Contracts and orders, plant and equipment, in 1972 dollars (5)
6. New orders, capital goods, non-defence, in 1972 dollars (6)
7. New orders, consumer goods, in 1972 dollars (10)
8. Index of industrial production, consumer goods (11)
9. New orders, durable goods, in 1972 dollars (12)

All of these 9 component series except the index of help-wanted advertising have had small negative effect on USULI12. The effect of the index of help-wanted advertising, while positive, is almost imperceptible on Diagram 3, page 12.

DIAGRAM 3

MONTHLY CHANGES IN COMPONENTS OF USULI12_8410

[WEIGHTED STANDARDIZED SERIES]



Test of Reliability

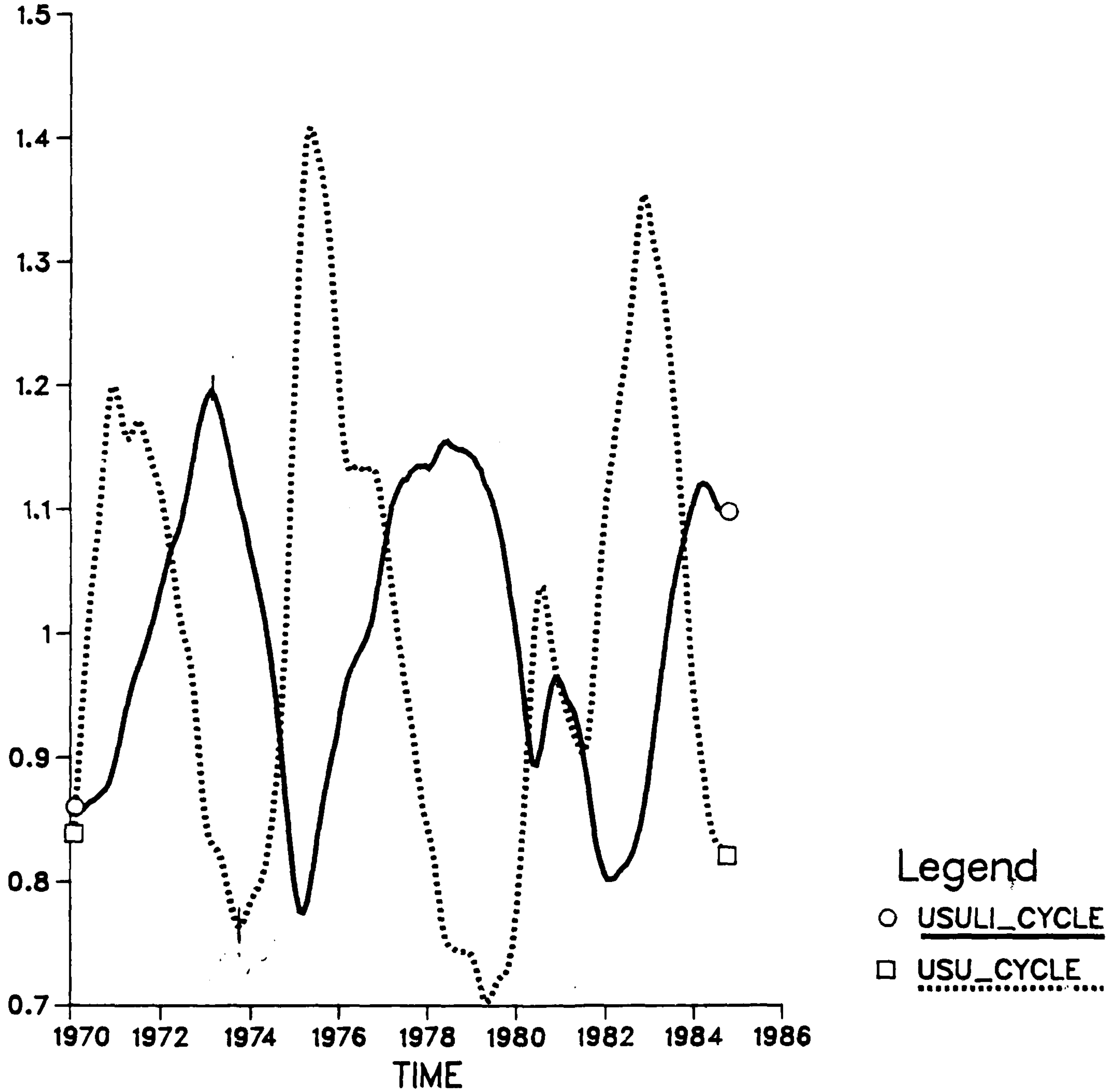
An obvious question is how accurately does this leading indicator predict the U.S. unemployment rate. Diagram 4, page 14, plots the cyclical components of USULI12 and USU (USULI12_C and USU_C). The leads of USULI12_C at all major turning points in USU_C are apparent from this graph. Since unemployment is counter-cyclical the peaks in the unemployment rate are led by troughs in the leading indicator. The monthly cyclical components of USULI12 and USU are given in the appendix. The major turning points in the cyclical components of the two series and the lead of USULI12_C on USU_C are as follows:

CYCLICAL COMPONENTS

USU_C Turning Points	USU_C Date	(Value)	USULI12_C Date	(Value)	Lead USULI12_C
Peak	1971-1	(1.198)	1970-5	(0.861)	8 months
Trough	1973-10	(0.764)	1973-2	(1.195)	8 months
Peak	1975-5	(1.407)	1975-3	(0.776)	2 months
Trough	1979-5	(0.703)	1978-6	(1.549)	11 months
Peak	1980-8	(1.037)	1980-6	(0.895)	2 months
Trough	1981-7	(0.904)	1980-11	(0.965)	8 months
Peak	1982-11	(1.353)	1982-2	(0.803)	9 months
Trough			1984-3	(1.121)	

If the same analysis is done for USLI (the U.S. leading indicator) the results are as follows:

DIAGRAM 4
TWELVE MONTH USU AND USULI: THE CYCLICAL COMPONENTS OF
U.S.UNEMPLOYMENT RATE AND
THE U.S.A. LEADING INDICATOR
1970-2 TO 1984-10

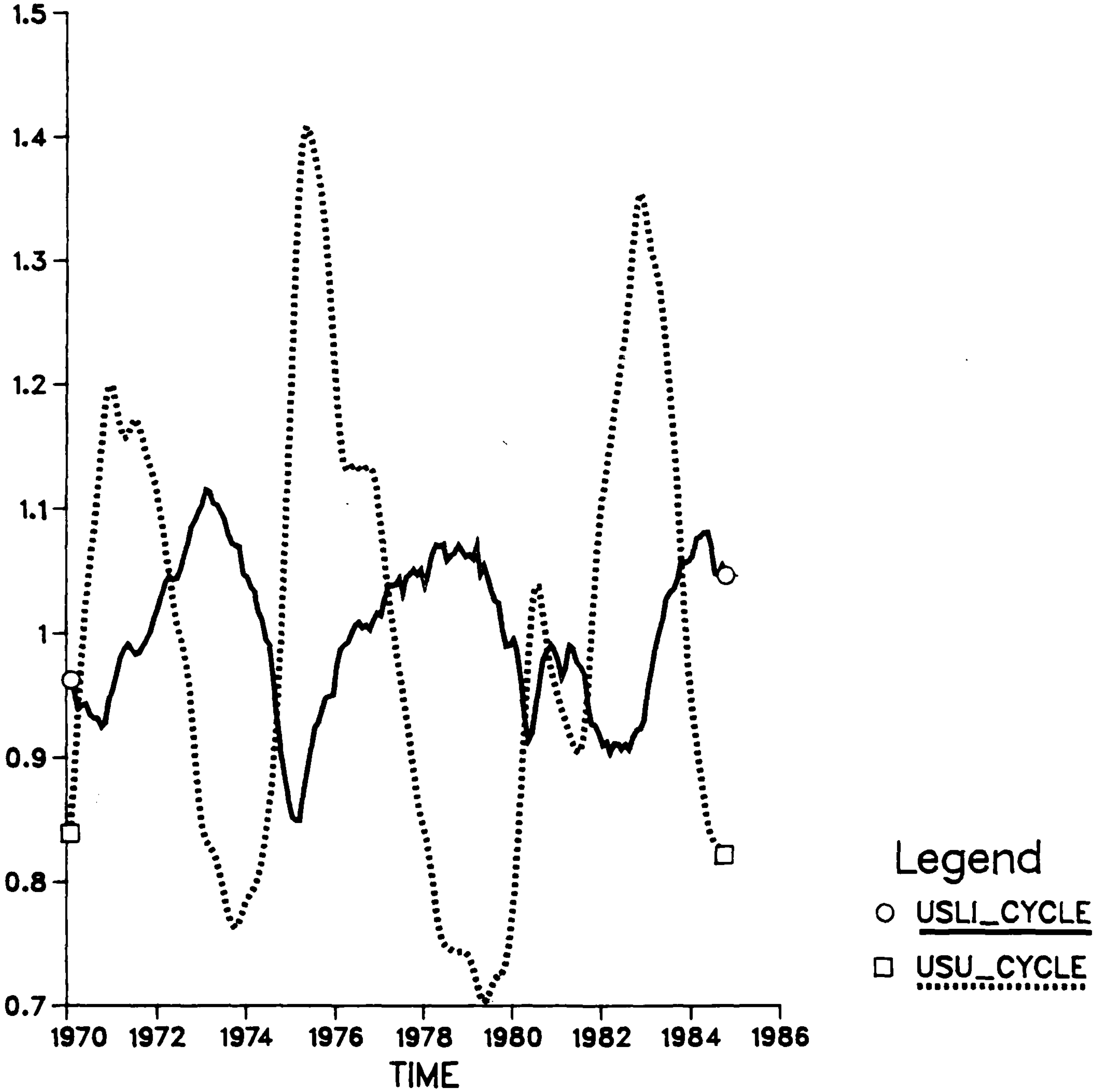


CYCLICAL COMPONENTS

USU_C Turning Points	USU_C Date (Value)	USLI_C Date (Value)	Lead USLI_C
Peak	1971-1 (1.198)	1970-10 (0.925)	3 months
Trough	1973-10 (0.764)	1973-2 (1.115)	8 months
Peak	1975-5 (1.407)	1975-2 (0.850)	3 months
Trough	1979-5 (0.703)	1979-3 (1.070)	2 months
Peak	1980-8 (1.037)	1980-5 (0.914)	3 months
Trough	1981-7 (0.904)	1980-10 (0.991)	9 months
Peak	1982-11 (1.353)	1982-6 (0.905)	5 months

Clearly, the USULI12 and USLI show an excellent record in forecasting the major turning points. USULI12 has had leads of 8, 2, 2 and 9 months at the four peaks (an average of 5 months) and leads of 8, 11, and 8 months at the three troughs (an average of 9 months) on USU. The leads of USULI12 at the troughs of USU tend to be longer than at the peaks of USU. The United States leading indicator (USLI) also leads the turning points in USU as shown by Diagram 5, page 16. USLI has had leads of 3 months on the first three peaks and a lead of 5 months on the last peak (an average of 3.5 months) and leads of 8, 2, and 9 (an average of 6 months) at the troughs. Thus USULI12 has a longer lead than USLI on the major turning points of USU. The difference averages 1.5 months at the 4 peaks and 3 months at the 3 troughs.

DIAGRAM 5
USLI_CYCLE AND USU_CYCLE: THE CYCLICAL COMPONENT OF USU AND THE U.S. NATIONAL LEADING INDICATOR
1970-2 TO 1984-10



A more comprehensive test on the predictive power of USULI12 and the USLI also confirms the superiority of the USULI12 for forecasting United States unemployment rates. We run regressions of the cyclical component of the U.S. unemployment rate on the cyclical components of both our leading indicators (USULI12 and USLI) with leads ranging from 1 to 18 months on the leading indicators. The results are show on Diagram 6, page 19. Clearly, USULI12 performs slightly better as a predictor of USU for leads of more than five months. At a twelve month lead the r^2 for USULI12 is 0.60, whereas it is only 0.49 for USLI. The maximum r^2 for USLI (0.80) occurs at a lead of six months, but even there it is 0.05 less than the corresponding r^2 for USULI12 (0.85). So, this stronger test of the predictive power of USLI and USULI12 confirms the conclusion that USULI12 provides additional useful information to forecast USU. A summary of r^2 by lead in these regressions is given below:

R^2 by Lead in Regressions of the Cyclical Component of USU on the Cyclical Components of USULI12 and USLI, 1970-2 to 1984-10

	R^2	
LEAD	USULI12	USLI
1 month	0.55	0.53
2 months	0.64	0.63
3 months	0.72	0.71
4 months	0.78	0.76
5 months	0.83	0.79
6 months	0.85	0.80
7 months	0.85	0.79
8 months	0.83	0.76
9 months	0.79	0.71
10 months	0.74	0.65
11 months	0.67	0.57
12 months	0.60	0.49
13 months	0.53	0.41
14 months	0.46	0.34
15 months	0.38	0.27
16 months	0.32	0.21
17 months	0.25	0.16
18 months	0.19	0.11

The similarity between USLI and USULI12 is shown on Diagram 7, page 20. There is a marginal gain in forecasting USU with USULI12 rather than the national leading indicator (USLI). The gain comes in part from the greater explanatory power of USULI12 and in part from smoothness which yields fewer false leads on major turning points.

DIAGRAM 6
R-SQUARED BY LEAD FOR TWELVE MONTH USULI AND USLI
IN FORECASTS OF USU
1970-2 TO 1984-10

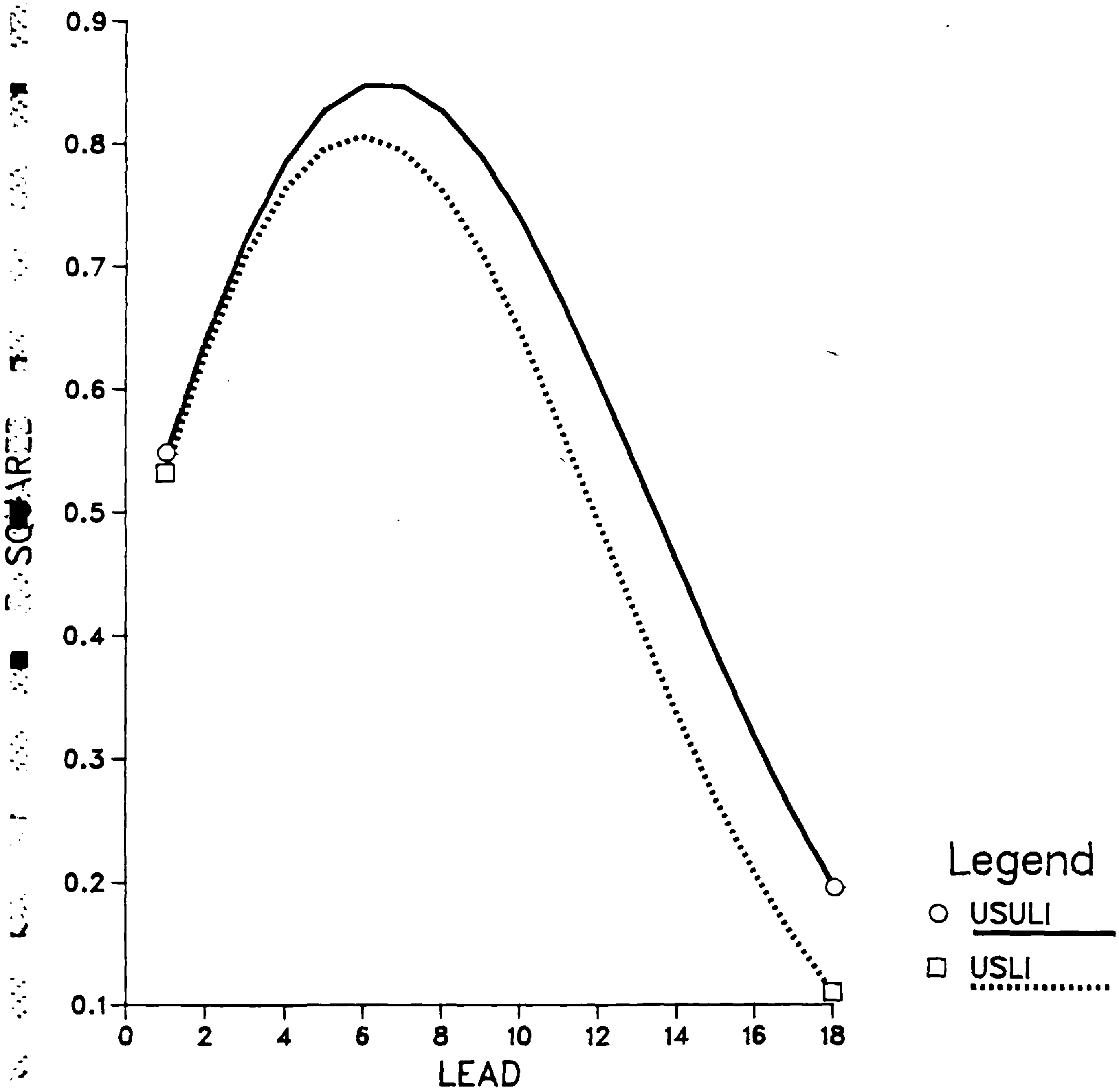
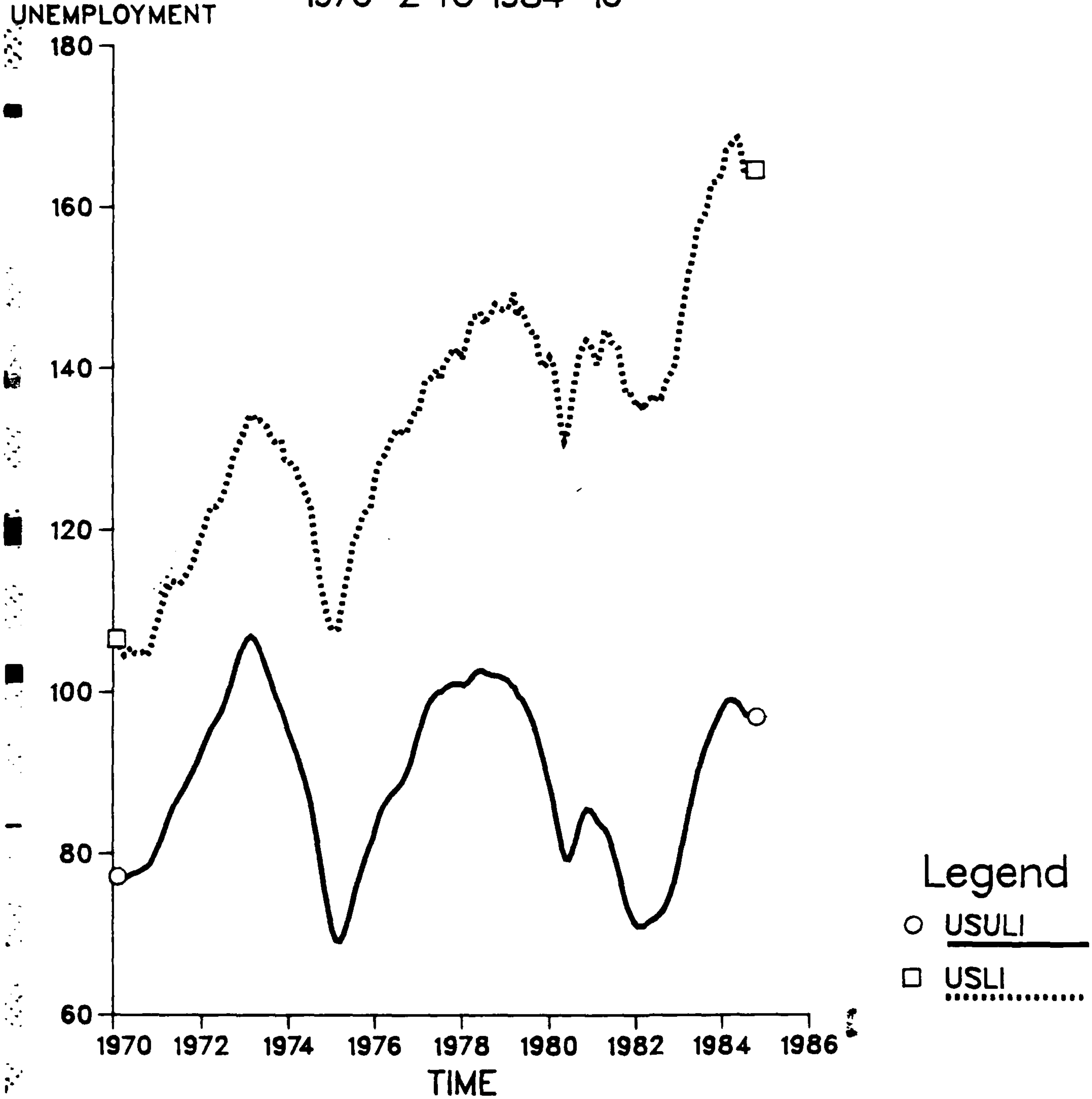


DIAGRAM 7
TWELVE MONTH USULI AND USLI: LEADING INDICATORS FOR U.S. UNEMPLOYMENT INDEX 1970-2 TO 1984-10



Forecast of the United States Unemployment Rate

Model Identification

Our initial model was identified after taking both first order nonseasonal and seasonal differences of the unemployment rate in order to obtain a stationary series. First differences were clearly required for stationarity and since the series remained non-stationary in the seasonal component, twelfth differences were taken subsequently.

Our forecasts of the unemployment rate are obtained from a transfer function model applied to the differenced series. USU is the output variable and USULI12 with a lead of twelve months is the input variable. A zero order transfer function is employed. The residuals from the transfer function are used to identify the noise component in the model. Our analysis led us to an ARIMA $(0,1,1)(3,1,0)_{12}$ noise component and the following model estimate[1].

$$(1-B)(1-B^{12})\,USU_t = \underset{(4.68)}{0.011}\,USULI12_{t-12} +$$

$$(1 - \underset{(2.41)}{0.207}\,B) \,/\, (1 - \underset{(7.33)}{0.667}\,B^{12} - \underset{(5.08)}{0.507}\,B^{24} - \underset{(3.32)}{0.328}\,B^{36})\,\epsilon_t$$

RSS=10.59

----

[1]The model is estimated with the SCA package using the maximum likelihood algorithm. The t-statistics are given below the coefficents in brackets.

Diagnostic Checking

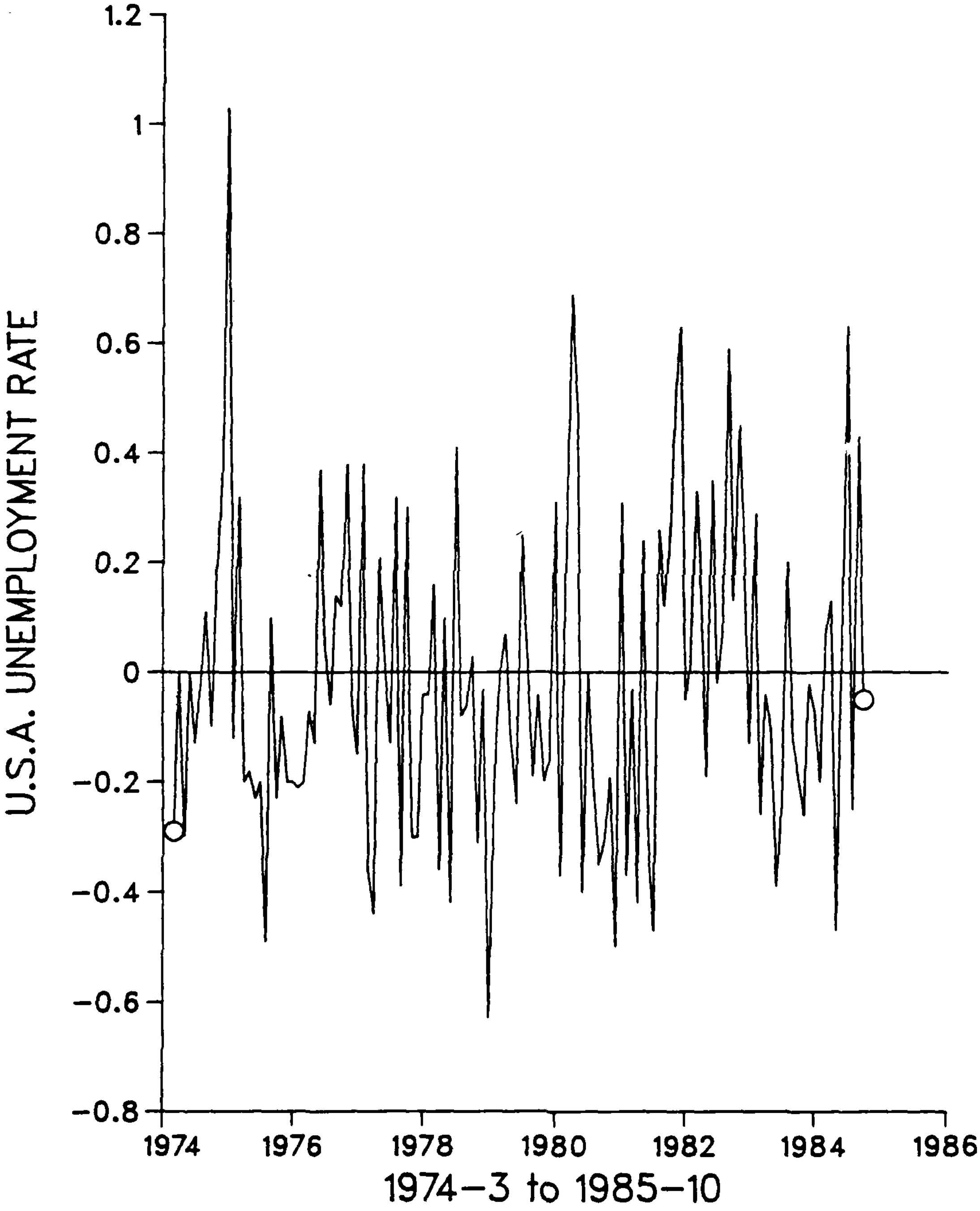
To determine if ARIMA $(0,1,1)(3,1,0)_{12}$ is the optimal model for the noise component two common procedures are carried out. First, we examine the residuals for a constant variance and a random pattern. Second, we overfit the original model to see if alternative specifications could improve the goodness of fit and the forecast accuracy, while adhering to the principle of parsimonious parameterization.

Residual Analysis of the Transfer function model with an ARIMA $(0,1,1)(3,1,0)_{12}$ Noise Component.

The traditional tests of the residuals include examining a plot of the residuals and estimating their autocorrelation function. Individual autocorrelation coefficients are tested using a t test, and the Box-Pierce Q statistic is used to test the hypothesis that the first K autocorrelation coefficients are each equal to zero.

A plot of the residuals is shown in Diagram 8, page 23. The variance appears constant over the estimation period. If the residuals were particularly large at the beginning of the estimation period, this would suggest a change of structure in the underlying process, and we would consider dropping those early observations from the analysis. If the residuals at the end of the observation period were particularly large, this would make us wary of our

DIAGRAM 8
RESIDUALS OF THE TWELVE MONTH TRANSFER FUNCTION MODEL
ARIMA $(0,1,1)(3,1,0)_{12}$



forecasts. Neither of these outcomes appear on Diagram 8.

However, the results of t tests and the chi square test with the Q statistic are less satisfactory. Two of the residual autocorrelations (at lags 2 and 15) are significant as is the Q statistic. At lag 20 for example the Q statistic of 26.8 exceeds the critical value of 24.996 at the 0.05 significance level (15 degrees of freedom). We cannot conclude, therefore, that our residuals are white noise and we must consider modifications of our model.

Overfitting.

No statistically adequate and parsimonious model could be found by simple revision of our ARIMA $(0,1,1)(3,1,0)_{12}$ noise component. Second order nonseasonal autoregressive and moving average coefficients did not improve the model, so we have ended up with a complete model revision by overfitting. Several alternative models were estimated and then compared to see which was the most parsimonious, had the best fit and provided the most accurate out of sample forecasts. The best model on these criteria has an ARIMA$(0,1,3)(0,1,2)_{12}$ noise component and the estimated coefficients and t-statistics are given below.

$$(1-B)(1-B^{12})\,USU_t = \underset{(4.21)}{0.011}\,USULI12_{t-12} \;+$$

$$(1 - \underset{(2.86)}{0.214}\,B^2 - \underset{(3.13)}{0.234}\,B^3)(1 + \underset{(8.65)}{0.689}\,B^{12} + \underset{(2.28)}{0.188}\,B^{24})\epsilon_t$$

RSS=9.88

The above transfer function with a pure moving average noise component is considered better than the model with a mixed noise component because it is more parsimonious in the seasonal part, has a lower residual sum of squares (9.88 compared to 10.59), and provides more accurate out of sample forecasts. Table 1 compares the 12 month out of sample forecasts for five different forecast periods for the two models presented in this paper[1].

Table 1

Forecast Period	Model 1* MAE	Model 1* RMSE	Model 2* MAE	Model 2* RMSE
7810-7909	0.361**	0.462	0.661	0.761
7911-8010	1.338	1.639	0.458**	0.576
8011-8110	0.486**	0.567	1.279	1.488
8203-8302	1.401	1.618	0.272**	0.317
8404-8503	0.335	0.364	0.171**	0.201

* Model 1 contains an ARIMA $(0,1,1)(3,1,0)_{12}$ noise component while model 2 contains an ARIMA $(0,1,3)(0,1,2)_{12}$ noise component.
**indicates lower MAE.

----

[1]Table 2 presents two goodness of forecast measures mean absolute forecast error (MAE) and the root mean squared forecast error (RMSE).

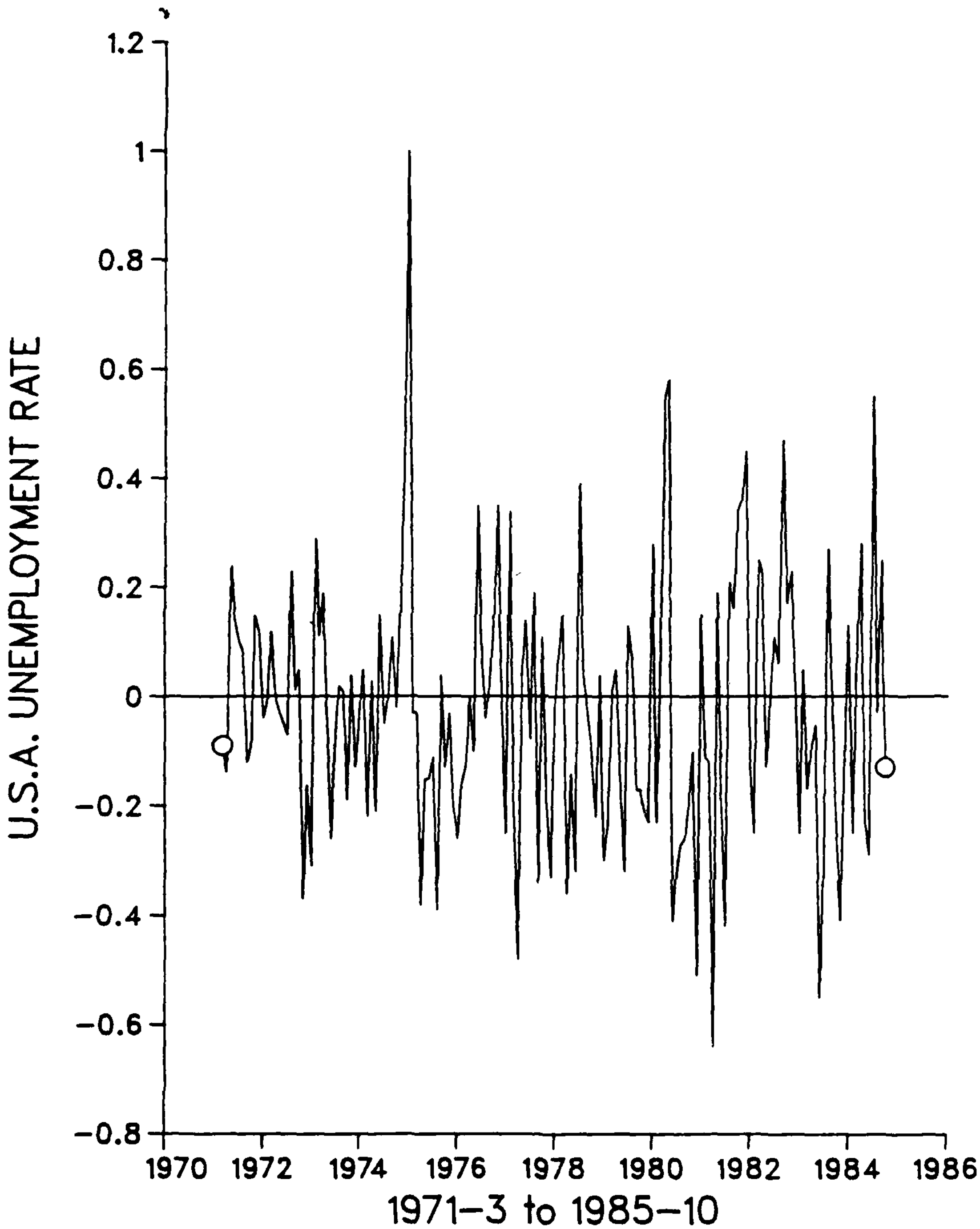
In three out of five periods, the transfer function model with a pure moving average noise component has substantially lower mean absolute forecast errors, while the model with a mixed noise component performs better in two of the five out of sample forecasts. Overall, the mean absolute forecast error is lower for the model with a pure moving average noise component (average MAE of 0.568 versus 0.784).

Each of our forecast periods starts nine months before a major turning point in the unemployment rate. The poorest performance of the transfer function model with a mixed noise component (1979-11 to 1980-10 and 1982-3 to 1983-2) occurs during the two periods where unemployment peaks. The other three time periods include an unemployment trough, and it is in those periods that the transfer function model with a mixed noise component forecasts best. It actually outperforms the model with a pure moving average noise component in two of those three forecast periods. This suggests the possibility that the transfer function with a mixed noise component cannot be relied on when unemployment is peaking, although it has performed well during the recovery and expansion phases of the business cycle that we have studied. The model with a pure moving average noise component, on the other hand, has performed well during both expanding and declining phases of the cycle. This, combined with its lower overall mean absolute forecast error, leads us to prefer this model. However, the choice is not crystal clear and we shall provide forecasts from both models.

Residual Analysis of the Transfer function model with an ARIMA $(0,1,3)(0,1,2)_{12}$ Noise Component.

The plot of the residuals for the transfer function model with a pure moving average noise component is shown in Diagram 9, page 28. The variance appears constant over the estimation period, and the Q statistic is now satisfactory. At lag 20 the Q statistic is 23.6 as compared to a critical value of 24.996 (0.05 significance level and 15 degrees of freedom). We conclude that the residuals of the model with a pure moving average noise components are white noise.

DIAGRAM 9
RESIDUALS OF THE TWELVE MONTH TRANSFER FUNCTION MODEL
ARIMA $(0,1,3)(0,1,2)_{12}$



Forecasts.

Diagram 10, page 30, shows the fitted and forecast values for USU using the ARIMA $(0,1,1)(3,1,0)_{12}$ noise component in the transfer function model. The 12 month forecast shows a seasonal increase in unemployment from 6.8 percent in November 1984 to 8.0 percent in January 1985 and then a decline throughout the next 4 months to 6.2 percent in May. A slight rise is forecast for June followed by declines to 5.7 in August and September and a slight rise to 5.8 percent in October.

As shown in Table 2, page 31, the U.S. unemployment rate has been improving since January 1983. The unemployment rate is lower throughout 1984 and it is forecast by this model to be even lower during 1985. On average, our 12 monthly forecasts from November 1984 to October 1985 are about one percentage point lower than in the corresponding months one year earlier.

DIAGRAM 10
ESTIMATED AND ACTUAL VALUES OF USU
THE TWELVE MONTH TRANSFER FUNCTION MODEL
ARIMA $(0,1,1)(3,1,0)_{12}$

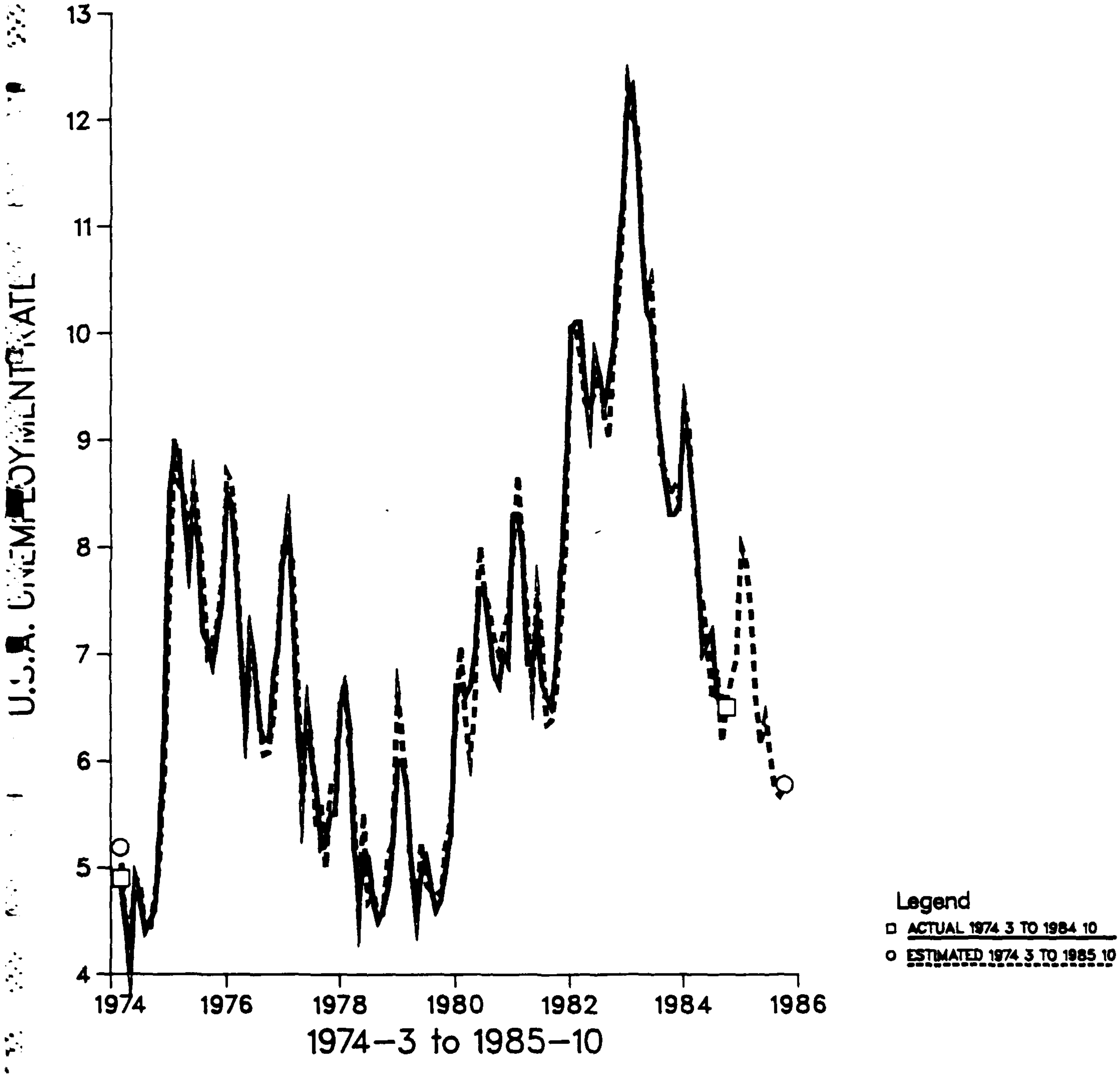


Table 2

Actual and Forecast Values of the U.S.
Unemployment Rate
(Transfer Function with ARIMA $(0,1,1)(3,1,0)_{12}$ Noise)

	Year		
Month	1983	1984	1985
January	12.2	9.3	8.0*
February	12.3	8.9	7.8*
March	11.7	8.4	7.4*
April	10.8	7.8	6.6*
May	10.2	7.0	6.2*
June	10.6	7.1	6.4*
July	9.4	7.2	6.1*
August	9.0	6.6	5.7*
September	8.6	6.6	5.7*
October	8.3	6.5	5.8*
November	8.3	6.8*	
December	8.4	6.9*	

* forecast values

Diagram 11, page 33, shows the fitted and forecast values for USU with the ARIMA$(0,1,3)(0,1,2)_{12}$ noise component in the transfer function model. The twelve month forecast shows a similar pattern to the model with a mixed noise component although the unemployment rate forecasts are less optimistic. From November 1984 to January 1985 unemployment rises from 6.8 to 8.2 percent and then declines over the next four months to 6.7 percent in May. A rise is forecast for June (7.2) followed by declines to 7.1 in July, 6.6 percent in August and September and then a slight rise to 6.7 percent in October. Table 3, page 34, shows an improvement in the unemployment picture from November 1984 through May 1985. However, the drop in unemployment from the same month in the year previous declines from 1.5 percentage points in November 1984 to 0.3 percentage points in May 1985. Following May 1985, these forecasts show little change from the corresponding months of 1984. However, the situation seems to be deteriorating throughout the forecast period and in the last month (October 1985), the forecast unemployment rate is slightly higher than one year earlier. This result is consistent with the downturn in USULI12 occurring in 1984-3 to 1984-10.

DIAGRAM 11
ESTIMATED AND ACTUAL VALUES OF USU
THE TWELVE MONTH TRANSFER FUNCTION MODEL
ARIMA $(0,1,3)(0,1,2)_{12}$

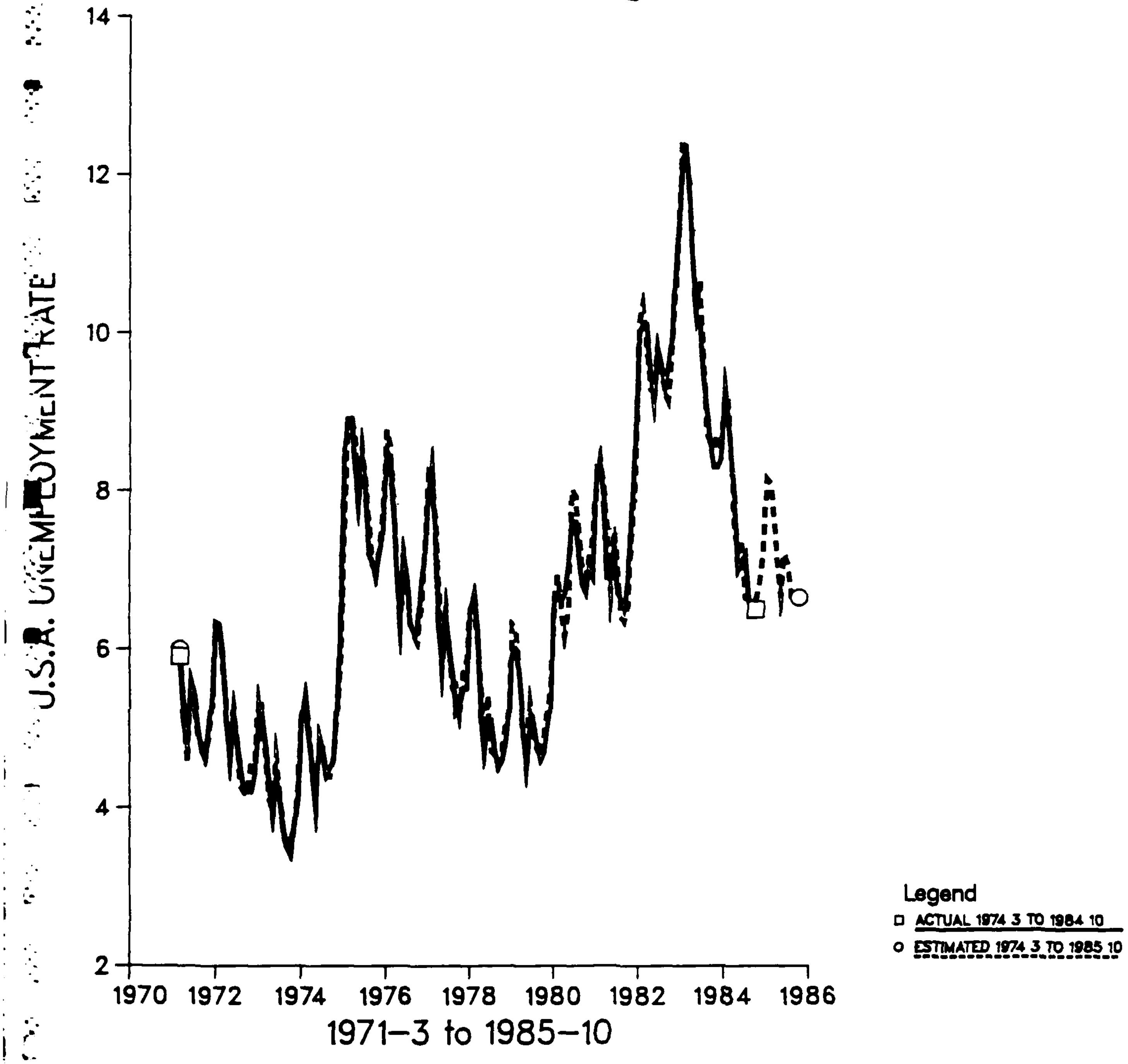


Table 3

Actual and Forecast Values of the U.S. Unemployment Rate

(Transfer Function with ARIMA $(0,1,3)(0,1,2)_{12}$ Noise)

	Year		
Month	1983	1984	1985
January	12.2	9.3	8.2*
February	12.3	8.9	8.1*
March	11.7	8.4	7.7*
April	10.8	7.8	7.1*
May	10.2	7.0	6.7*
June	10.6	7.1	7.2*
July	9.4	7.2	7.1*
August	9.0	6.6	6.6*
September	8.6	6.6	6.6*
October	8.3	6.5	6.7*
November	8.3	6.8*	
December	8.4	7.2*	

* forecast values

APPENDIX

USULI12_8410 MONTHLY DATA FROM 1970 2 TO 1984 10

1970	2	77.2056	77.0524	76.9998	77.264
1970	6	77.5324	77.6347	77.8446	78.1359
1970	10	78.3764	78.8859	79.8365	80.875
1971	2	82.1414	83.4885	84.7121	85.8157
1971	6	86.6533	87.402	88.1917	89.0574
1971	10	89.9692	90.967	92.1038	93.2148
1972	2	94.3346	95.3554	96.1606	96.8186
1972	6	97.6717	98.8129	100.174	101.641
1972	10	103.236	104.611	105.769	106.518
1973	2	106.871	106.495	105.61	104.62
1973	6	103.391	102.105	100.718	99.4639
1973	10	98.3461	97.2337	95.7435	94.562
1974	2	93.2807	92.087	90.635	89.2212
1974	6	87.4449	85.5778	83.1005	80.3862
1974	10	77.6496	74.9472	72.4331	70.4337
1975	2	69.3121	69.1943	69.9892	71.4009
1975	6	73.2141	75.1588	76.7887	78.3027
1975	10	79.6294	80.7851	81.9739	83.5906
1976	2	84.9708	85.9732	86.6749	87.266
1976	6	87.7606	88.2579	88.7895	89.6278
1976	10	90.6633	92.1852	93.8324	95.3094

1977	2	96.8719	98.1746	98.9574	99.5422
1977	6	100.	100.044	100.51	100.757
1977	10	100.962	100.924	100.983	100.752
1978	2	101.114	101.702	102.263	102.558
1978	6	102.674	102.323	102.181	102.025
1978	10	102.018	101.863	101.628	101.384
1979	2	100.869	100.503	99.5058	99.0926
1979	6	98.297	97.262	96.0704	94.7978
1979	10	92.9918	91.1947	89.5025	87.6931
1980	2	85.5072	83.1111	80.8831	79.4516
1980	6	79.3562	80.3981	82.0467	83.7913
1980	10	84.9883	85.5612	85.3957	84.8116
1981	2	83.9835	83.4667	83.0493	82.084
1981	6	80.6716	79.0775	77.3067	75.2762
1981	10	73.5586	72.4388	71.5938	71.0736
1982	2	71.0637	71.1274	71.5311	71.8193
1982	6	72.038	72.4685	72.9673	73.8477
1982	10	74.9933	76.3974	78.1614	80.4312
1983	2	82.5451	84.664	86.6658	88.5777
1983	6	90.4863	91.9997	93.2507	94.3643
1983	10	95.5506	96.4774	97.4258	98.2097
1984	2	98.8833	99.0091	98.9054	98.574
1984	6	97.911	97.1857	96.9867	97.0513
1984	10	96.9466			

USULI12_8410_CYCLE MONTHLY DATA FROM 1970 2 TO 1984 10

1970	2	0.860596	0.858966	0.858458	0.861481
1970	6	0.864551	0.86577	0.86819	0.871517
1970	10	0.874279	0.880042	0.890727	0.902394
1971	2	0.916607	0.931724	0.945465	0.957869
1971	6	0.967305	0.975752	0.984657	0.994412
1971	10	1.00468	1.01592	1.02871	1.04121
1972	2	1.05381	1.06531	1.0744	1.08185
1972	6	1.09149	1.10434	1.11965	1.13615
1972	10	1.15408	1.16956	1.18261	1.19109
1973	2	1.19516	1.19106	1.18126	1.1703
1973	6	1.15666	1.14237	1.12696	1.11302
1973	10	1.10062	1.08827	1.07168	1.05855
1974	2	1.04431	1.03104	1.01487	0.999131
1974	6	0.979329	0.958505	0.930843	0.900521
1974	10	0.869943	0.839743	0.811647	0.789314
1975	2	0.776815	0.775566	0.784547	0.800445
1975	6	0.820845	0.842726	0.861079	0.878136
1975	10	0.893095	0.90614	0.919558	0.937779
1976	2	0.953349	0.964683	0.972645	0.979367
1976	6	0.985008	0.99068	0.996737	1.00624
1976	10	1.01796	1.03514	1.05373	1.07041
1977	2	1.08806	1.10279	1.11169	1.11836
1977	6	1.12361	1.1242	1.12954	1.13242

1977	10	1.13482	1.1345	1.13527	1.13278
1978	2	1.13695	1.14367	1.15007	1.1535
1978	6	1.15491	1.15107	1.14957	1.14792
1978	10	1.14795	1.14632	1.14377	1.14113
1979	2	1.13544	1.13142	1.12029	1.11574
1979	6	1.10689	1.09533	1.08201	1.06778
1979	10	1.04753	1.02738	1.00841	0.988111
1980	2	0.963569	0.936654	0.911628	0.895574
1980	6	0.894581	0.906409	0.92508	0.944836
1980	10	0.958421	0.96497	0.963191	0.956691
1981	2	0.947437	0.941693	0.937068	0.926261
1981	6	0.910406	0.892498	0.872593	0.849751
1981	10	0.830437	0.81787	0.808404	0.802603
1982	2	0.802564	0.803358	0.807991	0.81132
1982	6	0.813865	0.818805	0.824516	0.83454
1982	10	0.847564	0.863512	0.883532	0.909273
1983	2	0.933255	0.957299	0.980023	1.00173
1983	6	1.02341	1.04063	1.05487	1.06757
1983	10	1.08109	1.09167	1.10251	1.11148
1984	2	1.1192	1.12073	1.11966	1.11601
1984	6	1.10861	1.10049	1.09834	1.09917
1984	10	1.09809			

USU_CYCLE MONTHLY DATA FROM 1970 1 TO 1984 10

1970	1	0.796	0.839	0.885	0.933
1970	5	0.981	1.020	1.051	1.077
1970	9	1.107	1.143	1.177	1.198
1971	1	1.198	1.185	1.167	1.156
1971	5	1.157	1.167	1.172	1.168
1971	9	1.156	1.144	1.134	1.125
1972	1	1.113	1.095	1.075	1.054
1972	5	1.032	1.012	0.998	0.988
1972	9	0.972	0.945	0.909	0.873
1973	1	0.847	0.834	0.829	0.825
1973	5	0.819	0.807	0.792	0.777
1973	9	0.767	0.764	0.768	0.776
1974	1	0.785	0.791	0.795	0.802
1974	5	0.815	0.833	0.856	0.885
1974	9	0.924	0.977	1.046	1.124
1975	1	1.208	1.290	1.355	1.396
1975	5	1.407	1.401	1.388	1.373
1975	9	1.355	1.330	1.292	1.246
1976	1	1.199	1.161	1.137	1.131
1976	5	1.133	1.135	1.133	1.130
1976	9	1.132	1.134	1.130	1.117
1977	1	1.094	1.067	1.042	1.018

1977	5	0.997	0.976	0.957	0.939
1977	9	0.919	0.896	0.873	0.855
1978	1	0.843	0.831	0.813	0.789
1978	5	0.766	0.752	0.748	0.746
1978	9	0.744	0.743	0.744	0.744
1979	1	0.741	0.733	0.721	0.708
1979	5	0.703	0.705	0.713	0.721
1979	9	0.724	0.725	0.732	0.749
1980	1	0.776	0.813	0.860	0.914
1980	5	0.968	1.013	1.036	1.037
1980	9	1.020	0.997	0.977	0.963
1981	1	0.952	0.941	0.931	0.922
1981	5	0.913	0.906	0.904	0.912
1981	9	0.940	0.984	1.033	1.074
1982	1	1.105	1.128	1.149	1.174
1982	5	1.196	1.216	1.239	1.269
1982	9	1.307	1.339	1.353	1.347
1983	1	1.326	1.308	1.296	1.282
1983	5	1.260	1.228	1.194	1.159
1983	9	1.120	1.074	1.025	0.979
1984	1	0.945	0.921	0.898	0.875
1984	5	0.853	0.839	0.831	0.829
1984	9	0.826	0.822		

Twelve Month Forecasts of

the United States Unemployment Rate

Supplement

R.A. Holmes

Ross Neill

Simon Fraser University

July 1985

1970-2 to 1985-4

Table 1

CYCLICAL COMPONENTS

USU_C

Turning Points	USU_C Date (Value)		USULI12_C Date (Value)		Lead USULI12_C
Peak	1971-1	(1.175)	1970-3	(0.861)	10 months
Trough	1973-10	(0.760)	1973-2	(1.201)	8 months
Peak	1975-5	(1.409)	1975-3	(0.772)	2 months
Trough	1979-5	(0.713)	1978-6	(1.150)	11 months
Peak	1980-8	(1.054)	1980-6	(0.887)	2 months
Trough	1981-7	(0.919)	1980-11	(0.955)	8 months
Peak	1982-11	(1.382)	1982-2	(0.793)	9 months

<u>Twelve Month Transfer Function Model</u>

<u>With an ARIMA $(0,1,1)(3,1,0)_{12}$ Noise Component</u>

$$(1 - B)(1 - B^{12})\ USU_t = \underset{(4.69)}{0.0099}USLI12_{t-12} +$$

$$\underset{(2.37)}{(1 + 0.2008B)} \,/\, (1 + \underset{(7.42)}{0.6544B^{12}} + \underset{(4.94)}{0.4827B^{24}} + \underset{(3.06)}{0.2826B^{36}})\ \epsilon_t$$

<u>Twelve Month Transfer Function Model</u>

<u>With an ARIMA $(0,1,3)(0,1,2)_{12}$ Noise Component</u>

$$(1 - B)(1 - B^{12})\ USU_t = \underset{(4.13)}{0.0103}USLI12_{t-12} +$$

$$(1 + \underset{(2.90)}{0.2132B^2} + \underset{(3.26)}{0.2385B^3})(1 - \underset{(9.40)}{0.7291B^{12}} - \underset{(2.75)}{0.2204B^{24}})\ \epsilon_t$$

Table 2

Actual and Forecast Values of the U.S. Unemployment Rate

(Transfer Function with ARIMA $(0,1,1)(3,1,0)_{12}$ Noise)

	Year		
Month	1984	1985	1986
January	9.3	8.2	8.5*
February	8.9	8.1	8.5*
March	8.4	7.6	8.2*
April	7.8	7.2	7.6*
May	7.0	6.8*	
June	7.1	7.0*	
July	7.2	6.7*	
August	6.6	6.3*	
September	6.6	6.2*	
October	6.5	6.3*	
November	6.8	6.8*	
December	7.2	7.4*	

* forecast values

Table 3

Actual and Forecast Values of the U.S.

Unemployment Rate

(Transfer Function with ARIMA $(0,1,3)(0,1,2)_{12}$ Noise)

	Year		
Month	1984	1985	1986
January	9.3	8.2	8.9*
February	8.9	8.1	8.9*
March	8.4	7.6	8.6*
April	7.8	7.2	8.2*
May	7.0	6.7*	
June	7.1	7.4*	
July	7.2	7.3*	
August	6.6	6.8*	
September	6.6	6.8*	
October	6.5	6.8*	
November	6.8	7.3*	
December	7.2	7.8*	

* forecast values

DIAGRAM 1
RELATIVE WEIGHTS OF THE COMPONENTS OF THE TWELVE MONTH U.S. UNEMPLOYMENT LEADING INDICATOR 1970-2 TO 1985-4

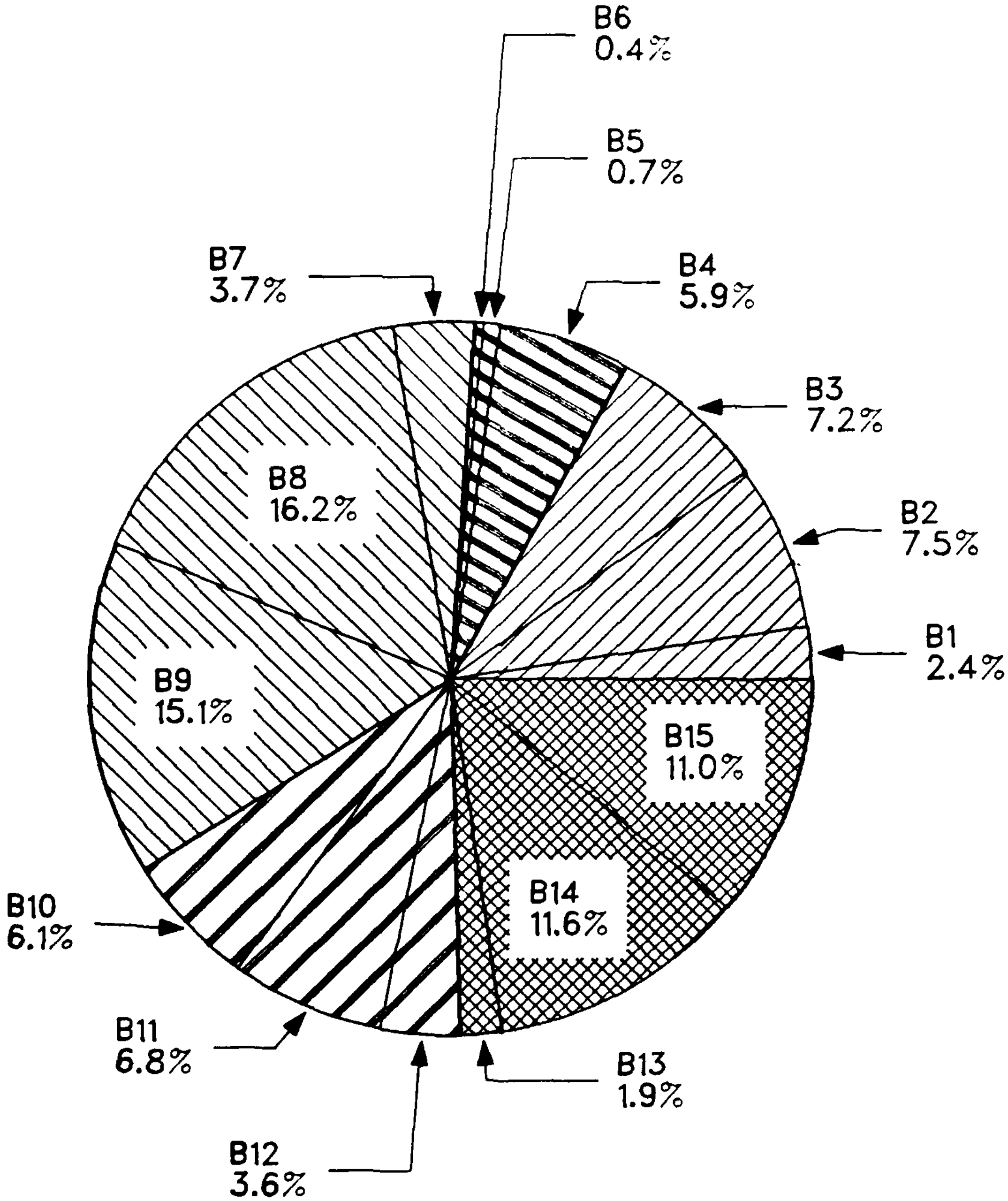


DIAGRAM 2
TWELVE MONTH LEADING INDICATOR FOR U.S. UNEMPLOYMENT 1970-2 TO 1985-4

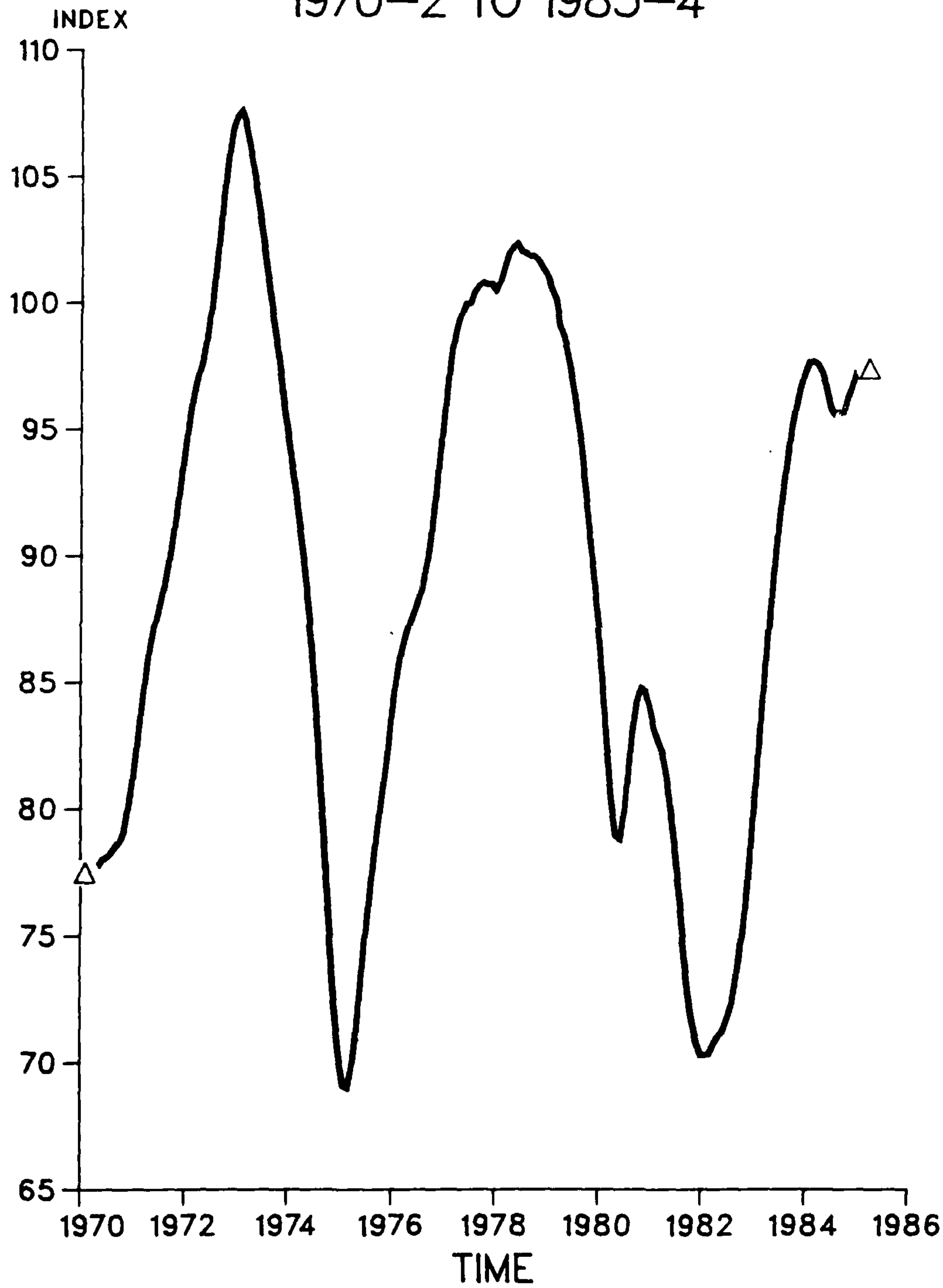


DIAGRAM 3

MONTHLY CHANGES IN COMPONENTS OF USULI12_854

[WEIGHTED STANDARDIZED SERIES]

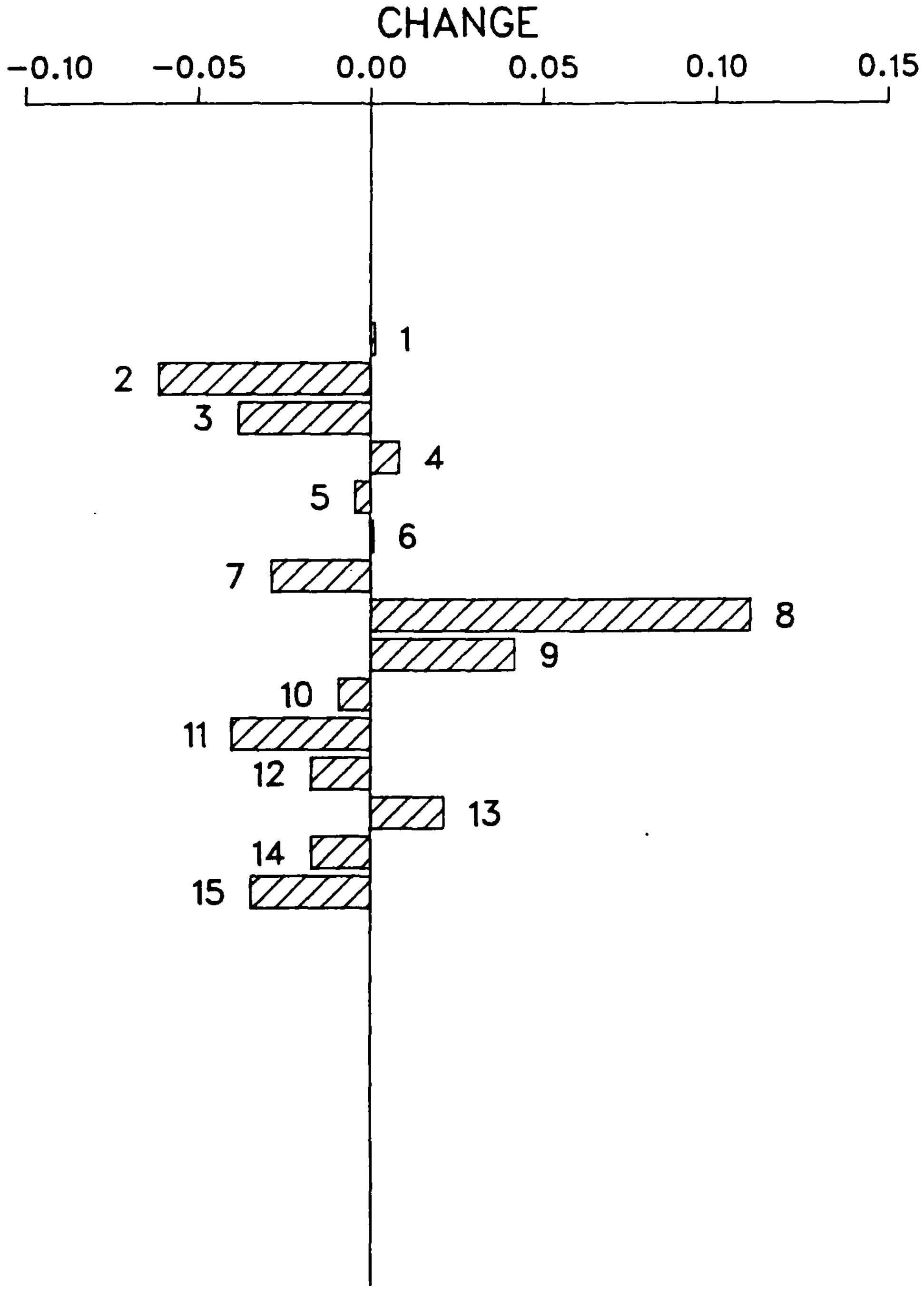


DIAGRAM 4
TWELVE MONTH USU AND USULI: THE CYCLICAL COMPONENTS OF
U.S.UNEMPLOYMENT RATE AND
THE U.S.A. LEADING INDICATOR
1970-2 TO 1985-4

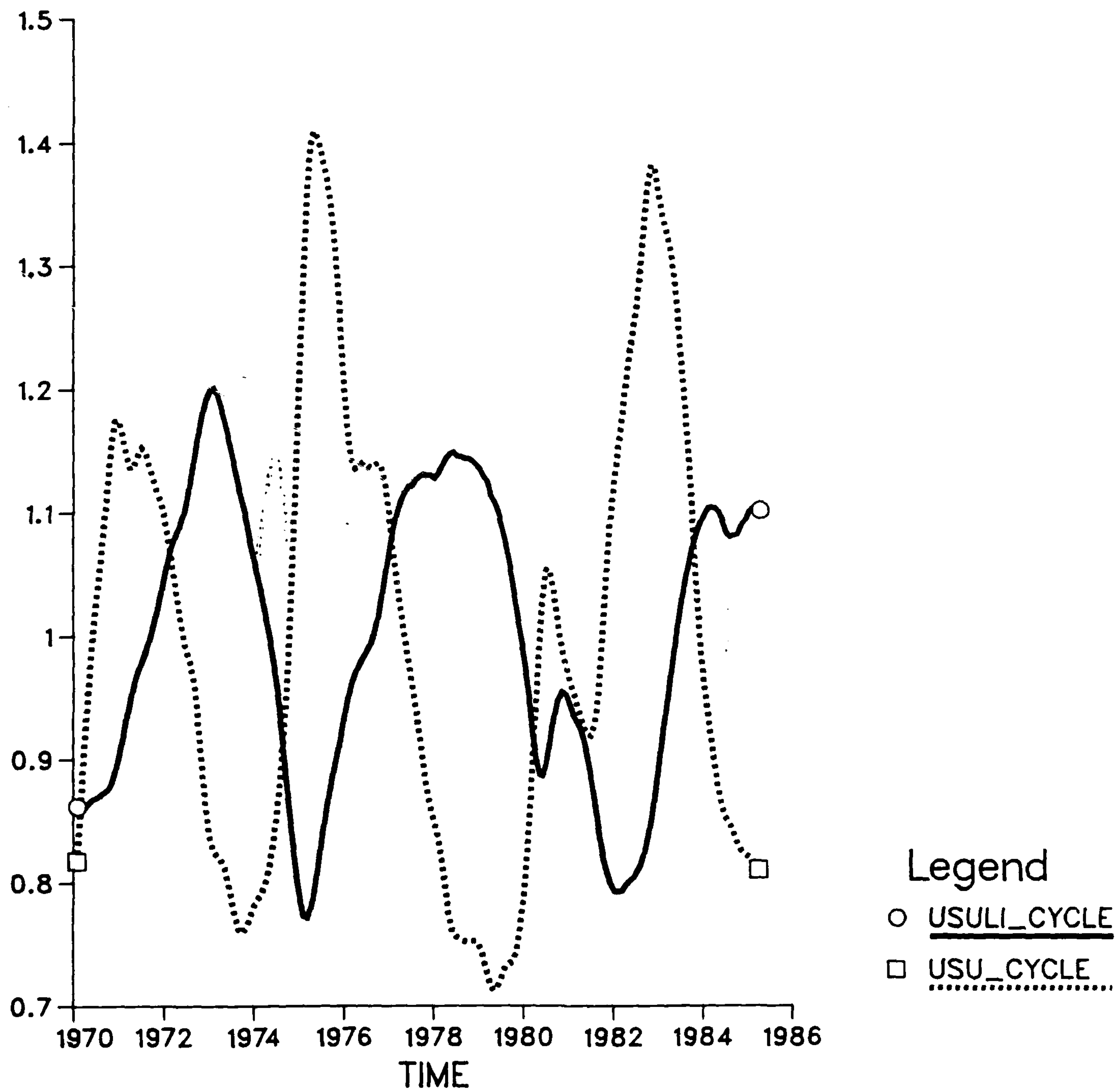


DIAGRAM 5
USLI_CYCLE AND USU_CYCLE: THE CYCLICAL COMPONENT OF USU AND THE U.S. NATIONAL LEADING INDICATOR 1970-2 TO 1985-4

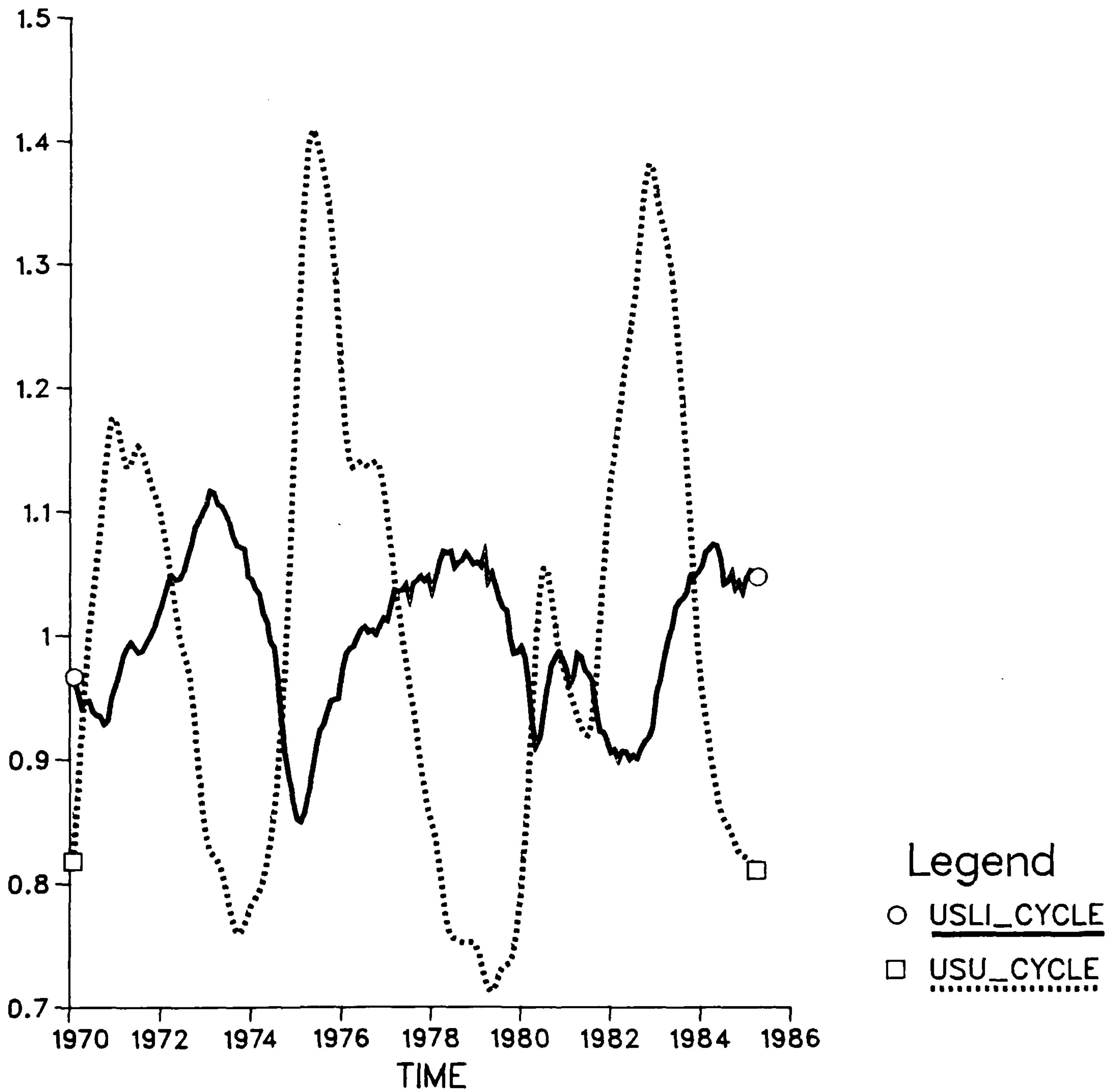


DIAGRAM 6
R–SQUARED BY LEAD FOR TWELVE MONTH USULI AND USLI
IN FORECASTS OF USU
1970–2 TO 1985–4

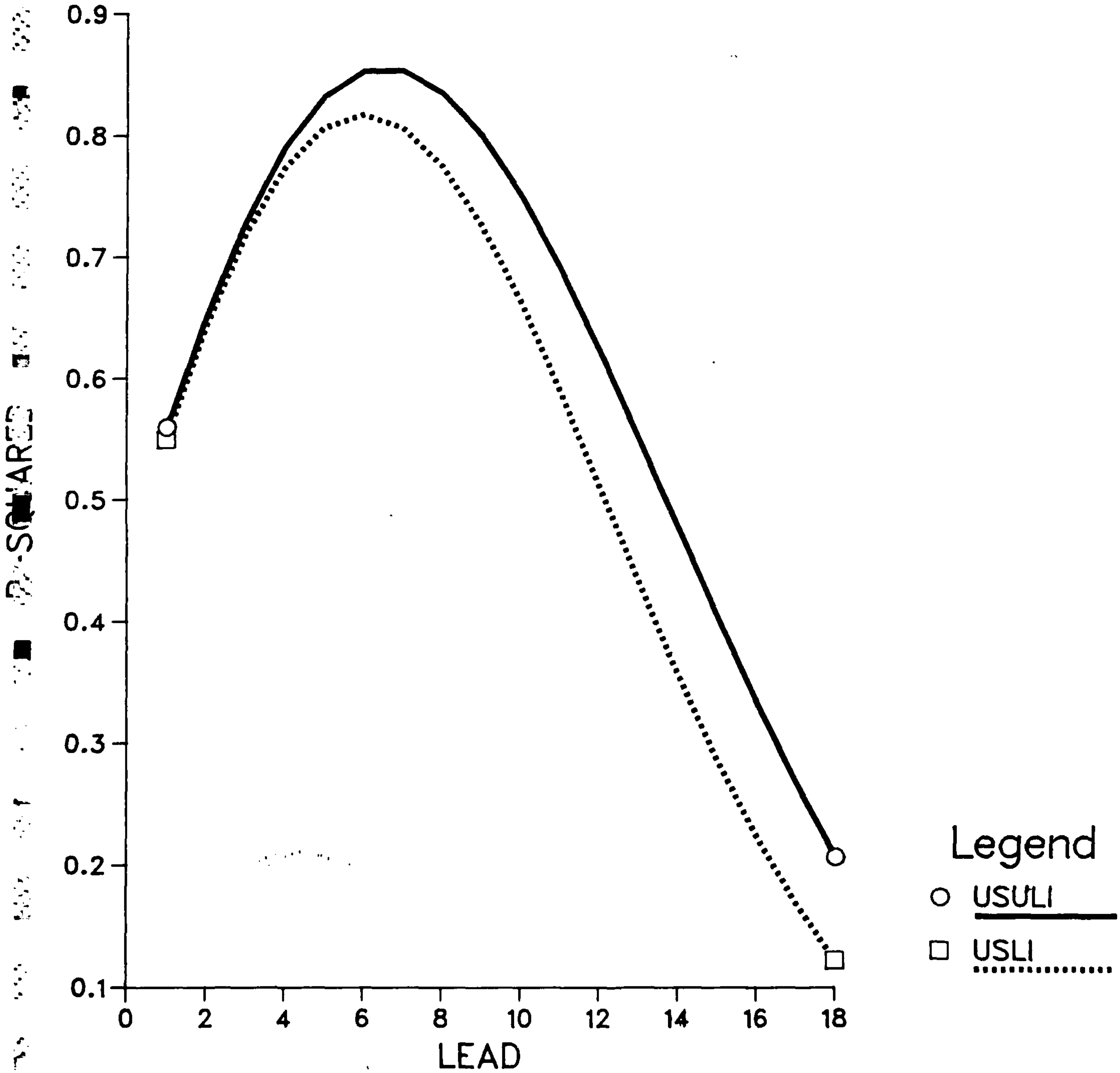


DIAGRAM 7
TWELVE MONTH USULI AND USLI: LEADING INDICATORS FOR U.S. UNEMPLOYMENT INDEX
1970-2 TO 1985-4

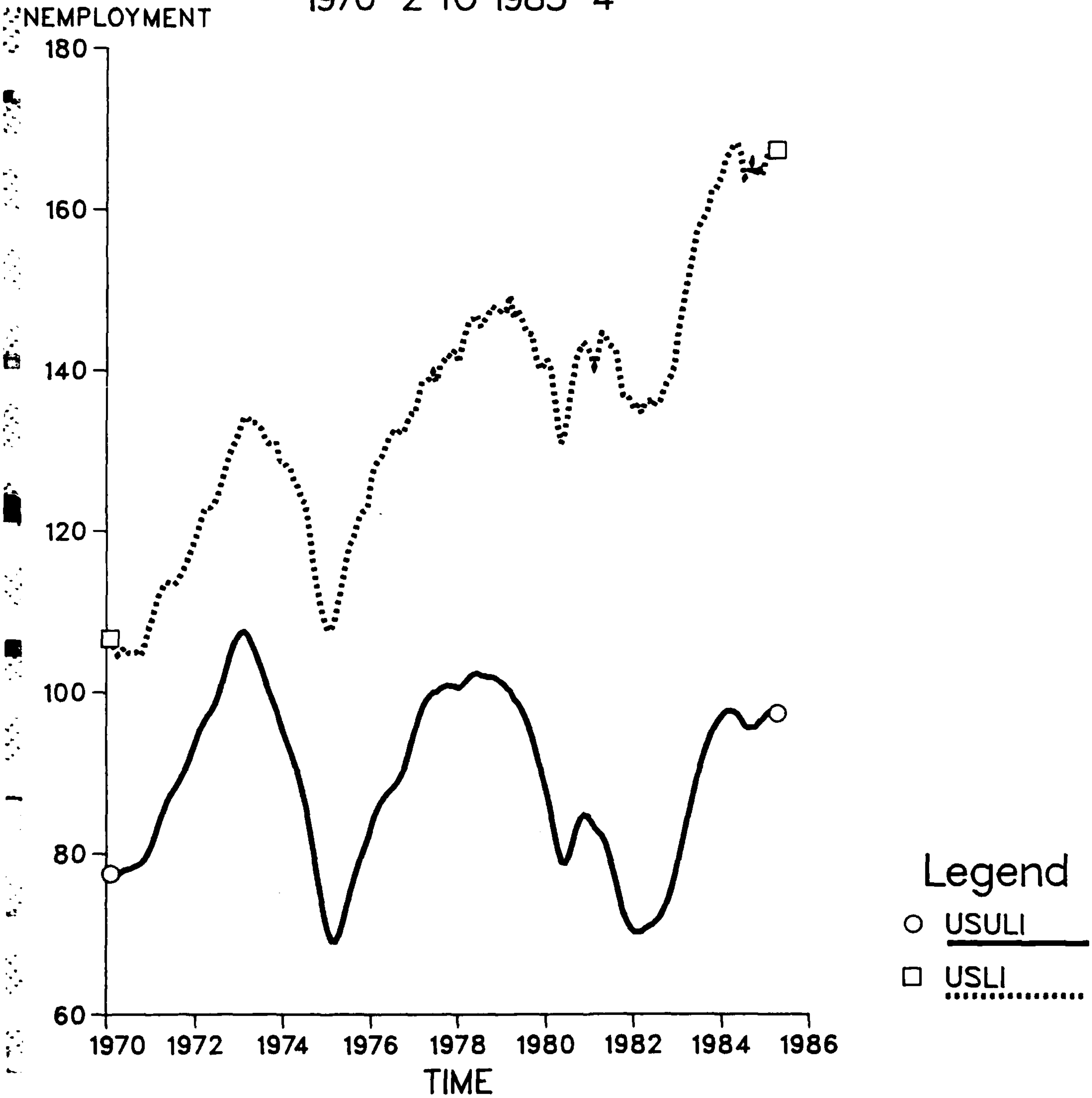


DIAGRAM 8
ESTIMATED AND ACTUAL VALUES OF USU
THE TWELVE MONTH TRANSFER FUNCTION MODEL
ARIMA $(0,1,1)(3,1,0)_{12}$

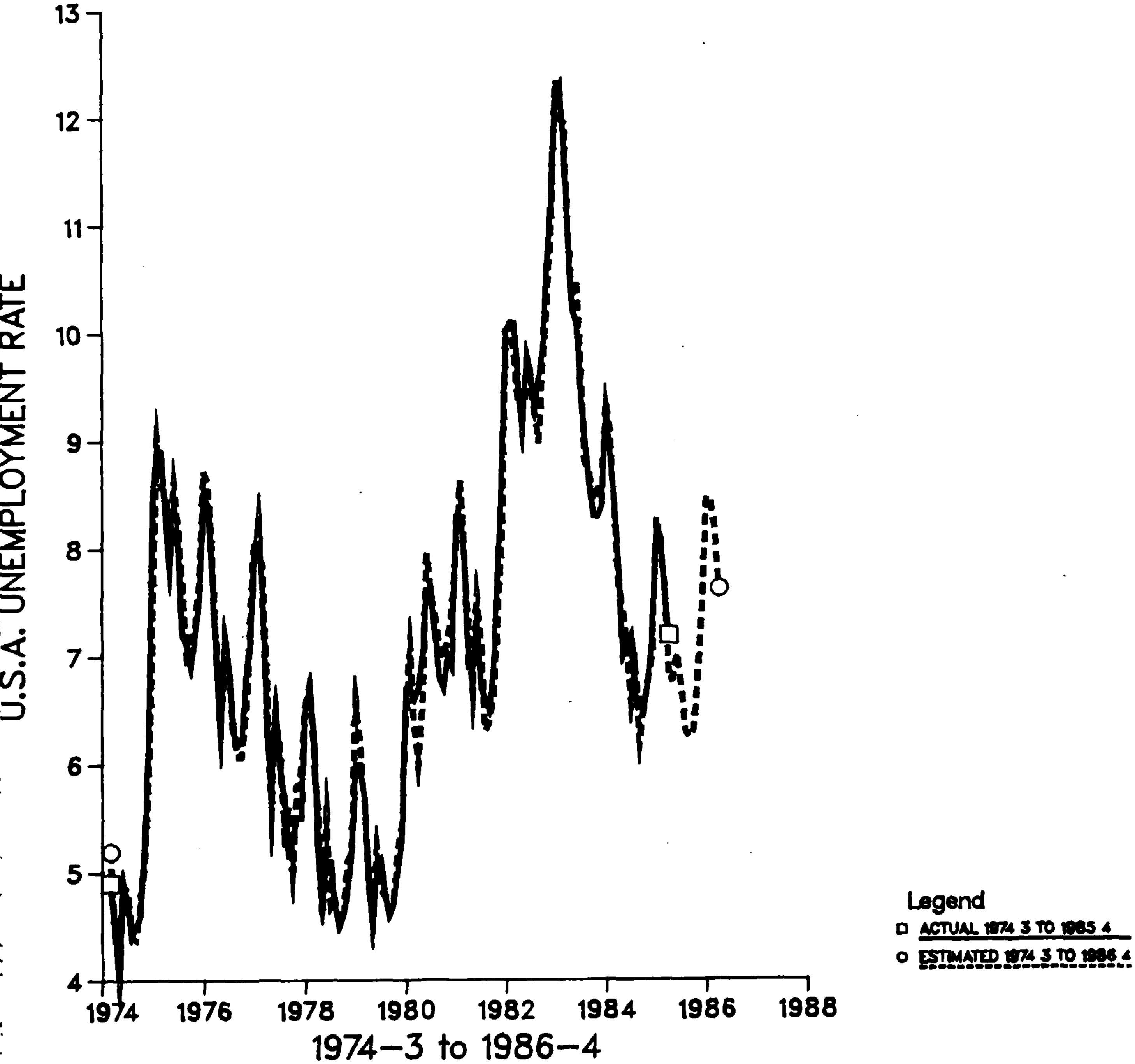
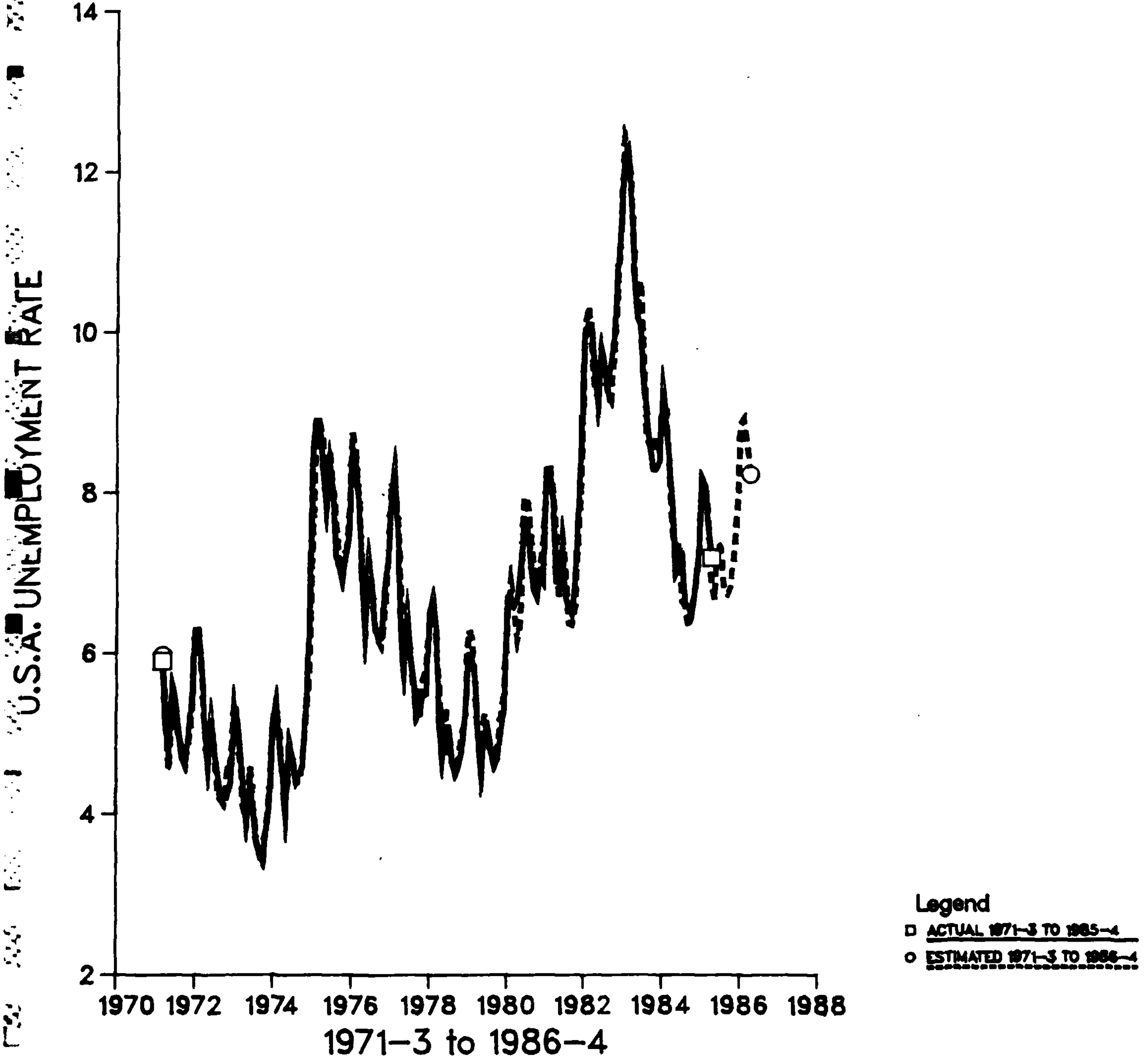


DIAGRAM 9
ESTIMATED AND ACTUAL VALUES OF USU
THE TWELVE MONTH TRANSFER FUNCTION MODEL
ARIMA $(0,1,3)(0,1,2)_{12}$



Appendix

USU MONTHLY DATA FROM 1970 1 TO 1985 5

1970	1	3.9	4.3	4.1	3.9
1970	5	3.6	4.8	4.7	4.2
1970	9	4.2	4.4	4.8	5.4
1971	1	6.4	6.4	5.9	5.1
1971	5	4.8	5.6	5.4	5.
1971	9	4.7	4.6	5.	5.4
1972	1	6.3	6.3	5.9	5.1
1972	5	4.6	5.2	4.8	4.5
1972	9	4.2	4.2	4.2	4.4
1973	1	5.	5.2	4.8	4.3
1973	5	3.9	4.4	4.1	3.7
1973	9	3.5	3.4	3.8	4.1
1974	1	5.1	5.4	4.9	4.5
1974	5	4.	4.9	4.7	4.4
1974	9	4.5	4.6	5.3	6.3
1975	1	8.5	8.9	8.9	8.3
1975	5	7.8	8.4	8.	7.2
1975	9	7.1	6.9	7.2	7.5
1976	1	8.5	8.4	7.8	7.
1976	5	6.3	7.2	6.9	6.3
1976	9	6.2	6.2	6.8	7.1

1977	1	7.9	8.3	7.5	6.3
1977	5	5.8	6.5	6.	5.7
1977	9	5.2	5.3	5.5	5.5
1978	1	6.5	6.7	6.3	5.2
1978	5	4.7	5.1	5.1	4.7
1978	9	4.5	4.6	4.8	5.2
1979	1	6.	6.	5.7	5.
1979	5	4.5	5.	5.1	4.8
1979	9	4.6	4.7	5.	5.3
1980	1	6.7	6.7	6.6	6.7
1980	5	7.	7.6	7.6	7.2
1980	9	6.8	6.7	7.	6.9
1981	1	8.3	8.3	7.9	6.9
1981	5	6.9	7.3	6.7	6.6
1981	9	6.5	6.9	7.8	8.7
1982	1	10.	10.1	10.1	9.5
1982	5	9.1	9.8	9.6	9.3
1982	9	9.6	9.9	10.7	11.3
1983	1	12.2	12.3	11.7	10.8
1983	5	10.2	10.1	9.4	9.
1983	9	8.6	8.3	8.3	8.4
1984	1	9.3	8.9	8.4	7.8
1984	5	7.	7.1	7.2	6.6
1984	9	6.6	6.5	6.8	7.2
1985	1	8.2	8.1	7.6	7.2

1985 5 6.6

USLI_854 MONTHLY DATA FROM 1970 2 TO 1985 4

1970	2	77.4931	77.4283	77.4342	77.7209
1970	6	77.9794	78.06	78.2374	78.4831
1970	10	78.6675	79.1256	80.0577	81.1096
1971	2	82.4271	83.8774	85.224	86.4132
1971	6	87.2566	87.945	88.671	89.5176
1971	10	90.4796	91.5883	92.8619	94.109
1972	2	95.3199	96.3317	97.0494	97.6291
1972	6	98.4771	99.689	101.172	102.747
1972	10	104.388	105.731	106.793	107.392
1973	2	107.594	107.116	106.175	105.156
1973	6	103.923	102.653	101.258	99.9834
1973	10	98.8363	97.6701	96.1073	94.881
1974	2	93.5778	92.3594	90.8749	89.4301
1974	6	87.6111	85.7028	83.1626	80.3535
1974	10	77.5078	74.7282	72.1943	70.2128
1975	2	69.1149	69.0139	69.8313	71.2759
1975	6	73.1105	75.0464	76.6503	78.1627
1975	10	79.5346	80.7582	81.9962	83.6308
1976	2	85.0072	86.0144	86.7214	87.3003
1976	6	87.7667	88.2369	88.759	89.6045
1976	10	90.6375	92.1518	93.7932	95.2732
1977	2	96.8545	98.1744	98.9642	99.5512

1977	6	100.	100.028	100.482	100.697
1977	10	100.856	100.756	100.767	100.512
1978	2	100.859	101.423	101.958	102.237
1978	6	102.378	102.078	102.002	101.89
1978	10	101.885	101.697	101.402	101.103
1979	2	100.554	100.154	99.1038	98.6587
1979	6	97.8594	96.8322	95.639	94.3499
1979	10	92.5114	90.6938	88.9924	87.1763
1980	2	84.9838	82.5883	80.3765	78.9554
1980	6	78.832	79.816	81.3894	83.0691
1980	10	84.2321	84.8035	84.6606	84.0816
1981	2	83.2352	82.6945	82.2637	81.2962
1981	6	79.8859	78.2778	76.4758	74.4192
1981	10	72.7111	71.6303	70.8262	70.328
1982	2	70.318	70.3671	70.7565	71.0454
1982	6	71.2696	71.7078	72.2208	73.1409
1982	10	74.3261	75.7363	77.4561	79.6558
1983	2	81.713	83.8286	85.8439	87.7592
1983	6	89.6897	91.2957	92.6951	93.9332
1983	10	95.1413	95.9497	96.6815	97.2421
1984	2	97.681	97.7358	97.6235	97.2875
1984	6	96.6729	95.8451	95.5774	95.6608
1984	10	95.6882	96.2913	96.6969	97.2871
1985	2	97.5471	97.5372	97.4014	

USU_854_CYCLE MONTHLY DATA FROM 1970 1 TO 1985 4

1970	1	0.775163	0.818013	0.863308	0.91084
1970	5	0.957666	0.996395	1.02722	1.0535
1970	9	1.08369	1.11984	1.15373	1.17435
1971	1	1.17544	1.16286	1.146	1.13566
1971	5	1.13743	1.14703	1.15279	1.1491
1971	9	1.13836	1.12739	1.11771	1.10936
1972	1	1.0979	1.08103	1.06168	1.04129
1972	5	1.02021	1.00079	0.987572	0.977649
1972	9	0.962589	0.936202	0.900606	0.865481
1973	1	0.840306	0.827159	0.82289	0.819394
1973	5	0.813058	0.801548	0.787058	0.772928
1973	9	0.762619	0.759662	0.763947	0.772268
1974	1	0.781627	0.787762	0.792353	0.799851
1974	5	0.812874	0.831606	0.85428	0.883946
1974	9	0.923149	0.976416	1.04539	1.12416
1975	1	1.20821	1.29025	1.35615	1.39693
1975	5	1.40919	1.40339	1.39042	1.37626
1975	9	1.35893	1.33336	1.29643	1.25049
1976	1	1.20331	1.16559	1.14217	1.13595
1976	5	1.13852	1.14106	1.13934	1.13681
1976	9	1.13911	1.14085	1.13719	1.12395
1977	1	1.10175	1.07474	1.04922	1.02627

1977	5	1.00529	0.984565	0.965729	0.947052
1977	9	0.927311	0.904278	0.880824	0.862999
1978	1	0.851444	0.839294	0.82159	0.797483
1978	5	0.774183	0.760438	0.756435	0.755086
1978	9	0.75302	0.752412	0.752826	0.752966
1979	1	0.749912	0.742359	0.729954	0.717909
1979	5	0.712913	0.71531	0.722952	0.731133
1979	9	0.73395	0.735655	0.743386	0.761036
1980	1	0.788815	0.826717	0.874199	0.929027
1980	5	0.984881	1.03076	1.0542	1.05427
1980	9	1.03744	1.01401	0.993407	0.979056
1981	1	0.967879	0.957253	0.947345	0.93719
1981	5	0.927715	0.920675	0.919313	0.928995
1981	9	0.95705	1.00197	1.05073	1.09257
1982	1	1.12456	1.1488	1.17289	1.19995
1982	5	1.2245	1.24512	1.26747	1.29716
1982	9	1.33354	1.36563	1.3816	1.37681
1983	1	1.35751	1.3393	1.32707	1.31424
1983	5	1.29253	1.26075	1.2248	1.18645
1983	9	1.14433	1.09693	1.04544	0.999051
1984	1	0.965092	0.941253	0.920462	0.898793
1984	5	0.877915	0.862239	0.853062	0.84827
1984	9	0.842397	0.833514	0.826447	0.822995
1985	1	0.821649	0.819592	0.815698	0.810945

USLI_854_CYCLE MONTHLY DATA FROM 1970 2 TO 1985 4

1970	2	0.862324	0.861682	0.861826	0.865096
1970	6	0.868053	0.86903	0.871085	0.8739
1970	10	0.876034	0.881215	0.891677	0.903476
1971	2	0.918235	0.934478	0.949567	0.962906
1971	6	0.972393	0.980153	0.988336	0.997863
1971	10	1.00868	1.02113	1.03543	1.04943
1972	2	1.06303	1.07441	1.08251	1.08908
1972	6	1.09864	1.11226	1.12891	1.14659
1972	10	1.16501	1.18011	1.19208	1.19887
1973	2	1.20124	1.196	1.18561	1.17434
1973	6	1.16067	1.14659	1.13112	1.11698
1973	10	1.10427	1.09134	1.07397	1.06037
1974	2	1.0459	1.03238	1.01588	0.999817
1974	6	0.979571	0.958322	0.930004	0.898672
1974	10	0.866925	0.835913	0.807643	0.785548
1975	2	0.773335	0.772277	0.781494	0.797734
1975	6	0.818343	0.840089	0.858123	0.875135
1975	10	0.890577	0.904362	0.918309	0.936702
1976	2	0.952207	0.963577	0.971587	0.978162
1976	6	0.983479	0.988838	0.994781	1.00435
1976	10	1.01602	1.03309	1.05159	1.06828
1977	2	1.08611	1.10102	1.10997	1.11666

1977	6	1.1218	1.12222	1.12742	1.12993
1977	10	1.13182	1.1308	1.13103	1.12827
1978	2	1.13227	1.13871	1.14482	1.14806
1978	6	1.14975	1.14649	1.14574	1.14459
1978	10	1.14464	1.14262	1.13942	1.13617
1979	2	1.1301	1.12571	1.114	1.1091
1979	6	1.10022	1.08877	1.07545	1.06106
1979	10	1.04048	1.02013	1.00108	0.980745
1980	2	0.956167	0.929301	0.904497	0.888587
1980	6	0.887281	0.898439	0.916234	0.935229
1980	10	0.948411	0.954933	0.953412	0.946979
1981	2	0.937533	0.93153	0.926762	0.915947
1981	6	0.900142	0.882102	0.861876	0.838776
1981	10	0.8196	0.807492	0.798501	0.792958
1982	2	0.792919	0.793546	0.798011	0.801343
1982	6	0.803947	0.808965	0.814828	0.825285
1982	10	0.838737	0.85473	0.874219	0.899129
1983	2	0.922436	0.946406	0.969248	0.990966
1983	6	1.01286	1.03109	1.04699	1.06107
1983	10	1.07482	1.08405	1.09242	1.09886
1984	2	1.10392	1.10464	1.10348	1.09978
1984	6	1.09294	1.08368	1.08075	1.08179
1984	10	1.0822	1.08913	1.09382	1.1006
1985	2	1.10364	1.10363	1.10219	

DISTRIBUTION LIST
Manpower R&D

Director, Technology Programs
Office of Naval Research (Code 200)
Arlington, VA 22217

Director, Research Programs
Office of Naval Research (Code 400)
Arlington, VA 22217

Manpower, Personnel and Training
Technology Project Manager
Office of Naval Research (Code 270)
Arlington, VA 22217

Associate Director for Life Sciences
Office of Naval Research (Code 440)
Arlington, VA 22217

Leader, Psychological Sciences Division
Office of Naval Research (Code 442)
Arlington, VA 22217

Engineering Psychology Group
Office of Naval Research (Code 442EP)
Arlington, VA 22217

Organizational Effectiveness Group
Office of Naval Research (Code 442OE)
Arlington, VA 22217

Personnel and Training Group
Office of Naval Research (Code 442PT)
Arlington, VA 22217

Defense Technical Information Center
DTIC/DDA-2
Cameron Station, Building 5
Alexandria, VA 22314

Director, Research & Analysis Division
Navy Recruiting Command (Code 22)
4015 Wilson Boulevard
Arlington, VA 22203

Department of Administrative Sciences
Naval Postgraduate School (Code 54Ea)
Monterey, CA 93940

Program Director
Manpower Research & Advisory Services
Smithsonian Institution
801 North Pitt Street
Alexandria, VA 22314

Director, Naval Research Laboratory
ATTN: Code 2627
Washington, D.C. 20375

END
FILMED

5-86

DTIC