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FORECASTING TURNING POINTS: IS A TWO-STATE CHARACTERIZATION OFTHE BUSINESS CYCLE APPROPRIATE?

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and

Research Paper

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Forecasting Turning Points: Is a Two-State Characterization of the Business Cycle Appropriate?

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Abstract: Two-state models of the Commerce Department's leading and coincident indexes appear to be misspecified. Cyclical peaks in these indexes are more rounded than are cyclical troughs. Further, the variability of changes in the indexes is unusually high near cyclical troughs.

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Introduction

Neftci's (1982) application of Shiryayev's (1978) results on the optimal detection of regime switches has gained popularity as a methodology for forecasting business-cycle turning points.[1] Using sequential analysis and monthly observations on a leading index--usually the Commerce Department's Composite Index of Leading Indicators (CLI)--the Neftci formula calculates the probability that a business-cycle turning point is imminent. The formula assumes that each observation of the percentage change in the CLI comes from one of two urns, an expansion urn or a contraction urn, and that the contents of each urn have distributions with constant means and variances.

Recent results indicate that simple rules-of-thumb often do as well as the more sophisticated Neftci methodology in predicting business-cycle turning points.[2] This finding raises doubts about whether Neftci's simple two-urn assumption is valid. Here, indeed, we show that both the mean and the variance of the CLI's growth rate vary systematically within the expansion and contraction phases of the index.

We also investigate the adequacy of two-state models for describing growth in the Commerce Department's Composite Index of Coincident Indicators (CCI). Just as Neftci has advocated a two-state model of changes in the index of leading indicators, Hamilton (1989) has suggested that growth in aggregate economic activity can usefully be modeled as a two-state Markov process. We

[1] Studies using this methodology include Diebold and Rudebusch (1989, 1991), Palash and Radecki (1985), and Niemira (1991).

[2] Koenig and Emery (1991) consider rules of thumb based upon the number of consecutive monthly declines (increases) in the CLI, the cumulative deviation of the CLI from recent local maxima (minima), and moving averages of the growth in the CLI. The analysis is conducted entirely in "real time," using unrevised data.

investigate the CCI because its movements are representative of trends in a broad cross-section of the economy but, unlike GNP, the CCI is available on a monthly basis.[3] Since the NBER assigns business-cycle peaks and troughs to specific months, the use of a monthly index allows us to achieve extra precision in our analysis. Further, since recessions sometimes last as few as six months--six months that may include only one complete quarter--the use of quarterly data would preclude an analysis of changes in the mean and variance of economic growth within contractions. Using the CCI, we find systematic changes in the variance of the economy's growth rate within contractions, and systematic changes in the economy's mean growth rate within expansions.

The Results

Our basic data extend from February 1948 to May 1991. Each expansion phase of the leading index was divided into three subperiods of equal length, which we label, respectively, stages 1, 2, and 3. Contraction phases were similarly divided, into stages 4 through 6.[4] The dates separating expansion phases from contraction phases are the peak and trough dates of the leading index itself, as published by the Commerce Department. Expansion and contraction phases of the coincident index were also divided into thirds. For

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[3] The composite coincident index includes measures of industrial production, real manufacturing and trade sales, real personal income (less transfers), and non-farm employment.

[4] Our six-stage division of the business cycle is a minor modification of an approach introduced by Burns and Mitchell (1946) and adopted by King and Plosser (1989). Burns and Mitchell treat the three months centered on peaks and the three months centered on troughs as transitional stages. The expansions and contractions that separate these transitions are then each split into three additional stages. When our estimations are repeated using the Burns and Mitchell stages, results do not differ qualitatively from those reported below.

the coincident index, we used two alternative datings of the expansion and contraction phases--one dating corresponding to the peaks and troughs of the coincident index itself, and a second dating based on the NBER business-cycle reference peaks and troughs.[5] Results are not sensitive to the difference in dating, so we focus on results based on the NBER reference cycle.

Table 1 presents mean growth rates of the leading and coincident indexes during the different stages of the business cycle. The mean growth rates for the indexes were obtained by regressing percent changes in the indexes on six dummy variables, each defined to equal one within a particular stage of the business cycle and zero otherwise. Table 1 also presents the results of tests obtained by running restricted versions of the regressions. All regressions use the Newey-West weighting scheme to correct for serial correlation and heteroskedasticity.

For the leading index, the Chi-Square test statistics indicate that the Neftci assumption of a constant mean rate of increase within expansions can be decisively rejected.[6] The mean rate of increase of the leading index during the first third of its expansion phase is significantly higher than in the second and third stages. During contractions, the Neftci assumption of constant mean growth is also rejected: the Chi-Square statistics indicate that the leading index declines significantly more rapidly in the two later stages of its contraction phase than during the first stage of contractions. In brief, the leading index's troughs are substantially sharper than its peaks.

For the coincident index, the Chi-Square statistics reported in Table 1

[5] At the time of this writing, no official end to the latest recession had been announced. We assume a trough was reached in May 1991.

[6] The correction for heteroskedasticity and serial correlation does not affect the results of these tests.

indicate that during economic downturns the hypothesis of a constant mean rate of decline cannot be rejected. However, the test statistics indicate that the coincident index--much like the leading index--increases at a faster rate in the first stage of expansions than in the second and third stages of expansions.[7] The latter finding is consistent with results obtained by Wynne and Balke (1992) for industrial production and by Sichel (1992) for GNP.

Table 2 presents estimates of the variances of growth in the leading and coincident indexes during different stages of the business cycle. Variance estimates were obtained by regressing squared residuals from the regressions reported in Table 1 on the same sets of dummies used as right-hand-side variables in the earlier regressions. Restricted versions of the variance regressions were used to obtain Chi-Square statistics for testing coefficient equality.

Within expansions, the Neftci assumption of constancy in the variance of percentage changes in the leading index is rejected at the 10-percent (but not the 5-percent) significance level. In particular, the variance of the growth rate of the index is significantly higher during the first third of the expansion phase than during the final third of the expansion phase. During contractions, this pattern is reversed: the variance of the growth rate of the leading index is significantly higher at the end of contractions than at the beginning of contractions. Thus, the rate of change of the leading index is more variable around troughs than it is around peaks.

Examining the coincident index, the hypothesis that the variance of the

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[7] Using the coincident index's own peaks and troughs (rather than the NBER reference dates) to define the stages of the business cycle, the coincident index increases faster in the first <u>two</u> stages of expansions than in the third stage. See Table 3.

growth rate is constant cannot be rejected for expansions but can be rejected for contractions.[8] As with the leading index, the sample variance of changes in the coincident index increases as the contraction proceeds.

Conclusions

This paper shows that models with at least four states are required to account for patterns in the mean and variance of growth in the Commerce Department's leading and coincident indexes. Thus, we find that both the leading index and the coincident index increase at a particularly fast rate early in expansions. The leading index also **decreases** at a particularly fast rate late in contractions. The variance of the growth rate of the leading index is higher both just before and just after troughs in the index than at other times. Similarly, the variance of the growth rate of the coincident index is especially high in the final stages of contractions.

Our results for the leading index may help to explain why it often fails to give reliable signals of business-cycle turning points, regardless of the rule used to interpret its movements. Because the leading index tends to increase at a decreasing rate as an expansion proceeds, the transition from expansion to contraction is often not sharp or distinct. And although there is a shift from very low to very high average growth rates as the index moves from its contraction into its expansion phase, the variance of the index's growth rate is particularly high both just prior to and just after the transition from contraction to expansion, making inference difficult.

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[8] Using the coincident index's own peaks and troughs (rather than the NBER reference dates) to define the stages of the business cycle, the variance of the growth rate appears to dip in the middle stage of expansions. See Table 3.

Our results for the composite coincident index should be of independent interest. They are consistent with recent work indicating the presence of a "bounce-back" effect in real economic activity, but extend this work by examining changes in the economy's mean growth rate within contractions and in the variance of the economy's growth rate over the business cycle.

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Table 1

Means of Percentage Changes in the Leading and Coincident Indexes Over Business-Cycle Stages 1948:2-1991:5

Regressions of Percentage Change on Stage Dummies: Coefficient Estimates Are Sample Means Over that Stage

	Leading Index		Coincident Index	
	Coeff.	t-statistic	Coeff.	t-statistic
Stage 1	.94	(10.87)	.69	(10.33)
2	.48	(6.65)	.45	(6.82)
3	.30	(4.51)	.32	(4.91)
4	-.38	(-4.23)	-.81	(-9.93)
5	-.71	(-6.22)	-.85	(-7.09)
6	-.91	(-5.54)	-.93	(-4.04)
	Adj. R^2 = .33		Adj. R^2 = .31	

Chi-Square statistics for mean equality:

Leading Index Test	χ^2	Coincident Index Test	χ^2
1 = 2	16.84***	1 = 2	6.57***
1 = 3	34.26***	1 = 3	15.25***
2 = 3	3.28*	2 = 3	1.82
1 = 2 = 3	34.73***	1 = 2 = 3	15.71***
4 = 5	4.97**	4 = 5	0.75
4 = 6	7.83***	4 = 6	0.21
5 = 6	1.00	5 = 6	0.78
4 = 5 = 6	9.93***	4 = 5 = 6	0.25
1 = 6	99.55***	1 = 6	45.83***
3 = 4	36.93***	3 = 4	117.03***

*** reject null hypothesis of equality at .01 significance level
** reject null hypothesis of equality at .05 significance level
* reject null hypothesis of equality at .10 significance level

Chi-Square statistics distributed with one degree of freedom for two-stage tests and with two degrees of freedom for three-stage tests.

Table 2

Variances of Percentage Changes in the Leading and Coincident Indexes Over Business-Cycle Stages 1948:2-1991:5

Coefficient Estimates Are Sample Variances of Percentage Change

	Leading Index			Coincident Index	
	Coeff.	t-statistic		Coeff.	t-statistic
Stage 1	.0092	(7.37)	Stage 1	.0061	(5.47)
2	.0069	(4.92)	2	.0061	(4.01)
3	.0057	(6.72)	3	.0063	(4.18)
4	.0034	(5.31)	4	.0020	(3.31)
5	.0065	(3.65)	5	.0058	(5.73)
6	.0110	(5.21)	6	.0150	(2.69)
Adj. R^2 = .01			Adj. R^2 = .01		

Chi-Square statistics for variance equality:

Leading Index Test	χ^2	Coincident Index Test	χ^2
1 = 2	1.53	1 = 2	0.60
1 = 3	5.42**	1 = 3	0.19
2 = 3	0.53	2 = 3	0.14
1 = 2 = 3	5.43*	1 = 2 = 3	0.22
4 = 5	2.70	4 = 5	10.78***
4 = 6	11.94***	4 = 6	5.42**
5 = 6	2.70*	5 = 6	2.68
4 = 5 = 6	13.65***	4 = 5 = 6	15.45***
1 = 6	0.52	1 = 6	2.52
3 = 4	4.80**	3 = 4	7.25*

*** reject null hypothesis of equality at .01 significance level
** reject null hypothesis of equality at .05 significance level
* reject null hypothesis of equality at .10 significance level

Chi-Square statistics distributed with one degree of freedom for two-stage tests and with two degrees of freedom for three-stage tests.

Table 3

Means and Variances of Percentage Changes in the Coincident Index Over Business-Cycle Stages 1948:2-1991:5

(Stages defined by using the Commerce Department's dating of Coincident Index turning points)

	Sample Means			Sample Variances	
	Coeff.	t-statistic		Coeff.	t-statistic
Stage 1	.66	(8.25)	Stage 1	.0083	(3.33)
2	.48	(8.42)	2	.0044	(7.05)
3	.25	(3.05)	3	.0093	(4.51)
4	-.64	(-8.45)	4	.0017	(5.53)
5	-.54	(-4.62)	5	.0055	(4.99)
6	-.66	(-2.97)	6	.0150	(4.16)
Adj. R^2 = .21			Adj. R^2 = .01		

Chi-Square statistics for mean and variance equality:

Mean Tests		Variance Tests	
Test	χ^2	Test	χ^2
1 = 2	3.24*	1 = 2	2.32
1 = 3	13.26***	1 = 3	0.10
2 = 3	5.72**	2 = 3	5.20**
1 = 2 = 3	13.37***	1 = 2 = 3	7.07**
4 = 5	0.50	4 = 5	10.86***
4 = 6	0.01	4 = 6	13.46***
5 = 6	0.23	5 = 6	6.31**
4 = 5 = 6	0.54	4 = 5 = 6	23.77***
1 = 6	30.95***	1 = 6	2.33
3 = 4	64.29***	3 = 4	13.17***

*** reject null hypothesis of equality at .01 significance level
** reject null hypothesis of equality at .05 significance level
* reject null hypothesis of equality at .10 significance level

Chi-Square statistics distributed with one degree of freedom for two-stage tests and with two degrees of freedom for three-stage tests.

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