Background on the Chicago Fed National Activity Index

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Summary

The Chicago Fed National Activity Index (CFNAI) is a weighted average of 85 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 pressure. 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 indicators. Research studies by economists at Harvard University, Princeton University, and the Federal Reserve Bank of Chicago have shown that the CFNAI often provides early indications of business cycle turning points and changes in inflationary pressure.

Origins of the CFNAI

Methodologically, the Chicago Fed National Activity Index is similar to the index of economic activity developed by James Stock (Harvard University) and Mark Watson (Princeton University) in a 1999 article on inflation forecasting.[1] They found that a single index constructed from the first principal component of 85 economic activity series forecasted inflation as well as or better than several other common models. Furthermore, in the March 2000 *Chicago Fed Letter*, Jonas D. M. Fisher, the current Chicago Fed vice president of macroeconomic research, reported that substantial increases in the activity index within the period 1960–99 forewarned periods of increasing inflation and identified threshold values of the index that signaled these periods.[2] In the 2002 third quarter issue of *Economic Perspectives*, Charles L. Evans, the current Chicago Fed president, along with Chin Te Liu and Genevieve Pham-Kanter, formalized the use of threshold rules to identify recessions and inflationary episodes.[3] In the November 2009 *Chicago Fed Letter*, Scott Brave, policy economist, expanded on this analysis.[4] Table 1 provides a summary of threshold values for the index's three-month moving average, CFNAI-MA3.

What is the CFNAI?

The economic indicators used for the CFNAI are drawn from four broad categories of data: 1) production and income (23 series), 2) employment, unemployment, and hours (24 series), 3) personal consumption and

[1] James Stock and Mark Watson, 1999, "Forecasting inflation," *Journal of Monetary Economics*, Vol. 44, No. 2, October, pp. 293–335.

[2] Jonas D. M. Fisher, 2000, "Forecasting inflation with a lot of data," *Chicago Fed Letter*, Federal Reserve Bank of Chicago, No. 151, March.

[3] Charles L. Evans, Chin Te Liu, and Genevieve Pham-Kanter, 2002, "The 2001 recession and the Chicago Fed National Activity Index: Identifying business cycle turning points," *Economic Perspectives*, Federal Reserve Bank of Chicago, Vol. 26, Third Quarter, pp. 26–43.

[4] Scott Brave, 2009, "The Chicago Fed National Activity Index and business cycles," *Chicago Fed Letter*, Federal Reserve Bank of Chicago, No. 268, November.

housing (15 series), and 4) sales, orders, and inventories (23 series). All of the data are adjusted for inflation, and a complete list appears in table 3.

The CFNAI is a weighted average of the 85 economic indicators. Put simply, the index is the first principal component of the 85 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.

An excellent discussion of this statistical procedure is presented in the econometrics textbook by Henri Theil.[5] 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

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

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 3 lists the transformation for each indicator. In some cases, as with the Institute for Supply Management's Purchasing Managers' Index, the data require no transformation. Second, each series is de-meaned and standardized; in other words, each series has a mean of zero and a standard deviation of one.

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

$$CFNAI_t \quad = \quad x_t a,$$

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 $X_T' X_T$.[6] 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 renormalizing the series to have a mean of zero and standard deviation of one.

The CFNAI is revised with each monthly release. For every release there are two potential reasons for minor revisions to the index. First, the underlying monthly data are released with varying degrees of delay. One of our objectives is to release the CFNAI each month 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 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 also alter the underlying monthly data. Finally, the weighting vector a is reestimated each month so that changes in a will affect the history of the index. However, in practice we have found this source of revision to be small.

Figure 1 displays the CFNAI over the period March 1967–October 2016. The index is constructed to have an average value of zero and a standard deviation of one. Since economic activity tends toward a 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 3 displays the three-month moving average of the CFNAI, the CFNAI-MA3; the reduction in month-to-month volatility is readily apparent.

Intuitively, the CFNAI is the single index that best captures the co-movement of all 85 economic indicators within a month. To the extent that all 85 series track together in a month, the degree of co-movement will

[5] Henri Theil, 1971, *Principles of Econometrics*, New York: John Wiley and Sons, pp. 46–48.

[6] This corresponds to Theil's (1971) equation (9.6), p. 48.

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 co-movement 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, its weights are determined by the historical importance of each variable's contribution to the overall co-movement of the 85 series.

In his November 2009 *Chicago Fed Letter*, Scott Brave also illustrated the usefulness in looking closely at the different categories of indicators that make up the index in explaining business cycles. Figure 2 plots the history of the four categories of indicators defined previously. The production and income category and the sales, orders, and inventories category tend to turn negative more quickly during a recession and turn positive once a recovery begins. The employment, unemployment, and hours category typically lags the business cycle, making its greatest negative contribution near the end of a recession. There does not appear to be any discernible pattern for the personal consumption and housing category during recessions. These observations are consistent with well-documented business cycle facts.

The CFNAI-MA3 tracks economic expansions and contractions

The CFNAI is a coincident indicator of economic expansions and contractions. To highlight this fact, it is best to focus on the CFNAI-MA3. Over the period of March 1967–October 2016, there have been seven economic recessions identified by the National Bureau of Economic Research (NBER).[7] The shaded regions in Figure 3 correspond to these recession periods. Although a total of seven recessions is a small number of events, the CFNAI-MA3 appears to be a useful guide for identifying whether the economy has moved 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's Business Cycle Dating Committee did not officially announce the recession's end until 21 months later, in December 1992. Furthermore, the official NBER announcement stating the 2001 recession ended in November 2001 was not made until July 17, 2003 – a lag of 20 months.

- In each of the seven recessions, the CFNAI-MA3 fell below -0.7, which corresponds to the negative horizontal dashed line in Figure 3, near the onset of the recession. Specifically, the index first fell below the -0.7 threshold in the third month of the 1981–82, 1990–91, and 2007–09 recessions. In the 1969–70, 1973–75, and 1980 recessions, the index fell below -0.7 in the second, 11th, and fourth months, respectively, while it fell below -0.7 one month prior to the start of the 2001 recession.

- Apart from the months preceding or following a recession, the only false recession alarms occurred in July 1989 (one year prior to the NBER business cycle peak) and December 1991/January 1992 (eight months after the NBER business cycle trough). From mid-1988 through the spring of 1989, the Federal Open Market Committee pursued a policy to reduce inflationary pressure. This led to an increase in the federal funds rate to 9.75 percent. The CFNAI-MA3 struggled unsuccessfully toward 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. A similar decline also occurred at the start of the Iraq war in 2003, although the index remained just slightly above -0.7.

- For the majority of the seven recessions, the CFNAI-MA3 moved 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 +0.2, the likelihood that the recession has ended according to the NBER business cycle measures is significant. The positive horizontal dashed 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 seven recessions, this happened within five months of the business cycle trough. Following the 1969–70 recession, the index exceeded +0.2 two months after the trough. For the 1973–75, 1980, and 1981–82 recessions,

[7] See http://www.nber.org/cycles.html.

the threshold was crossed in the fifth, third, and fourth months, respectively, after the official trough. Following the 1990–91, 2001, and 2007–09 recessions, the index did not provide an early indication of the recession's end according to this threshold rule, crossing +0.2 in the 13th, 24th, and 11th months (April 1992, November 2003, and May 2010), respectively, after each 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; it may also account for the NBER committee waiting 21 months to declare the recession's end. This lends justification for the false positive in December 1991/January 1992 as well. Finally, for both the 1990–91 and the 2001 recessions, employment-related indicators took a considerable amount of time to rebound, contributing to the lagging CFNAI; while for the 2007–09 recession housing-related indicators displayed a similar pattern.

- Instead, we have found the crossing of the -0.7 threshold at least six months after a recession's trough to be a more reliable indicator of an increasing likelihood of an end of a recession. This criterion improves the CFNAI's performance in correctly dating the trough of the business cycle for all but one of the recessions since 1967. The most marked improvements can be seen in the 1990–91, 2001, and 2007–09 recessions. In these recessions the CFNAI-MA3 crossed -0.7 three, two, and three months, respectively, after the NBER trough date.

- In a 2011 paper, Travis J. Berge and Òscar Jordà develop a routine using a receiver operating characteristics curve (ROC) that yields another alternative threshold rule for the CFNAI-MA3 that simultaneously identifies recessions and expansions.[8] The optimal threshold for the CFNAI-MA3 as defined by Berge and Jordà (2009) as of September 2010 is -0.8. This rule places equal weight on avoiding misclassifying a recession month as a nonrecession month and a nonrecession month as a recession month. As such, our -0.7 threshold puts only marginally more weight on the second type of classification error. In fact, repeating the analysis above using -0.8 as the appropriate threshold results only in a one-month closer correspondence to the end of the 1990–91 and 2007–09 recessions and a one-month later correspondence to the beginning of the 2007–09 recession.

- In a 2012 *Chicago Fed Letter*, Scott Brave and Max Lichtenstein[9] found that the crossing of a -0.35 threshold by the CFNAI Diffusion Index (which is explained in greater detail later) signaled an increased likelihood of the beginning (from above) and end of a recession (from below). This threshold was determined using the Berge and Jordà ROC method. Additionally, Brave and Lichtenstein found that, on average, the CFNAI Diffusion Index signals the beginning and end of recessions one month earlier than the CFNAI-MA3. For more information on the CFNAI Diffusion Index, see p. 7.

The CFNAI-MA3 tracks sustained increases of inflation

The level of the CFNAI-MA3 also provides information about the likelihood of a near-term, sustained increase of inflation. Over the sample period March 1967–October 2016, we have identified five episodes of a sustained increase in inflation: 1968–71, 1973–75, 1977–81, 1988–91, and 2004–08. Figure 5 displays the CFNAI-MA3 with the five inflation episodes shaded. In each of these situations, the CFNAI-MA3 rose above +0.7 (which is the lower horizontal dashed line in Figure 5) prior to or early on in the episode. The first three episodes were more severe than the 1988–91 and 2004–08 episodes, and in these earlier cases, the index rose to near or above +1.0 (the upper horizontal dashed line in Figure 5). It is important to note that each of the five episodes occurred at least two years after 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

[8]Travis J. Berge and Òscar Jordà, 2011, "Evaluating the classification of economic activity into recessions and expansions," *American Economic Journal: Macroeconomics*, Vol. 3, No. 2, April, pp. 246–277.

[9]Scott Brave and Max Lichtenstein, 2012, "A different way to review the Chicago Fed National Activity Index," *Chicago Fed Letter*, Federal Reserve Bank of Chicago, No. 298, May.

associated with a sustained increase of inflation. In general, negative or small positive readings of the index's three-month moving average have not been associated with the onset of increasing inflation.

To determine the dates of sustained increases of inflation, some judgment is required. There currently are no formal dates determined by an official government agency or an organization of distinguished economists; however, there has been a considerable amount of research pertaining to the CFNAI and inflationary phenomena. In the 2002 first quarter issue of *Economic Perspectives*, Fisher, Liu, and Zhou find that, while forecasting inflation with the CFNAI has had varied success over the period 1977–2000, there has been reasonable success in forecasting the direction of change of inflation.[10] Later, in the 2004 fourth quarter issue of *Economic Perspectives*, Fisher and Brave, motivated by past failings of inflation forecasts, find that incorporating many different models and indicator series along with the CFNAI provides a more robust inflation forecast.[11]

For the period March 1967–October 2016, we have identified five episodes when two measures of monthly consumer core inflation increased by at least 0.75 percentage points on a year-ago basis and met certain other criteria: 1968–71, 1973–75, 1978–81, 1987–89, and 2004–08. Core rates of inflation exclude food and energy inflation. Figure 6 displays these episodes in a graph with core Consumer Price Index (CPI) and core Personal Consumption Expenditures (PCE) inflation. Details of the calculation of these dates are in the Appendix.

What is the purpose of releasing the CFNAI?

Research by James Stock, Mark Watson, and economists at the Chicago Fed has shown that 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 postwar business and inflation cycles is the number of recessions and episodes of increasing inflation is fairly small. As the CFNAI is tracked over time, additional information about its predictive power will be obtained. Another caveat is that, each of the previously discussed analyses have used economic data that may have been revised after their initial release. Evaluation of the importance of 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.

Both caveats are also important with respect to the threshold values used to indicate NBER recessions and periods of increasing inflation. The thresholds have been identified with the benefit of hindsight and the 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 real-time guides. Some initial benefits of the real-time release of the CFNAI have been seen. For instance, for the 2001 recession, the CFNAI-MA3 identified the start of the recession as December 2000 in the March 5, 2001, release. Ten months later, the NBER identified the start date of the recession as March 2001. The CFNAI-MA3 then identified the end of the 2001 recession as February 2002 in the March 27, 2002, release. Sixteen months later, the NBER determined the end date to be November 2001.

The index's real-time performance during the 2007–09 recession was even better. In the March 24, 2008, release, the CFNAI-MA3 correctly identified December 2007 as the recession's start date, eight months before the NBER announcement doing the same. Similarly, it then identified the end of the recession as September 2009 in the October 26, 2009, release, nearly 11 months before the NBER announcement declaring June 2009 as the end of the recession. For more information on the real-time performance of the index, including its ability to forecast real GDP growth and core PCE inflation, see the April 2010 *Chicago Fed Letter* by Scott Brave and R. Andrew Butters.[12]

[10] Jonas D. M. Fisher, Chin Te Liu, and Railin Zhou, 2002, "When can we forecast inflation?," *Economic Perspectives*, Federal Reserve Bank of Chicago, Vol. 26, First Quarter, pp. 30–42.

[11] Jonas D. M. Fisher and Scott Brave, 2004, "In search of a robust inflation forecast," *Economic Perspectives*, Federal Reserve Bank of Chicago, Vol. 28, Fourth Quarter, pp. 12–31.

[12] Scott Brave and R. Andrew Butters, 2010, "Chicago Fed National Activity Index turns ten–Analyzing its first decade of

How has the CFNAI changed over time?

In response to the demand for real-time CFNAI research, we now release the real-time history of the CFNAI on our website.[13] Each release is available in its entirety as it was originally made available at the time of release.[14] What follows is a brief outline of the major changes to the component series of the CFNAI since its initial release in 2001 that have had a significant impact on the index's history.

SIC/NAICS conversion

In December 2002, the conversion of industry data from the Standard Industrial Classification (SIC) system to the North American Industry Classification System (NAICS) took place. A splice was utilized to generate the full historical series of the CFNAI. With stronger emphasis on emerging and service-producing industries, as well as some restructuring of the organization of different industries, the NAICS uses a more unified approach than the SIC system.

Base year changes (2003 and 2009)

In November 2003, the base year for the national income and product accounts (NIPAs) changed. In the course of updating the CFNAI, it was discovered that a handful of the original 85 indicators were no longer readily available. These series were subsequently replaced, with the changes documented in the technical report on our website. In July 2009, in addition to another base year change, the personal consumption expenditures accounts were substantially revised. While the changes had only a minimal impact on the index, they did affect the timing of previously determined episodes of increasing inflation, as documented in the Appendix.

Other changes to indicators

The Conference Board's decision to discontinue the publication of its Help-Wanted Advertising Index (of print advertising) resulted in the loss of two indicators in September 2010. These indicators were replaced by utilizing a splicing technique similar to the SIC/NAICS conversion. The information in the Help-Wanted Advertising Index from December 2000 onward was replaced with the total job openings data from the *Job Opening and Labor Turnover Survey* (JOLTS) produced by the U.S. Bureau of Labor Statistics.

Contributions from indicator categories

In July 2011, we began making available the real-time history of the contributions from each of the four broad categories of indicators that make up the index: production and income (P&I); employment, unemployment, and hours (EU&H); personal consumption and housing (C&H); and sales, orders, and inventories (SO&I). For some releases, our records were incomplete (March 2001–July 2001). These months are represented by missing values in our archives. Additionally, from February 2001 through September 2003, contributions from five categories of indicators were originally reported. We have condensed them to the four that are provided for the index at this time. This was done by summing the contributions from the manufacturing and trade sales category and from the inventories category, and represents the contribution from the sales, orders, and inventories category during these months.

performance," *Chicago Fed Letter*, Federal Reserve Bank of Chicago, No. 273, April.

[13] See https://www.chicagofed.org/cfnai.

[14] The December 19, 2002, release is truncated because of temporarily missing data as a result of the SIC/NAICS conversion. Data prior to 1972 was unavailable for these four series: 1) industrial production: durable goods, 2) industrial production: nondurable goods, 3) industrial production: mining, and 4) industrial production: electric and gas utilities. As a result, the CFNAI that month was generated over the 1972–2002 sample.

CFNAI Diffusion Index

In April 2012, we began publishing the CFNAI Diffusion Index, a metric based on the magnitude of the weight given to each of the underlying indicators in the CFNAI when constructing the index as their weighted average. The index is calculated as the sum of the absolute values of the underlying indicators whose contribution to the CFNAI is positive in a given month less the sum of the absolute values of the weights for those indicators whose contribution is negative or neutral, expressed as a proportion of the total sum of the absolute values of the weights. By construction, the sum of the absolute values of the CFNAI weights is one. To make this measure comparable to the CFNAI-MA3, we take its three-month moving average. In December 2016, we also made available its real-time history.

Real-time CFNAI Data

The partial federal government shutdown in October 2013 affected the September and October 2013 CFNAI releases. Federal agencies postponed the release of several data series used to compile the CFNAI, and the September release was subsequently postponed from October 21 to November 12. Because of the delay, the September release was able to include September personal consumption expenditure data and revised September employment data, but was not able to include September housing starts or permits. The October release included October housing starts, but did not include September or October housing permits. In December 2016, we updated the method used to splice certain series with their corresponding historical series.

Contact for CFNAI

The primary contact for more information about the CFNAI is Scott Brave, policy economist, of the Economic Research Department at the Federal Reserve Bank of Chicago. He can be reached at (312) 322-5784 or sbrave@frbchi.org.

Appendix

Dates for episodes of increasing inflation

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

1. Starting with a period that is not experiencing an increase 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. While only one series moving 0.75 percentage points can trigger a possible date, in order for this date to be considered the start of an episode the other series must be moving in an upward direction; there must be "co-movement." 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.[15]

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.

NIPA revisions in 2009[16] redefined the makeup of core PCE. As a result, the dates of the previously defined inflationary episodes were subject to change. Table 4 describes the four episodes as defined by the dating procedure used *before* the NIPA revisions.

Table 5 describes the four episodes as defined by the dating procedure *after* the NIPA revisions of 2009. Dates and numbers in red indicate changes from table 4. In summary, the first episode of increasing inflation was revised to start one month later, while the second episode was revised to start one month earlier. The third episode was shifted two months later, to begin in June instead of April, and it was extended from 23 months to 24 months. Finally, the fourth episode's start was pushed to March 1988 from its original start in October 1987.

Table 6 summarizes the episodes of increasing inflation of both price series in their entirety. The use of a "co-movement" and "reasonable decline" criterion in the methodology does have real effects on the dates of the episodes. The first such effect is its handling of the sharp increase in CPI in 1984. The methodology taken in the strictest sense would have defined an episode starting in January 1984 when CPI reached 5.02 percent, 1.93 percentage points above its minimum in August 1983. This spike in CPI was accompanied, however, by a decline in PCE inflation. The "co-movement" rule eliminated January 1984 as a start date.

The fourth inflation episode's duration is less clear than the previous three. During this episode both core inflation measures began to decline in February 1989 for several months. Both measures resumed their increase and later reached peaks slightly above their February 1989 levels. In this analysis, we have assumed this time period to be one continuous episode of increasing inflation, appealing to the idea that neither experience a "reasonable decline" before their subsequent rise.

[15] One possible example of this constraint could be as follows: The three-month change in the 12-month inflation rates of both series are calculated; if this change is less than 0.125 for *either* series at the candidate period, this date is rejected as a possible start date.

[16] Details about the NIPA revisions can be found at http://www.bea.gov.

The "co-movement" rationale also had substantial effects on defining the fifth episode. Again, if the methodology was taken in the strictest sense, we would have defined an episode to have begun in November 2000, when CPI reached 2.63 percent, 0.75 percentage points above its level in December 1999. This possible start date was ruled out, however, because PCE inflation was essentially flat during this period. As a result of this elimination, the new method found the fifth inflationary episode to begin in June 2004, when CPI reached 1.84 percent, 0.75 percentage points above its level in December 2003.

Table 1: Interpreting the Chicago Fed National Activity Index three-month moving average (CFNAI-MA3)

If CFNAI-MA3<-0.7 following a period of economic expansion	Increasing likelihood that a recession has begun
If CFNAI-MA3>-0.7 following a period of economic contraction	Increasing likelihood that a recession has ended
If CFNAI-MA3>+0.2 following a period of economic contraction	Significant likelihood that a recession has ended
If CFNAI-MA3>+0.7 more than two years into an economic expansion	Increasing likelihood that a period of sustained increasing inflation has begun
If CFNAI-MA3>+1.0 more than two years into an economic expansion	Substantial likelihood that a period of sustained increasing inflation has begun

Table 2: CFNAI-MA3 and CFNAI Diffusion Index business cycle dates

	Recessions since 1967													
NBER Dates	Dec-69	Nov-70	Nov-73	Mar-75	Jan-80	Jul-80	Jul-81	Nov-82	Jul-90	Mar-91	Mar-01	Nov-01	Dec-07	Jun-09
CFNAI-MA3	Jan-70	Jan-71	Sep-74	Jun-75	Mar-80	Sep-80	Sep-81	Jan-83	Sep-90	May-91	Feb-01	Jan-02	Jan-08	Sep-09
Diffusion	Jan-70	Jan-71	Aug-74	Jun-75	Mar-80	Aug-80	Aug-81	Jan-83	Jun-90	Jun-91	Jan-01	Jan-02	Dec-07	Aug-09

Table 3: Chicago Fed National Activity Index component data series

Haver mnemonic	**Scaled eigenvector**	**Transformation**[a]	**Description**
Production and income			
IPMFG	0.025	DLN	Industrial Production: Manufacturing SA, 2012=100
IP	0.025	DLN	Industrial Production Index SA, 2012=100
CUMFG	0.024	DLN	Capacity Utilization: Manufacturing SA, Percent of Capacity
IPMDG[c]	0.024	DLN	Industrial Production: Durable Manufacturing SA, 2012=100
IPTP	0.023	DLN	Industrial Production: Final Products and Nonindustrial Supplies SA, 2012=100
IP531	0.023	DLN	Industrial Production: Materials: Durable SA, 2012=100
IP54	0.023	DLN	Industrial Production: Nonindustrial Supplies SA, 2012=100
IP53	0.022	DLN	Industrial Production: Materials SA, 2012=100
IPFP	0.022	DLN	Industrial Production: Final Products SA, 2012=100
IP521	0.020	DLN	Industrial Production: Business Equipment SA, 2012=100
NAPMOI	0.020	LV	ISM Manufacturing: Production index SA, 50+ = Econ Expand
NAPMC	0.020	LV	ISM Manufacturing: PMI Composite Index SA, 50+=Econ Expand
IPMND[c]	0.018	DLN	Industrial Production: Nondurable Manufacturing SA, 2012=100
IP51	0.018	DLN	Industial Production: Consumer Goods SA, 2012=100
IP511	0.017	DLN	Industrial Production: Durable Consumer Goods SA, 2012=100
IP532	0.016	DLN	Industrial Production: Materials: Nondurable SA, 2012=100
YPLTPMH	0.013	DLN	Real Personal Income Less Transfer Payments SAAR, Bil. Chn. 2009$
IP512	0.010	DLN	Industrial Production: Nondurable Consumer Goods SA, 2012=100
CONSTPV[d]	0.007	DLN	Private nonresidential construction, SAAR Mil$, Chained/2009$ (constructed)
YPDHM	0.006	DLN	Disposable Personal Income SAAR, Bil. Chn. 2009$
IPB0[c]	0.006	DLN	Industrial Production: Mining SA, 2012=100
CONSTPU[d]	0.003	DLN	Public construction, SAAR Mil$, Chained/2009$ (constructed)
IPUTL[c]	0.001	DLN	Industrial Production: Electric and Gas Uitilies SA, 2012=100
Sum of Abs[b] Values	**0.383**		

[a]For a series y_t, the transformations $x_t = f(y_t)$ are: LV: $x_t = y_t$; DLV: $x_t = \Delta y_t$; LN: $x_t = \log(y_t)$; DLN: $x_t = \Delta \log(y_t)$

[b]The scaled eigenvector is constructed to sum to one in absolute value over all four categories.

[c]Data are spliced to discontinued SIC series to construct full series history.

[d]Deflated using appropriate NIPA deflators. CONSTPV = CPV - CPVR, CONSTPU = CPG.

Haver mnemonic	Scaled eigenvector	Transformation[a]	Description
Employment, unemployment, and hours			
LAPRIVA	0.024	DLN	All Employees: Private Nonfarm Payrolls SA, Thousands
LAGOODA	0.024	DLN	All Employees: Goods-Producing Industries SA, Thousands
LANAGRA	0.024	DLN	Employees on Nonfarm Payrolls SA, Thousands
LAMANUA	0.023	DLN	All Employees: Manufacturing SA, Thousands
LADURGA	0.023	DLN	All Employees: Durable Goods Manufacturing SA, Thousands
LASERPA	0.020	DLN	All Employees: Service-Producing Industries SA, Thousands
LATRDA[f]	0.019	DLN	All Employees: Retail and Wholesale Trade SA, Thousands (constructed)
LANDURA	0.019	DLN	All Employees: Nondurable Goods Manufacturing SA, Thousands
LASRVSA[d]	0.018	DLN	All Employees: Services SA, Thousands (constructed)
LHELPR[c]	0.017	DLN	Ratio: Help-Wanted Advertising/JOLTS: Job Openings to Number Unemployed SA,
NAPMEI	0.017	LV	ISM Manufacturing: PMI Employment Index
LACONSA	0.017	DLN	All Employees: Construction SA, Thousands
LR	-0.016	DLV	Civilian Unemployment Rate SA, Percent
LENA	0.016	DLN	Civilian Employment: Nonagricultural Industries SA, Thousands
LE	0.016	DLN	Civilian Employment: Sixteen Years & Over SA, Thousands
LRM25	-0.015	DLV	Civilian Unemployment Rate: Men, 25-54 Years SA, Percent
LAFIREA	0.013	DLN	All Employees: Finance, Insurance and Real Estate SA, Thousands
LHELP[c]	0.013	DLN	Index of Help-Wanted Advertising/JOLTS: Job Openings SA
LCUN	-0.012	DLN	Weekly Initial Claims For Unemployment Insurance SA, Thousands
LATPUTA[e]	0.012	DLN	All Employees: Transportation and Public Utilities SA, Thousands (constructed)
LRMANUA	0.011	DLV	Average Weekly Hours: Manufacturing SA, Hours
LOMANUA	0.009	DLV	Average Weekly Overtime Hours: Manufacturing SA, Hours
LAMINGA	0.004	DLN	All Employees: Mining SA, Thousands
LAGOVTA	0.002	DLN	All Employees: Government SA, Thousands
Sum of Abs[b] Value	**0.298**		

[a]For a series y_t, the transformations $x_t = f(y_t)$ are: LV: $x_t = y_t$; DLV: $x_t = \Delta y_t$; LN: $x_t = \log(y_t)$; DLN: $x_t = \Delta \log(y_t)$

[b]The scaled eigenvector is constructed to sum to one in absolute value over all four categories.

[c]JOLTS series (LJJTLA and LTU) spliced to help-wanted series.

[d]LASRVSA = LAINFOA + LAPBSVA + LAEDUHA + LALEIHA + LASRVOA.

[e]LATPUTA = LATTULA - LAWTRDA - LARTRDA.

[f]LATRDA = LAWTRDA + LARTRDA.

Haver mnemonic	**Scaled eigenvector**	**Transformation**[a]	**Description**
Personal consumption and housing			
HPT	0.014	LN	Housing Units Authorized by Building Permits SAAR, Thousands of Units
HST	0.014	LN	Housing Starts SAAR, Thousands of Units
HSTS	0.013	LN	Housing Starts: South SAAR, Thousands of Units
HSTW	0.013	LN	Housing Starts: West SAAR, Thousands of Units
HSTMW	0.012	LN	Housing Starts: Midwest SAAR, Thousands of Units
HSTNE	0.011	LN	Housing Starts: Northeast SAAR, Thousands of Units
CBHM	0.010	DLN	Personal Consumption Expenditures SAAR, Bil./Chained/2009$
RSH[c]	0.009	DLN	Real Retail Sales SA, Millions/Chained/2009$
RSDH[c]	0.009	DLN	Real Retail Sales: Durable Goods SA, Mil./Chained/2009$
HSM	0.009	LN	Manufacturers' Shipment of Mobile Homes SAAR, Thousands of Units
CDBHM	0.008	DLN	Personal Consumption Expenditures: Durable Goods SAAR, Bil./Chained/2009$
CSBHM	0.007	DLN	Personal Consumption Expenditures: Services SAAR, Bil./Chained/2009$
CNBHM	0.007	DLN	Personal Consumption Expenditures: Nondurable Goods SAAR, Bil./Chained/2009$
RSNH[c]	0.006	DLN	Real Retail Sales: Nondurable Goods SA, Mil./Chained/2009$
CDVHM	0.005	DLN	Personal Consumption Expenditures: Motor vehicles SAAR, Bil./Chained/2009$
Sum of Abs[b] Value	**0.148**		

[a]For a series y_t, the transformations $x_t = f(y_t)$ are: LV: $x_t = y_t$; DLV: $x_t = \Delta y_t$; LN: $x_t = \log(y_t)$; DLN: $x_t = \Delta \log(y_t)$

[b]The scaled eigenvector is constructed to sum to one in absolute value over all four categories.

[c]Data are spliced to discontinued SIC series to construct full series history.

Haver mnemonic	**Scaled eigenvector**	**Transformation**[a]	**Description**
Sales, orders and inventories			
NAPMNI	0.020	LV	ISM Manufacturing: Diffusion Index
TSTH[c]	0.019	DLN	Real Manufacturing and Trade: Sales SA, Mil./Chained/2009$
TSMH[c]	0.017	DLN	Sales: Manufacturing SA, Mil./Chained/1996$
TSMDH[c]	0.016	DLN	Sales: Manufacturing: Durable Goods SA, Mil./Chained/2009$
TSWDH[c]	0.016	DLN	Sales: Wholesale: Durable Goods SA, Mil./Chained/2009$
MOCGMC	0.016	DLN	Real Man. New Orders: Consumer Goods & Materials SA, Mil./Chained 1982$
TRMH[c]	-0.015	DLV	Inventory/Sales Ratio: Manufacturing SA, Chained/2009$
TRTH[c]	-0.015	DLV	Real Manufacturing & Trade: Inventory/Sales Ration SA, Chained/2009$
TSWH[c]	0.013	DLN	Sales: Merchant Wholesalers SA, Mil./Chained/2009$
NAPMVDI	0.012	LV	ISM Manufacturing: Suppliers Deliveries Index
MDOQ	0.012	DLN	Real Manufacturers' New Orders: Durable Goods Industries, Bil./Chained/2009$
NAPMII	0.011	LV	ISM Manufacturing: Inventories Index
TSMNH[c]	0.011	DLN	Sales: Manufacturing: Nondurable Goods SA, Mil./Chained/2009$
TIRH[c]	0.011	DLN	Inventories: Retail Trade EOP, SA, Mil./Chained/2009$
TITH[c]	0.010	DLN	Real Manufacturing & Trade Inventories EOP, SA, Mil./Chained/2009$
TRWH[c]	-0.010	DLV	Inventory/Sales Ratio: Merchant Wholesalers SA, Chained/2009$
TSWNH[c]	0.006	DLN	Sales: Wholesale: Nondurable Goods SA, Chained/2009$
TIWH[c]	0.005	DLN	Inventories: Merchant Wholesalers EOP, SA, Mil./Chained/2009$
MOCNC	0.005	DLN	Real Man. New Orders: Nondef. Capital Goods Industries SA, Mil./Chained/1982$
TIMH[c]	0.005	DLN	Inventories: Manufacturing EOP, SA, Mil./Chained/2009$
TIMDH[c]	0.004	DLN	Inventories: Manufacturing: Durable Goods EOP, SA, Mil./Chained/2009$
TIMNH[c]	0.004	DLN	Inventories: Manufacturing: Nondurable Goods EOP, SA, Mil./Chained/2009$
TRRH[c]	-0.002	DLV	Inventory/Sales Ratio: Retail Trade SA, Chained/2009$
Sum of Abs[b] Value	**0.171**		

[a]For a series y_t, the transformations $x_t = f(y_t)$ are: LV: $x_t = y_t$; DLV: $x_t = \Delta y_t$; LN: $x_t = \log(y_t)$; DLN: $x_t = \Delta \log(y_t)$

[b]The scaled eigenvector is constructed to sum to one in absolute value over all four categories.

[c]Data are spliced to discontinued SIC series to construct full series history.

Table 4: Increasing inflation episodes as defined by dating procedure, before 2009 NIPA revisions

	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%
$\Delta\pi > 0.75$	Jan-68	Feb-68	Jun-73	Sep-73	Apr-77	May-78	Oct-87	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%
$\Delta\pi < -0.75$	Oct-71	Mar-71	May-75	May-75	Mar-81	Jul-80	Jun-91	Jul-91
$\Delta\pi$(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
CPI means Consumer Price Index. PCE means Personal Consumption Expenditures Price Index. NIPA means *National Income and Product Accounts of the United States.*								

Table 5: Increasing inflation episodes as defined by dating procedure, after 2009 NIPA revisions

	Episode I		Episode II		Episode III		Episode IV	
	PCE	CPI	PCE	CPI	PCE	CPI	PCE	CPI
Min date	Jun-67	Jul-67	Jan-73	Jan-73	Dec-76	Oct-77	Feb-86	Feb-87
Min π	2.89%	3.27%	2.69%	2.53%	5.84%	5.98%	3.54%	3.57%
$\Delta\pi > 0.75$	Feb-68	Feb-68	May-73	Sep-73	Jun-77	May-78	May-88	Mar-88
Max date	Jul-71	Nov-70	Feb-75	Feb-75	Nov-80	Jun-80	Aug-90	Feb-91
Max π	5.07%	6.63%	10.23%	11.86%	9.74%	13.60%	4.66%	5.64%
$\Delta\pi < -0.75$	Oct-71	Mar-71	May-75	May-75	Jun-81	Jul-80	Apr-91	Jul-91
$\Delta\pi$(Max-Min)	2.18%	3.36%	7.54%	9.33%	3.90%	7.62%	1.12%	2.07%
	Start	End	Start	End	Start	End	Start	End
Episode dates	Feb-68	Oct-71	May-73	May-75	Jun-77	Jun-81	Mar-88	Jul-91
CPI means Consumer Price Index. PCE means Personal Consumption Expenditures Price Index. NIPA means *National Income and Product Accounts of the United States.*								
Note: Dates and values in red indicate changes from Table 4.								

Table 6: Increasing inflation episodes over full history

	Episode I		Episode II		Episode III		Episode IV		Episode V	
	PCE	CPI	PCE	CPI	PCE	CPI	PCE	CPI	PCE	CPI
Min date	Jun-67	Jul-67	Jan-73	Jan-73	Dec-76	Oct-77	Feb-86	Feb-87	Jun-2003	Dec-2003
Min π	2.89%	3.27%	2.69%	2.53%	5.84%	5.98%	3.54%	3.57%	1.45%	1.09%
$\Delta\pi > 0.75$	Feb-68	Feb-68	May-73	Sep-73	Jun-77	May-78	May-88	Mar-88	Jun-04	Jun-04
Max date	Jul-71	Nov-70	Feb-75	Feb-75	Nov-80	Jun-80	Aug-90	Feb-91	Aug-08	Sep-06
Max π	5.07%	6.63%	10.23%	11.86%	9.74%	13.60%	4.66%	5.64%	2.65%	2.93%
$\Delta\pi < -0.75$	Oct-71	Mar-71	May-75	May-75	Jun-81	Jul-80	Apr-91	Jul-91	Dec-08	Jun-07
$\Delta\pi$(Max-Min)	2.18%	3.36%	7.54%	9.33%	3.90%	7.62%	1.12%	2.07%	1.20%	1.84%
	Start	End	Start	End	Start	End	Start	End	Start	End
Episode dates	Feb-68	Oct-71	May-73	May-75	Jun-77	Jun-81	Mar-88	Jul-91	Jun-04	Dec-08
CPI means Consumer Price Index. PCE means Personal Consumption Expenditures Price Index.										

Figure 1: Chicago Fed National Activity Index (CFNAI)

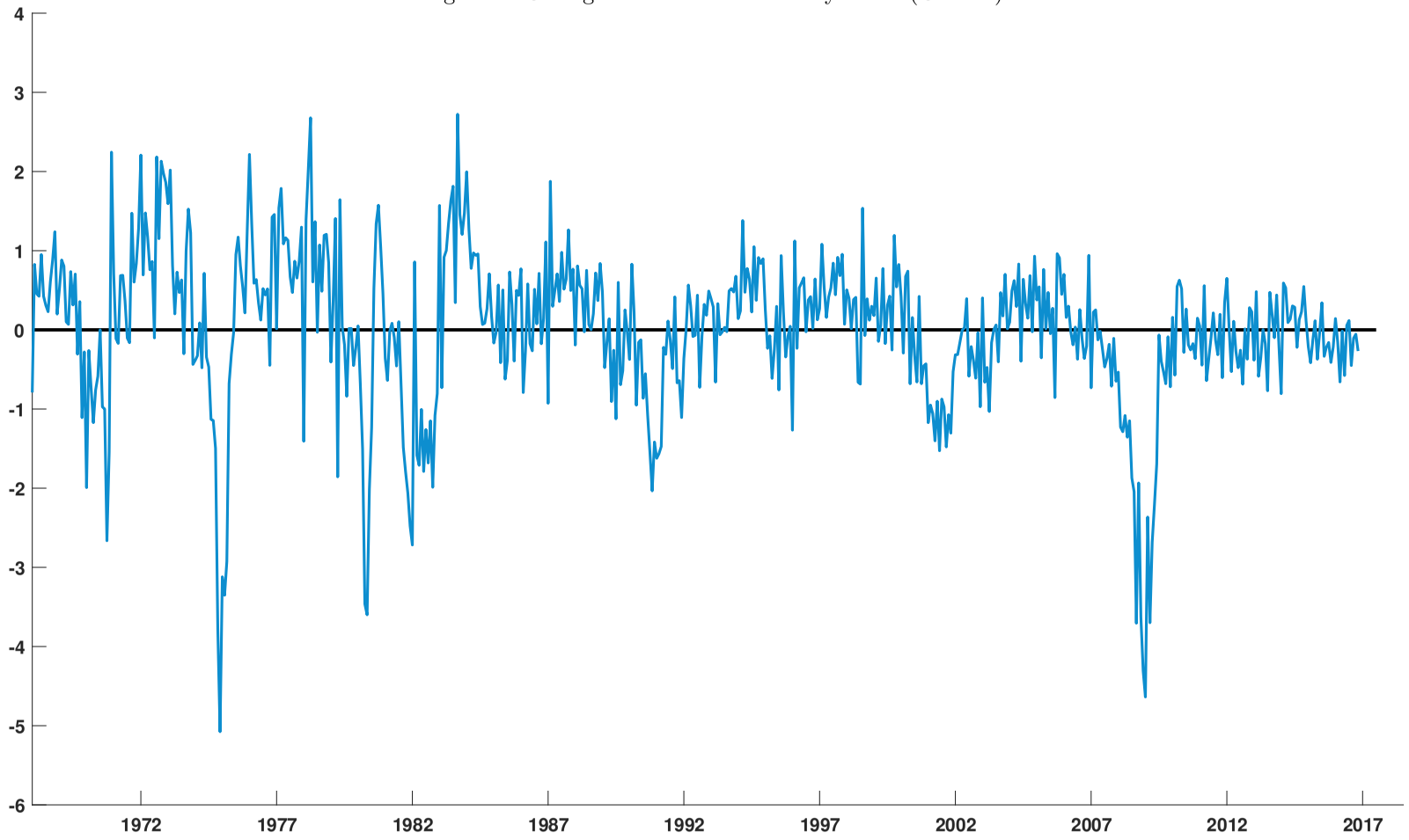
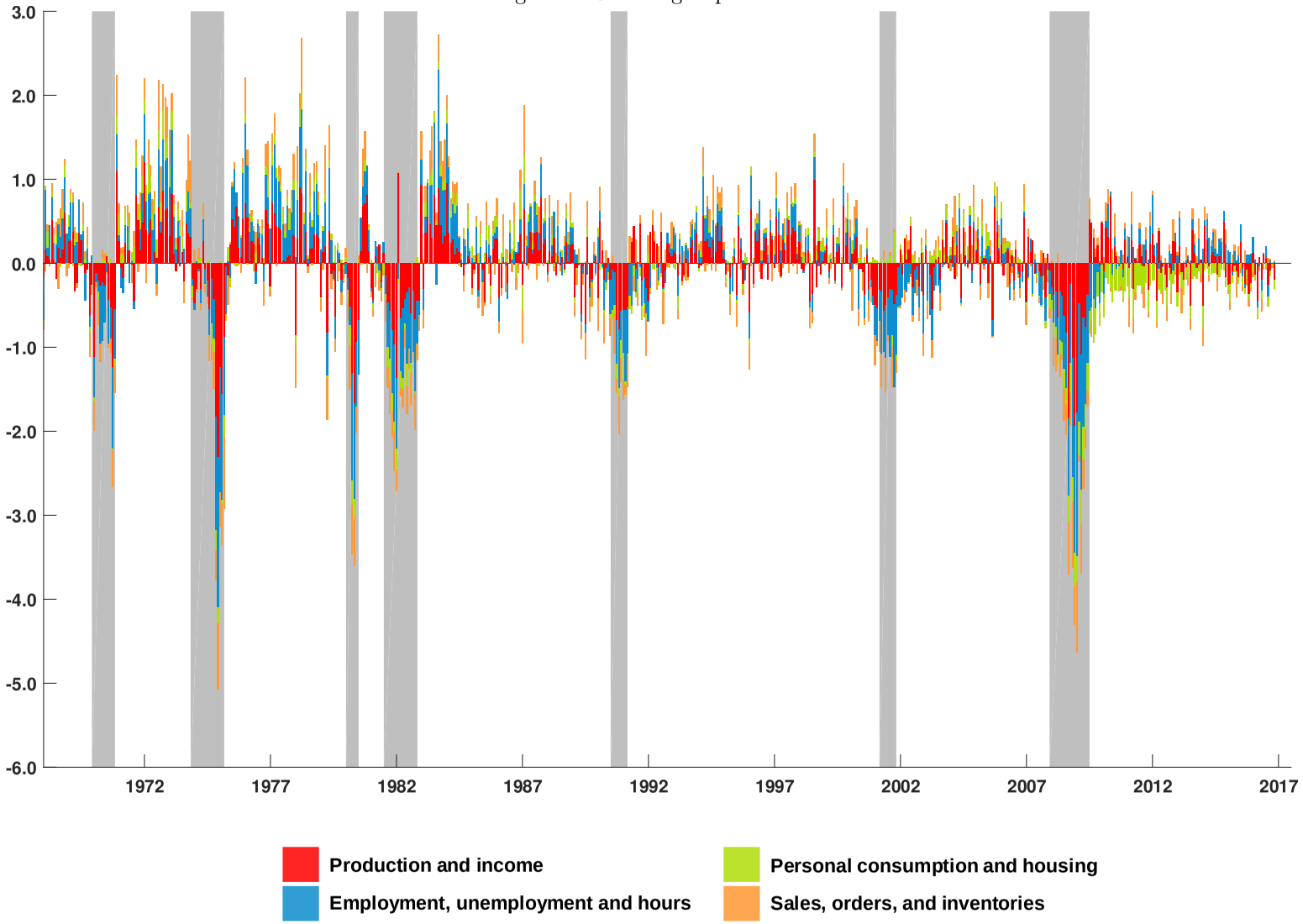
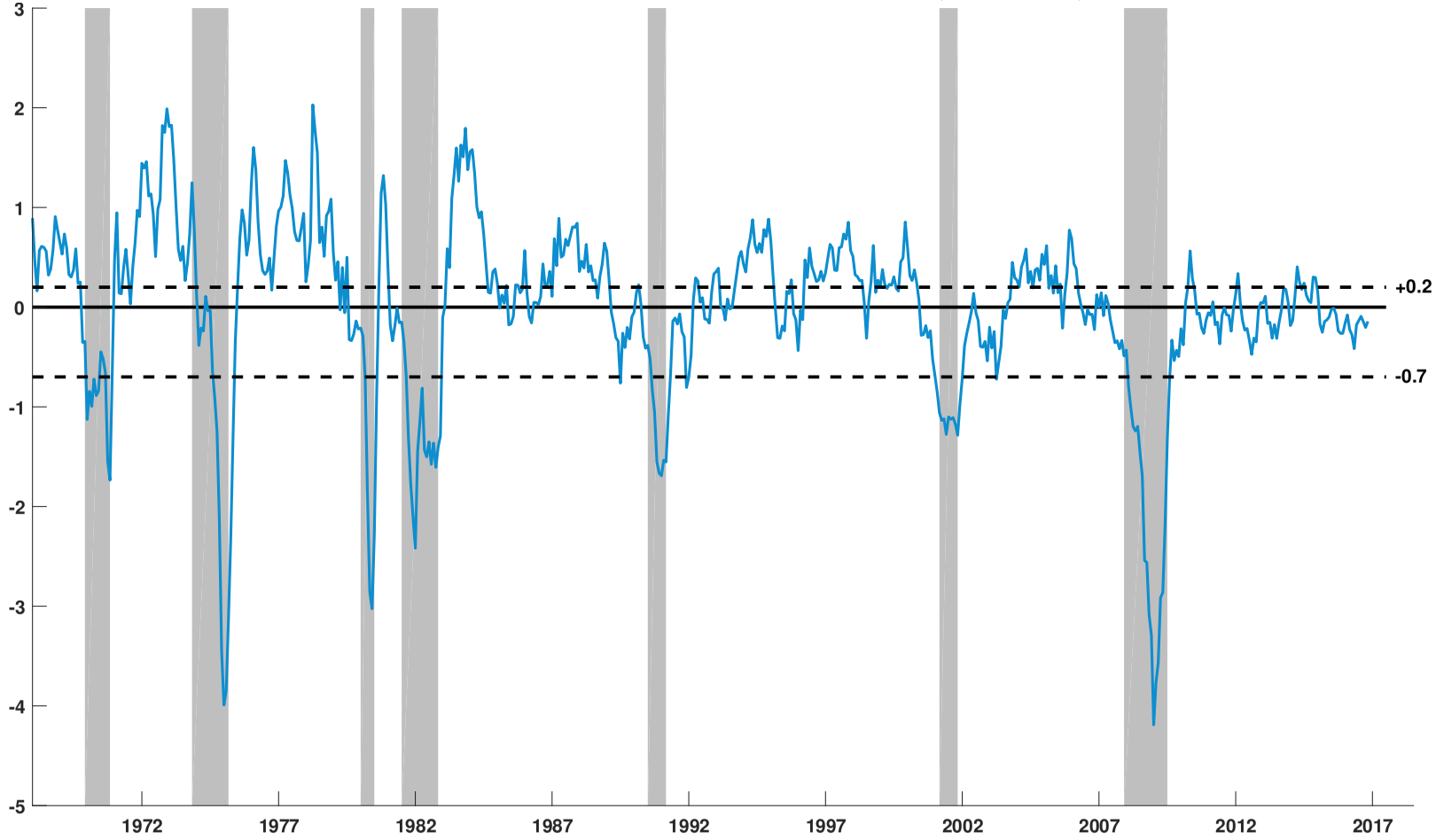


Figure 2: CFNAI group contributions



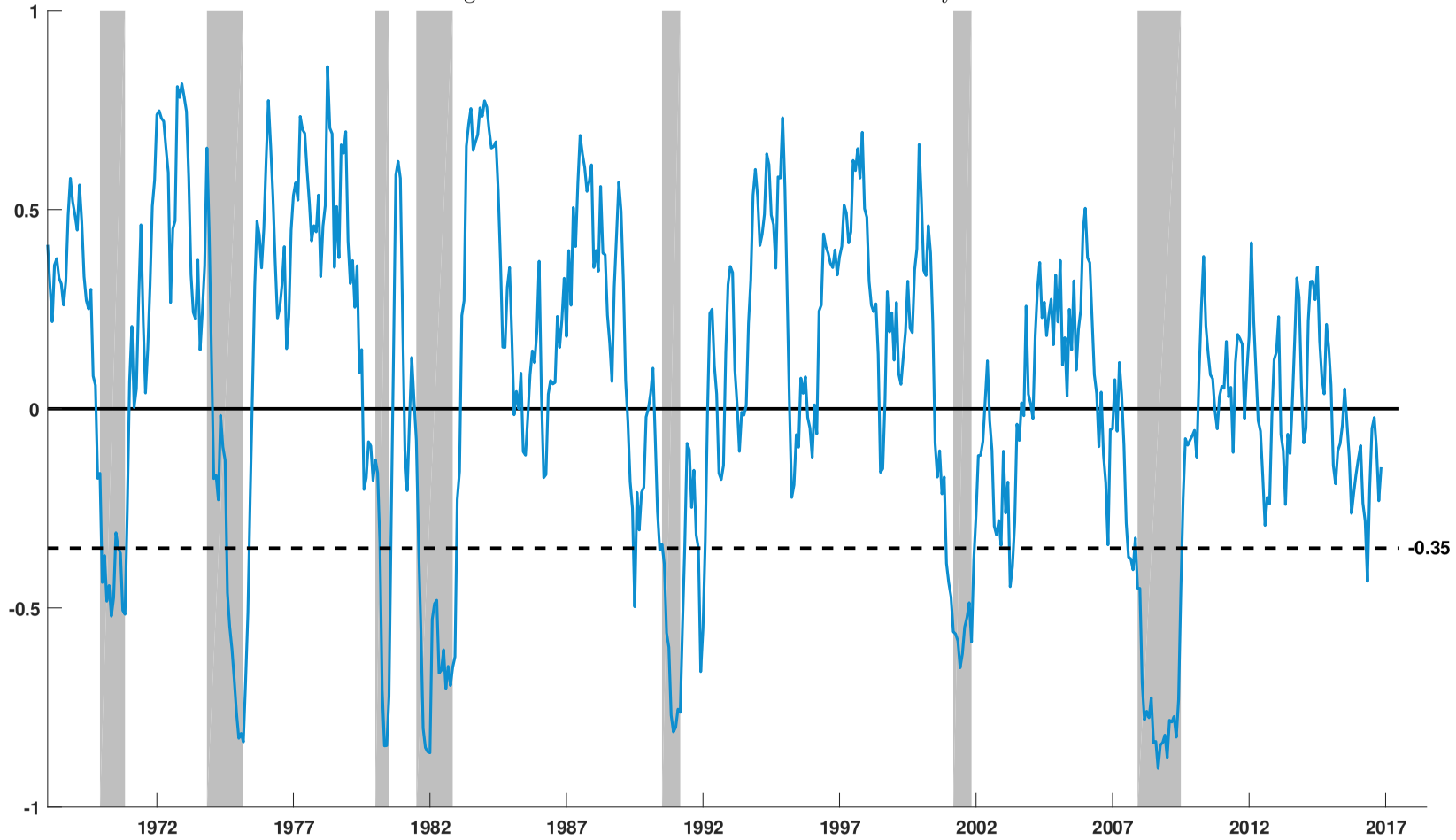
Note: Shading indicates official periods of recession as identifed by the National Bureau of Economic Research.

Figure 3: Chicago Fed National Activity Index three-month moving average (CFNAI-MA3) and business cycles



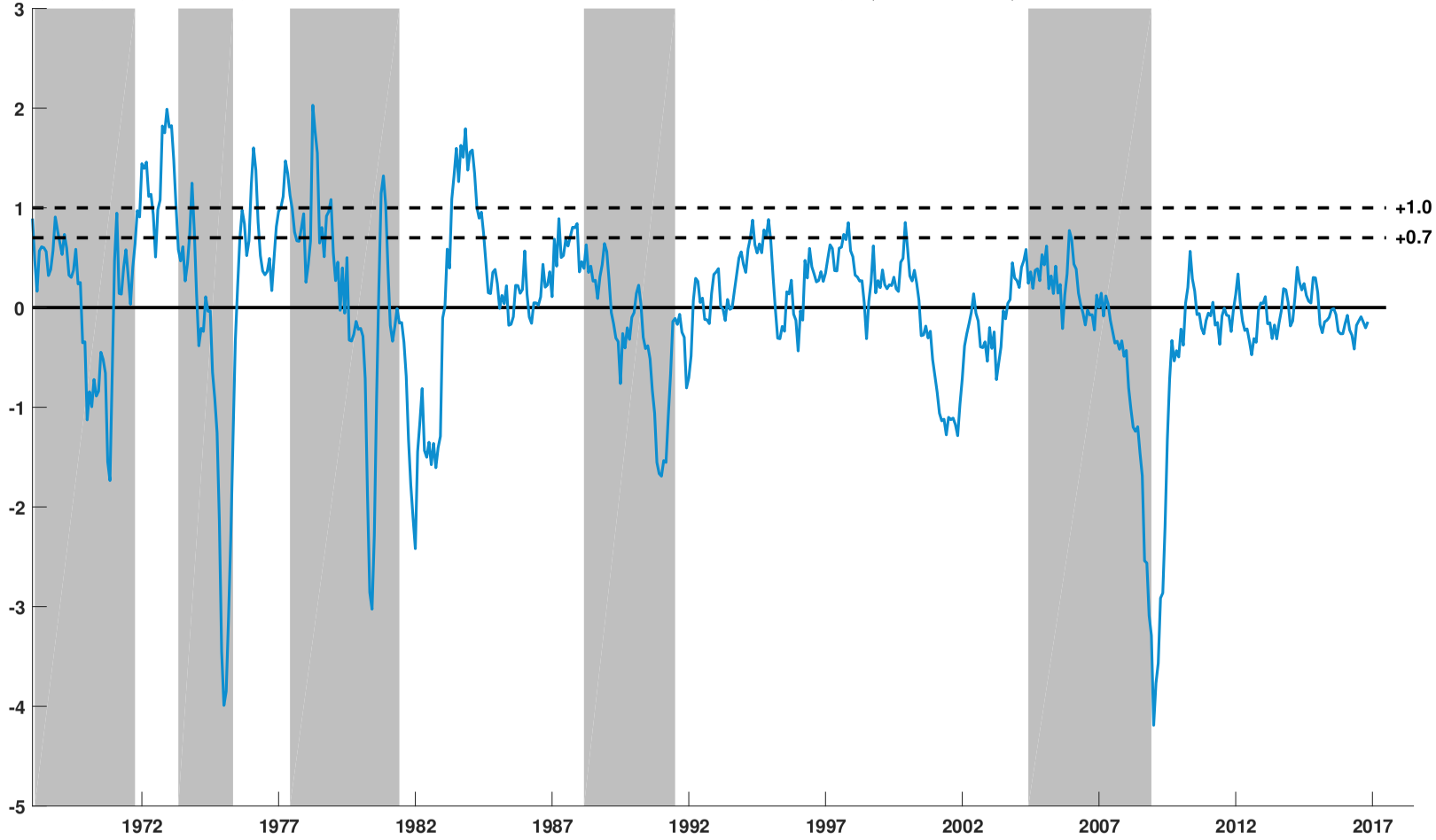
Notes: Shading indicates official periods of recession as identified by the National Bureau of Economic Research. Following a period of economic expansion, an increasing likelihood of a recession has historically been associated with a CFNAI-MA3 value below 0.70. Conversely, following a period of economic contraction, an increasing likelihood of an expansion has historically been associated with a CFNAI-MA3 value above 0.70 and a significant likelihood of an expansion has historically been associated with a CFNAI-MA3 value above +0.20.

Figure 4: CFNAI Diffusion Index and business cycles



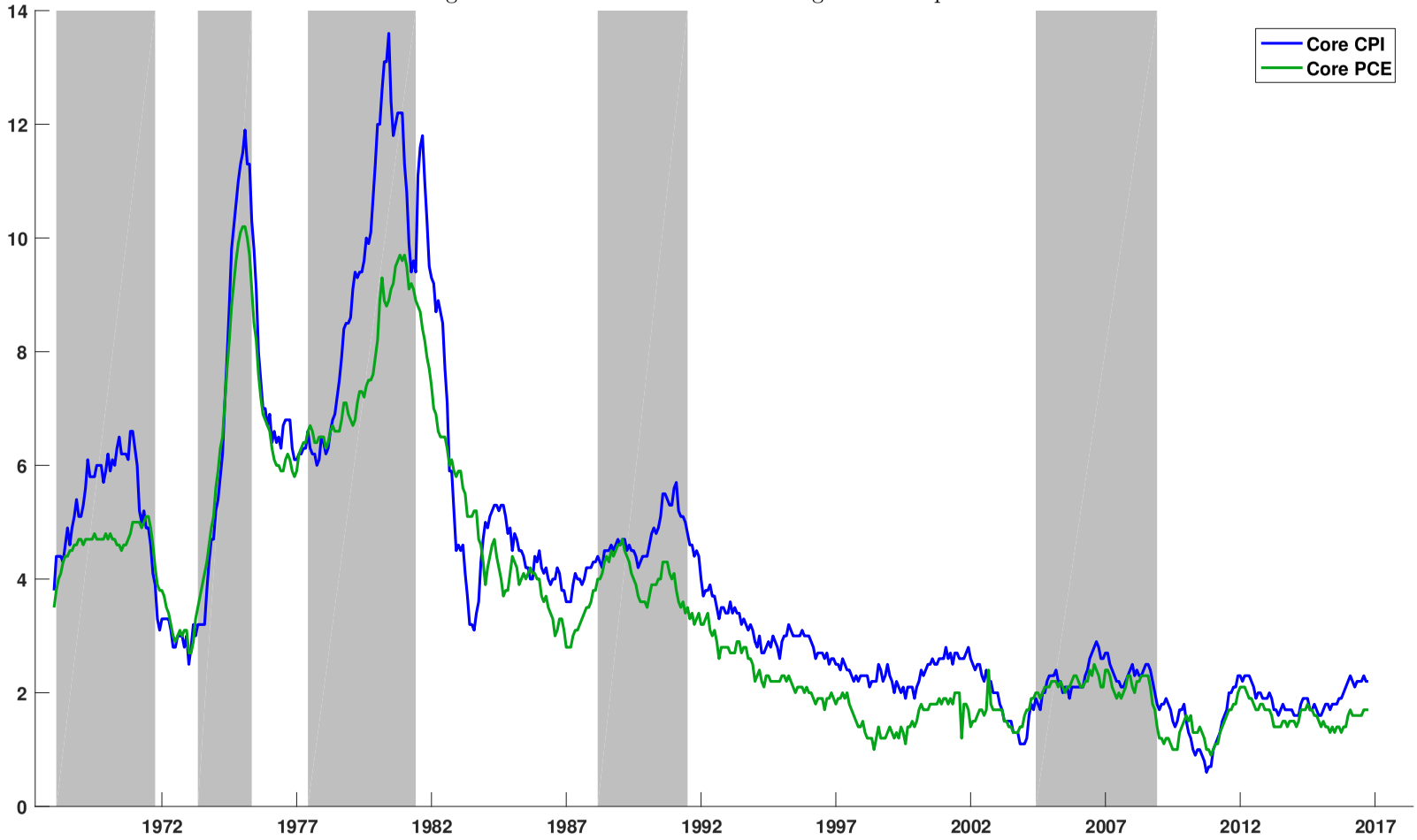
Notes: Shading indicates official periods of recession as identified by the National Bureau of Economic Research. The CFNAI Diffusion Index represents the three-month moving average of the sum of the absolute values of the weights for the underlying indicators whose contribution to the CFNAI is positive in a given month less the sum of the absolute values of the weights for those indicators whose contribution is negative or neutral in a given month. Periods of economic expansion have historically been associated with values of the CFNAI Diffusion Index above 0.35.

Figure 5: Chicago Fed National Activity Index three-month moving average (CFNAI-MA3) and increasing inflation episodes



Notes: Shading represents periods of sustained increasing inflation. An increasing likelihood of a period of sustained increasing inflation has historically been associated with values of the CFNAI-MA3 above +0.70 more than two years into an economic expansion. Similarly, a substantial likelihood of a period of sustained increasing inflation has historically been associated with values of the CFNAI-MA3 above +1.00 more than two years into an economic expansion.

Figure 6: Core inflation and increasing inflation episodes



Notes: Core CPI means Consumer Price Index minus food and energy prices. Core PCE means Personal Consumption Expenditures Price Index minus food and energy prices.