

CFNAI Background Release

Chicago Fed National Activity Index

Summary

The Federal Reserve Bank of Chicago will begin releasing its new monthly indicator of U.S. economic activity. The new data series, the Chicago Fed National Activity Index (CFNAI), is a weighted average of 85 existing, monthly indicators of national economic activity. The CFNAI provides a single, summary measure of a common factor in these national economic data. As such, historical movements in this Chicago Fed index closely track periods of economic expansion and contraction, as well as periods of increasing and decreasing inflationary pressures. The Chicago Fed's goal in releasing this index monthly is to provide an objective, real-time statistical measure of coincident economic activity derived from a wide-range of monthly economic indicators. Research studies by economists at Harvard, Princeton and the Federal Reserve Bank of Chicago have shown that this economic indicator often provides early indications of changes in inflationary pressures.

Origins of the CFNAI

Methodologically, the Chicago Fed National Activity Index is the same index of economic activity developed by James Stock (Harvard University) and Mark Watson (Princeton University) in a 1999 article on inflation forecasting.¹ Stock and Watson's article assessed the relative forecasting performance of over 100 economic indicators as well as Phillips curve models. They found that a single index constructed from the first principal component of 85 economic activity series forecast inflation as well as or better than the other models. In the March 2000 *Chicago Fed Letter*, "Forecasting inflation with a lot of data," Senior Economist Jonas Fisher reported that substantial increases in the activity index within the period 1960-1999 forewarned periods of accelerating inflation.

¹ James Stock and Mark Watson, 1999, "Inflation forecasting," *Journal of Monetary Economics*.

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What is the CFNAI?

The economic indicators comprising the CFNAI are drawn from five broad categories of data: (1) output and income (21 series); (2) employment, unemployment and hours (24 series); (3) personal consumption, housing starts and sales (13 series); (4) manufacturing and trade sales (11 series); and (5) inventories and orders (16 series). All of the data are adjusted for inflation, and a complete list is contained in appendix A.

The CFNAI is a weighted average of the 85 economic indicators. A precise technical description of the index is contained in appendix B. Put simply, the index is the first principal component of the 85 data series. If all 85 series were proportional to a single common variable plus individual noise discrepancies, the CFNAI would be the estimate of the common variable that minimizes the implied noise discrepancies in a least-squares sense.

Figure 1

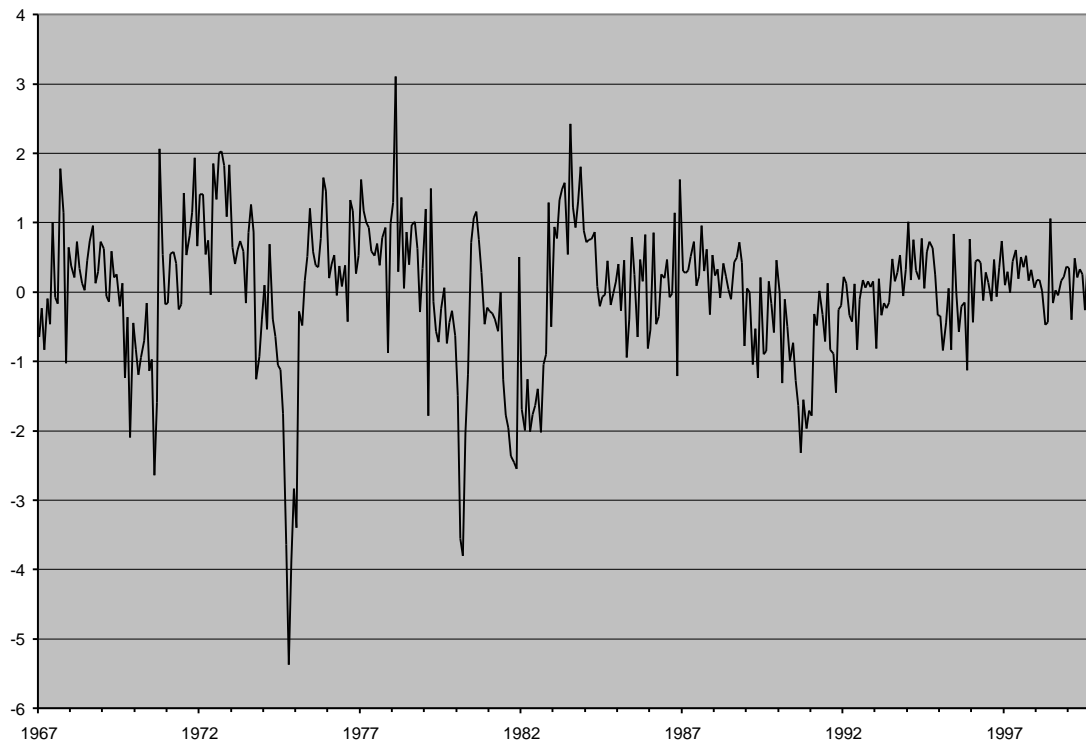
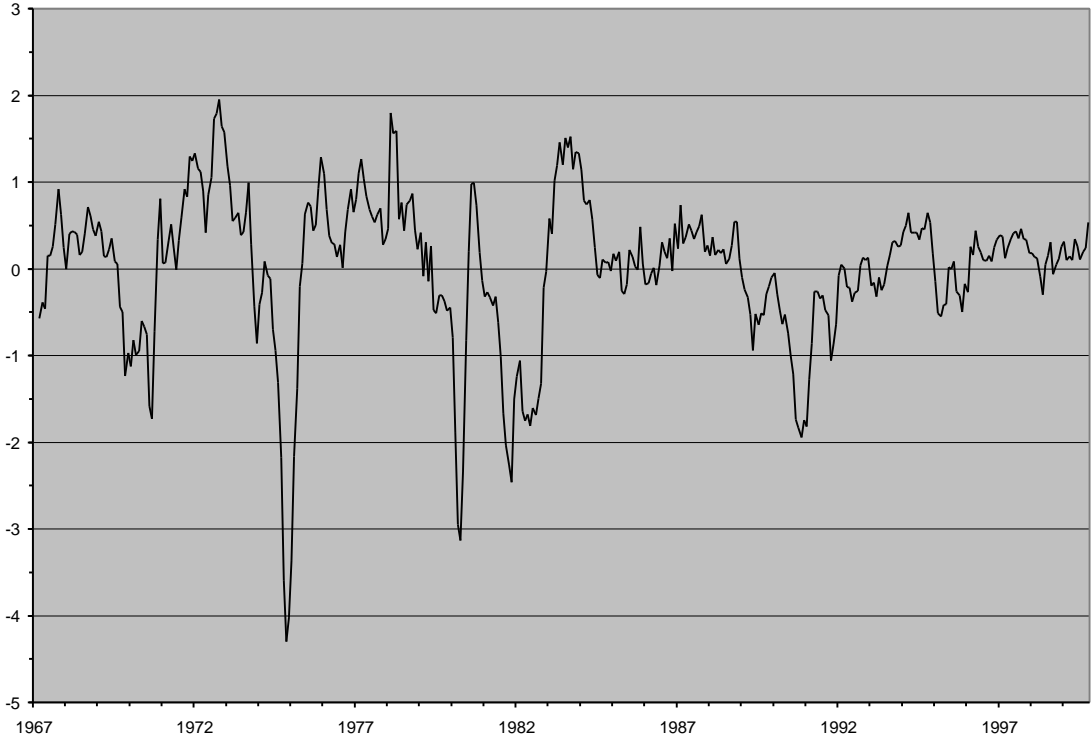


Figure 1 displays the CFNAI from 1967-1999. The index is constructed to have an average value of zero and a standard deviation of one. Since economic activity tends toward trend growth rate over time, an index reading of zero corresponds to an economy growing at trend. The underlying monthly data series are somewhat volatile; consequently, the monthly CFNAI is also quite volatile. Figure 2 displays the three-month moving average of the CFNAI, CFNAI-MA3, and the reduction in month-to-month volatility is readily apparent.

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Figure 2



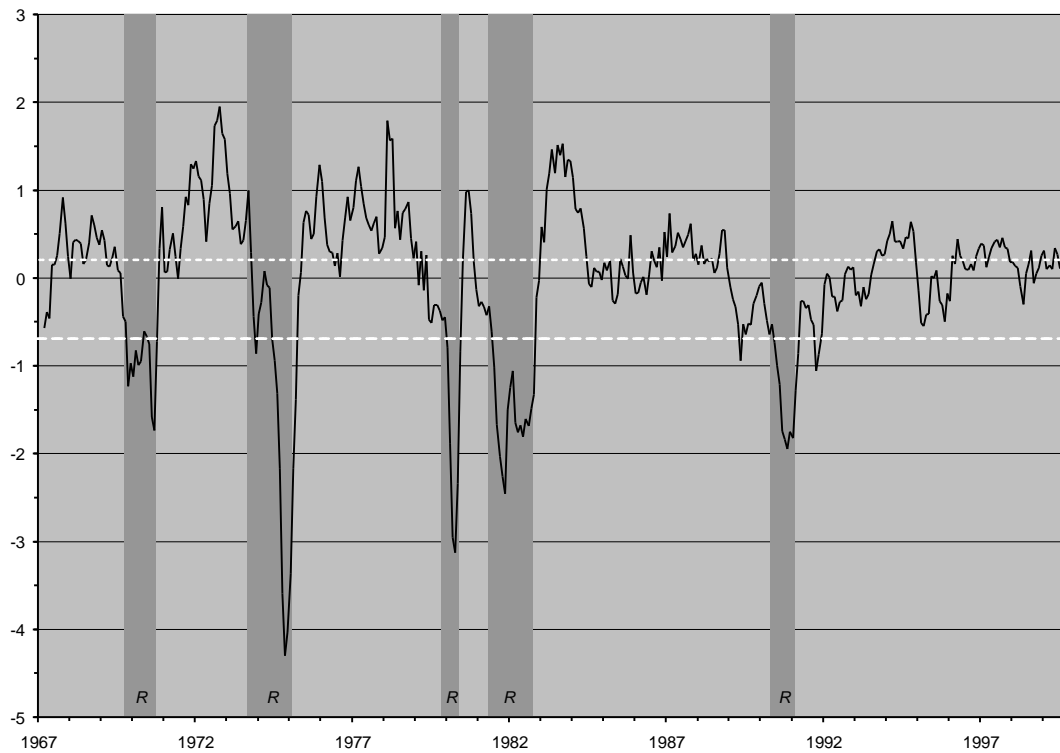
Intuitively, the CFNAI is the single indicator which best captures the comovement of all 85 economic indicators within a month. To the extent that all 85 series track together in a month, the degree of comovement will be high. In this case, the individual weights on each data series are relatively unimportant. But when the data point in different directions, the degree of comovement is low. In this case, the individual weights critically determine how the CFNAI resolves the conflict and reports the common element. Since the CFNAI is the first principal component of the data, the CFNAI weights are determined by the historical importance of each variable's contribution to the overall comovement of the 85 series.

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The CFNAI-MA3 tracks economic expansions and contractions

The CFNAI is a coincident indicator of economic expansions and contractions. To highlight useful benchmark measures, it is best to focus on the CFNAI-MA3. Over the period 1967-1999, there have been five economic recessions identified by the National Bureau of Economic Research (NBER). The shaded regions in Figure 3 correspond to these recession periods. Although five recessions is a small number of events, the CFNAI-MA3 appears to be a useful guide for identifying whether the economy has slipped into and out of a recession. This is useful because the definitive recognition of business cycle turning points usually occurs many months after the event. For example, even though the 1990-91 recession ended in March 1991, the NBER business cycle dating committee did not officially announce the recession's end until 21 months later in December 1992. The official announcements of the end of the 1980 and 1981-82 recessions occurred 12 and 8 months after the trough, respectively.

Figure 3



- In each of the five recessions, the CFNAI-MA3 fell below -0.70, which corresponds to the negative horizontal line in Figure 3, near the onset of the recession. Specifically, the index first fell below the -0.70 threshold in the first month of the 1970, 1981-82 and 1990-91 recessions. In the 1973-75 and 1980 recessions, the index fell below -0.70 in the third and second months, respectively.

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- The only false recession alarm occurred in July 1989 when the CFNAI-MA3 fell to -0.9383, one year prior to the NBER business cycle peak. From mid-1988 through the spring of 1989, the Federal Open Market Committee pursued a policy to reduce inflationary pressures. This led to an increase in the federal funds rate to 9.75 percent. The CFNAI-MA3 struggled unsuccessfully towards positive territory into the spring of 1990. But by April 1990, the index began a steady decline that accelerated following the Iraqi invasion of Kuwait in August 1990.
- When the economy is coming out of a recession, the CFNAI-MA3 moves significantly into positive territory a few months after the official NBER date of the trough. Specifically, after the onset of a recession, when the index first crosses +0.20, the recession has ended according to the NBER business cycle measures. The positive horizontal line in Figure 3 is at +0.2. The critical question is: how early does the CFNAI-MA3 reveal this turning point? For four of the last five recessions, this happened within five months of the business cycle trough. Following the 1970 recession, the index exceeded +0.20 two months after the trough. For the 1973-75, 1980 and 1981-82 recessions, the threshold was crossed in the fifth, third, and fourth months following the official trough. Following the 1990-91 recession, the index did not provide an early indication of the recession's end, crossing +0.2 only in the thirty-second month (November 1993) following the trough. Figure 3 displays the choppy nature of the 1991-92 recovery. This stop-go pattern is consistent with contemporaneous business economists' accounts of double- and triple-dips in economic activity during this period, as well as the NBER committee waiting 21 months to declare the recession's end.

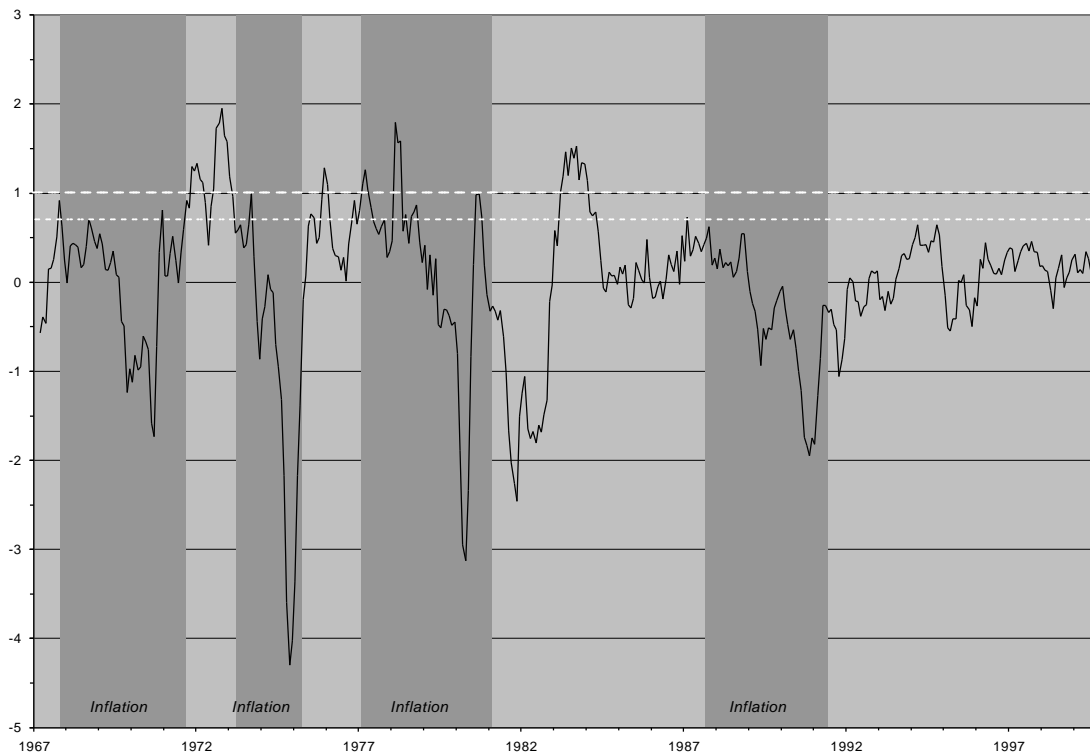
There is an important caveat regarding these threshold values. The thresholds have been identified with the benefit of hindsight and a CFNAI constructed using a full-sample of revised data. Until more research has been conducted on the usefulness of these thresholds in real-time assessments, caution should be exercised in using them as guides. Nevertheless, the CFNAI-MA3 is a promising early indicator of turning points in national economic activity.

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The CFNAI-MA3 tracks sustained accelerations of inflation

The level of the CFNAI-MA3 provides information about the likelihood of a near-term, sustained acceleration of inflation. Over the sample period 1967-99, we have identified four episodes of a sustained acceleration of inflation: 1968-71, 1973-75, 1977-81, and 1987-91. Figure 4 displays the CFNAI-MA3 with the four inflation episodes in shading. In each of these situations, the CFNAI-MA3 rose above +0.70 (which is the lower horizontal line in Figure 4). The first three inflation episodes were more severe than the 1987-91 period, and the index rose above +1.0 in these cases (the upper horizontal line in Figure 4). It is important to note that each of the four inflation episodes occurred at least two years following the previous business cycle trough. In the early months following the completion of an economic recession, the index has often risen strongly (rising above +0.7) without being associated with a sustained acceleration of inflation. In general, negative or small positive readings of the average index have not been associated with the onset of accelerating inflation.

Figure 4

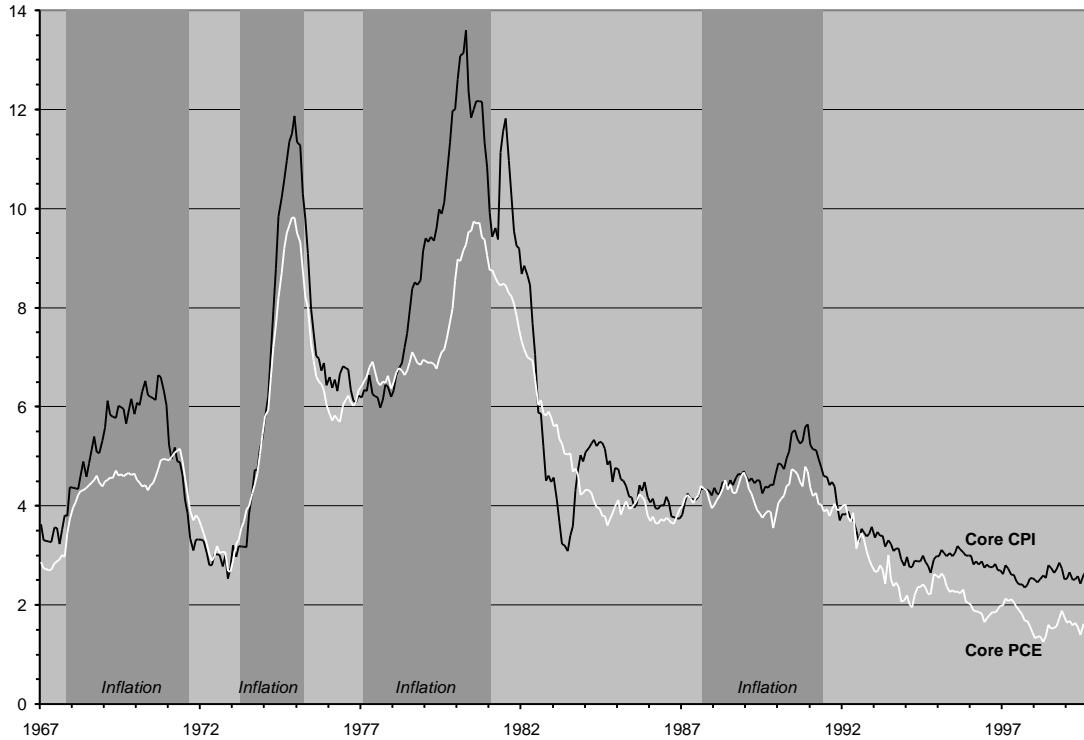


In determining the dates of sustained accelerations of inflation, some judgement is required. There currently are no formal dates determined by an official government agency or an organization of distinguished economists. For the period 1967-1999, we have identified four episodes when two measures of monthly consumer core inflation increased by at least 0.75 percentage point (on a year-ago basis): 1968-71, 1973-75, 1978-81 and 1987-89. Core rates of

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inflation are defined to exclude food and energy inflation. Figure 5 displays these episodes in a graph of core Consumer Price Index (CPI) and core Personal Consumption Expenditures (PCE) inflation. Appendix C details the calculation of these dates.

Figure 5



Summary threshold values for CFNAI-MA3

The following table provides a summary for the threshold values for the CFNAI-MA3.

Table 1: Interpreting the 3-month smoothed CFNAI

If CFNAI-MA3 < -0.70 following a period of economic expansion...	Increasing likelihood that a recession has begun.
If CFNAI-MA3 > +0.20 following a period of economic contraction...	Significant likelihood that a recession has ended.
If CFNAI-MA3 > +0.70 more than two years into an economic expansion...	Increasing likelihood that a period of sustained accelerating inflation has begun.
If CFNAI-MA3 > +1.00 more than two years into an economic expansion...	Substantial likelihood that a period of sustained accelerating inflation has begun.

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What is the purpose of releasing the CFNAI?

Research by James Stock, Mark Watson and economists at the Chicago Fed has found that economic indexes such as the CFNAI provide useful information on the current and future course of economic activity and inflation in the United States. A caveat in all statistical investigations of post-war business cycles is the relatively small number of recession and inflation episodes. By tracking the CFNAI over time, additional information about its predictive power will be obtained. Perhaps just as importantly, each of the previously discussed analyses has used a single set of economic data that contain substantial revisions from their initial releases. Evaluation of the importance of the real-time economic measures requires a careful tracking of the data revisions. By releasing the CFNAI each month, the extent to which data revisions influence inferences from the index should become clearer.

When will the CFNAI be released?

The initial release of the CFNAI will be the January 2001 index. This will be released on March 5, 2001 at 9:00 a.m. CST. The following are the official release dates for 2001.

Table 2: 2001 release dates for CFNAI

Date of Release	Monthly Data for
March 5, 2001	January 2001
April 3, 2001	February 2001
May 2, 2001	March 2001
May 31, 2001	April 2001
July 5, 2001	May 2001
August 2, 2001	June 2001
September 4, 2001	July 2001
October 3, 2001	August 2001
November 5, 2001	September 2001
December 5, 2001	October 2001

Who can I contact to learn more about the CFNAI?

The primary contact for more information about the CFNAI is James Pieper, Public Affairs Specialist in the Corporate Communications Department of the Federal Reserve Bank of Chicago. He can be reached at (312) 322-2387.

Appendix A: CFNAI component data series

Table A1: CFNAI component data series

Series	Eigenvector weights	Transformation code*	Description
IPMFG	0.0213	DLN	Industrial production: manufacturing (92=100 sa)
IP	0.0211	DLN	Industrial production: total index (92 = 100 sa)
CUMFG	0.0209	DLV	cap util rate : manufacturing, total(% of capacity, sa)(frb)
LAGOODA	0.0208	DLN	employees on nonag payrolls: goods producing (thous, sa)
LAPRIVA	0.0206	DLN	employees on nonag payrolls: total, private (thous, sa)
LANAGRA	0.0203	DLN	employees on nonag payrolls: total (thous, sa)
IPDG	0.0202	DLN	Industrial production: durable manufacturing (92=100 sa)
LAMANUA	0.0201	DLN	employees on nonag payrolls: manufacturing(thous, sa)
IPTP	0.0197	DLN	Industrial production: products, total (92 =100 sa)
LADURGA	0.0196	DLN	employees on nonag payrolls: durable goods (thous, sa)
IP53	0.0187	DLN	Industrial production: materials (92=100 sa)
IPDM	0.0186	DLN	Industrial production: durable materials (92=100 sa)
IPFP	0.0185	DLN	Industrial production: final products (92 = 100 sa)
NAPMNI	0.0183	LV	napm new orders index (percent)
NAPMOI	0.0181	LV	napm production index (percent)
NAPMC	0.0176	LV	purchasing managers index (percent)
IP52001	0.0165	DLN	Industrial production: business equipment (92=100 sa)
TSTH	0.0164	DLN	manuf and trade: total (mil of chained 96 dollars) (sa)
IP54	0.0161	DLN	Industrial production: intermediate products (92=100 sa)
NAPMEI	0.0160	LV	NAPM employment index (percent)
HST	0.0159	LN	housing starts: nonfarm(1947-1959), total farm and nofarm (1959-)
LANDURA	0.0159	DLN	employees on nonag payrolls: non durable goods (thous, sa)
IPND	0.0158	DLN	Industrial production: non durable manufacturing (92=100 sa)
HPT	0.0158	LN	building permits for new private housing units(thousands)
LATRDA	0.0157	DLN	employees on nonag payrolls: wholesale and retail trade (thous, sa)
LHELPR	0.0155	DLN	employment:ratio; help wanted add: number of unemployed clif
TSMH	0.0152	DLN	manuf and trade: manuf: total (mil of chained 96 dollars) (sa)
IP51	0.0151	DLN	Industrial production: consumer goods (92=100 sa)
LR	-0.0148	DLV	UR: All workders, 16 years and over (% , sa)
TSMDH	0.0146	DLN	manuf and trade: manuf: durables (mil of chained 96 dollars) (sa)

HSTS	0.0143	LN	housing starts: south (thous, sa)
IP5102	0.0142	DLN	Industrial production: durable consumer goods (92=100 sa)
TRMH	-0.0141	DLV	ratio for mfg and trade: mfg; inv/sales, sa
YPLTPMH	0.0141	DLN	personal income less transfer payments (chained) (#51) (bil 96\$ saar)
LASERPA	0.0140	DLN	employees on nonag payrolls: service producing (thous, sa)
HSTW	0.0140	LN	housing starts: west (thous, sa)
IPNM	0.0139	DLN	Industrial production: non durable materials (92=100 sa)
TRTH	-0.0139	DLV	ratio for mfg and trade: inventory/sales, sa
LENA	0.0136	DLN	Civilian Labor Force: employed, non agric industries (ths, sa)
LRM25	-0.0133	DLV	unemp rate, men 25 to 54 years old
LACONSA	0.0132	DLN	employees on nonag payrolls: contract construction (thous, sa)
MOCGMC	0.0132	DLN	new orders (net) consumer goods and materails, 1996 dollars (bci)
LE	0.0131	DLN	Civilian Labor Force: employed, total(ths, sa)
TSWDH	0.0128	DLN	sales, wholesale trade durables, chained 1996 dollars
LHELP	0.0123	DLN	Index of help-wanted advertising in newspapers(1967=100, sa)
HSTMW	0.0122	LN	housing starts: midwest (ths, sa)
TSMNH	0.0114	DLN	manuf and trade: manuf: nondurables (mil of chained 96 dollars) (sa)
LCUN	-0.0108	DLV	avg weekly intial claims, state unemp insurance (thousands)
MDOQ	0.0107	DLN	new order, durable goods industries, 1996 dollars (bci)
TSWH	0.0104	DLN	sales, wholesale trade, chained 1996 dollars
NAPMVDI	0.0104	LV	napm vendor deliveries index (%)
LASRVSA	0.0103	DLN	employees on nonag payrolls: services (thous, sa)
HSTNE	0.0096	LN	housing starts: northeast (thous, sa)
LOMANUA	0.0095	DLV	avg weekly hrs of prod wkrs mft overtime hrs
NAPMII	0.0094	LV	napm inventories index (percent)
IP51021	0.0093	DLN	Industrial production: non durable consumer goods (92=100 sa)
HSM	0.0092	LN	mobile homes: manufactures shipments (thous of units, saar)
TRWH	-0.0090	DLV	ratio for mfg and trade: wholesales; inv/sales, sa
LAFIREA	0.0089	DLN	employees on nonag payrolls: finance and real estate (thous, sa)
LRMANUA	0.0088	DLV	avg weekly hrs of production wkrs: manufacturing (sa)
CBHM	0.0087	DLN	personal cons expenditures (chained) - total (bil 96\$, saar)
TIRH	0.0085	DLN	manu and trade inv: retail trade (mil of 96 chained sa)
RSH	0.0085	DLN	sales, retail trade, chained 1996 dollars
RSDH	0.0084	DLN	sales, retail trade durables, chained 1996 dollars
LATPUTA	0.0074	DLN	employees on nonag payrolls: transportation and public utilities (thous, sa)

CDBHM	0.0072	DLN	personal cons expenditures (chained) - durables (bil 96, saar)
YPDHM	0.0065	DLN	disposable personal income (chained) (series #52) (bil 96\$, SAAR)
CDMNHM	0.0056	DLN	personal cons expenditures (chained) - new cars ((bil 96, saar)
CNBHM	0.0055	DLN	personal cons expenditures (chained) - nondurables (bil 96, saar)
TITH	0.0054	DLN	manu and trade inventories: total (mil of chained 1996) (sa)
RSNH	0.0049	DLN	sales, retail trade nondurables, chained 1996 dollars
TSWNH	0.0046	DLN	sales, wholesale trade nondurables, chained 1996 dollars
CSBHM	0.0044	DLN	personal cons expenditures (chained) - services (bil 96, saar)
IPMIN	0.0040	DLN	Industrial production: mining (92=100 sa)
CONDO9	0.0039	LN	construct contracts: comml & indus bldgs (mil sq ft floor sp sa)
MOCNC	0.0037	DLN	new orders, non defense capital goods, in 1996 dollars (bci)
MPCONQ	0.0029	DLN	contract and orders for plant and equipment (bci)
LAMINGA	0.0028	DLN	employees on nonag payrolls: mining (thous, sa)
TRRH	-0.0028	DLV	ratio for mfg and trade: retail; inv/sales, sa
TIWH	0.0019	DLN	manu and trade inv: merchant wholesalers (mil 96 chained sa)
LAGOVTA	0.0016	DLN	employees on nonag payrolls: government (thous, sa)
IPUTI	0.0015	DLN	Industrial production: utilities (92=100 sa)
TIMDH	0.0010	DLN	Inventories, bus durables (mil of 96 chained sa)
TIMH	0.0007	DLN	manu and trade inventories: mfg (mil of chained 1996, SA)
TIMNH	-0.0004	DLN	inventories, bus nondurables (mil of 96 chained sa)

*For a series y_t , the transformations $x_t = f(y_t)$ are:

1. LV : $x_t = y_t$
2. DLV: $x_t = \Delta y_t$
3. LN: $x_t = \ln(y_t)$
4. DLN: $x_t = \Delta[\ln(y_t)]$

Technical description of Chicago Fed National Activity Index (CFNAI) construction

The CFNAI is the first principal component of a data set containing 85 economic indicators. An excellent discussion of this statistical procedure is presented in the econometrics textbook by Henri Theil, *Principle of Econometrics*, New York: John Wiley and Sons, 1971, pp. 46-48. Let x_t denote the 1-by-85 element row vector of data at time t . Let X_T denote the T-by-85 stacked matrix of data vectors

$$X_T = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_T \end{bmatrix}.$$

Each column of X_T contains T observations of an individual economic indicator. Prior to the construction of X_T , each individual data series is transformed from its release values in two ways. First, each series is filtered by a stationary-inducing transformation. For example, the employment and industrial production data are log-differenced, so that they are in growth rates. Table A1 lists the transformation for each indicator. In some cases, like the purchasing managers' index, the data require no transformation. Second, each series is de-measured and standardized; in other words, each series has mean zero and standard deviation one.

Since the CFNAI is a principal component, it is a weighted average of the 85 (transformed) economic indicators

$$CFNAI_t = x_t a$$

where a is an 85-by-1 vector of weights. The weights correspond to the eigenvector associated with the largest eigenvalue of the second-moment matrix $X_T'X_T$.¹ The vector of weights a is time-invariant for a fixed set of data X_T . The final step in computing the $CFNAI_t$ series simply involves re-normalizing the series to have mean zero and standard deviation one.

For every monthly release of the $CFNAI$, there are likely to be two reasons for minor revisions to the index. First, the underlying monthly data are released with varying degrees of delay. For example, the September 2000 employment data were available on October 6, while the September nominal retail inventory data will be released on November 15 (and the inflation-adjusted inventories at the

¹This corresponds to Thiel's equation (9.6) on page 48.

end of November). One of our objectives is to release the *CFNAI* in a timely fashion. Consequently, our initial release includes *projected* monthly values for approximately one-third of the 85 series. In the following month's release when the actual data for these missing data become available, correcting the projection error becomes a source of revision in the *CFNAI*. Second, throughout the calendar year, the 85 monthly data series are systematically revised by the original reporting institutions. These revisions will alter the weighting vector a , as well as the underlying monthly data. Other sources of revisions and renormalizations are expected to have negligible influences on the index.

Appendix C: Inflation episode dates

This appendix describes the method for identifying episodes of sustained accelerating inflation. Two measures of core consumer prices are considered, both of which exclude volatile food and energy prices: the core Personal Consumption Expenditures (PCE) and the core Consumer Price Index (CPI). Monthly inflation rates over the previous 12-month period are computed for each inflation series. There are 5 basic steps for establishing an inflation episode.

1. Starting with a period that is not experiencing an acceleration of inflation, determine the date when inflation is at a minimum. Do this for each inflation measure.
2. Determine the dates when each inflation measure has risen by 0.75 percentage points from its minimum. These dates constitute the start of the inflation episode and correspond to plausible dates when the episode would be recognized by financial market participants and other individuals.
3. Determine the dates when each inflation measure has reached its maximum value and then begins a “reasonably” continuous decline.
4. Determine the dates when each inflation measure has fallen by 0.75 percentage points from its maximum value during the episode. These dates are taken to be the end of the inflation episode and correspond to plausible dates when the end would be recognized by financial market participants and other individuals.
5. Date the overall inflation episode by selecting the earliest start date and latest end date.

In general, some judgement may be called for in interpreting erratic movements in the inflation measures. The procedure here was adopted with the expectation that typical inflation episodes would begin from a relatively low average inflation rate, increase substantially for a period of time, but then recede substantially and perhaps return to the initial level. This pattern fits three of the four identified episodes reasonably well, but the last episode’s duration is less clear. The fourth inflation episode begins in October 1987 and ends in July 1991. During this episode, however, both core inflation measures began to decline in February 1989 for several months (11 months for the core PCE and 6 months for the core CPI). Both measures resumed their increase and later reached peaks slightly above the February 1989 levels. In this analysis, we have assumed this to be one related inflation episode.

The following table describes the four episodes.

Table C1: Inflation Episode Dating

	Episode I		Episode II		Episode III		Episode IV	
	PCE	CPI	PCE	CPI	PCE	CPI	PCE	CPI
Min Date	Jun-67	Jul-67	Feb-73	Jan-73	Jul-76	Oct-77	Jun-86	Feb-87
Min π	2.70%	3.27%	2.67%	2.53%	5.69%	5.98%	3.64%	3.74%
$\Delta\pi > 0.75$	<i>Jan-68</i>	Feb-68	<i>Jun-73</i>	Sep-73	<i>Apr-77</i>	May-78	<i>Oct-87</i>	Sep-88
Max Date	Jul-71	Nov-70	Feb-75	Feb-75	Sep-80	Jun-80	Jan-91	Feb-91
Max π	5.15%	6.63%	9.82%	11.86%	9.73%	13.60%	4.79%	5.64%
$\Delta\pi < 0.75$	<i>Oct-71</i>	Mar-71	<i>May-75</i>	<i>May-75</i>	<i>Mar-81</i>	Jul-80	Jun-91	<i>Jul-91</i>
$\Delta\pi$ (Max-Min)	2.45%	3.36%	7.15%	9.33%	4.04%	7.62%	1.15%	1.90%
	Start	End	Start	End	Start	End	Start	End
Episode Dates	Jan-68	Oct-71	Jun-73	May-75	Apr-77	Mar-81	Oct-87	Jul-91