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Inflation Expectations and the Stabilization of Inflation: Alternative Hypotheses

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Abstract

This paper examines two candidate hypotheses explaining the stabilization of U.S. inflation since the 1970s and 1980s. The first explanation credits the stabilization of inflation expectations, and assumes those expectations have a strong positive causal effect on actual subsequent inflation, while the second explanation credits the disappearance of such a strong positive causal effect. The paper reports statistical tests favorable to both a stabilization of inflation expectations and a marked decline in the effect of the general public's inflation expectations on subsequent inflation.

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Conversations with many of my colleagues at the Federal Reserve Board motivated the paper and facilitated many of its ideas. However, the views expressed in the paper are those of the author alone and do not necessarily reflect the views of the Board of Governors of the Federal Reserve System or the rest of its staff.

1 Introduction

A large and growing statistical literature documents the stabilization of the time series process governing U.S. inflation in recent decades. In particular, the variance and persistence of innovations to the process have both declined considerably since the 1970s and 1980s.[1] This stabilization has important implications for inflation forecasting and quantitative risk assessments, so understanding the conditions under which it is likely to continue is critical. To that end, this paper examines two candidate explanations for the stabilization of inflation, both related to changes in the relationship between inflation and inflation expectations.

The first explanation is the current conventional wisdom, which associates the stabilization of inflation with the stabilization of inflation expectations.[2] Movements in inflation have a smaller effect on inflation expectations than in the 1970s and 1980s, perhaps due to the commitment of the central bank to price stability. In an expectations-augmented Phillips curve or a New Keynesian Phillips curve, movements in inflation expectations have a one-for-one or close to one-for-one effect on actual inflation. This first explanation assumes that implication of those models is correct, so the decline in the effect of lagged inflation on inflation expectations results in a decline in the variance and persistence of inflation itself.

While none of the inflation expectations measures examined here ever appear to have been completely anchored—they have all continued to respond to inflation to some extent, the statistical evidence documented here does suggest greater anchoring than in the 1970s and 1980s when inflation was more variable and persistent. However, it does not necessarily

[1] Examples include Stock and Watson (2007), Cogley, Primiceri and Sargent (2010), Mertens (2011), Clark and Doh (2014), and Nalewaik (2015). For a review of the literature on inflation forecasting, see Faust and Wright (2013).

[2] See Bernanke (2010), Ball and Mazumder (2011), Kiley (2015), Yellen (2015), Binder (2015), Coibion and Gorodnichenko (2015) and Blanchard (2016) for recent discussions.

follow that the greater anchoring explains the decline in inflation variability and persistence. In particular, this explanation relies critically on the positive causal effect of inflation expectations on subsequent actual inflation. The available data in the 1970s and 1980s are consistent with that assumption: movements in inflation expectations strongly predict movements in subsequent inflation with coefficients not far from one. Correlation does not imply causation, but the results are consistent with a positive causal effect, at least. However, at some point in the 1990s, all the measures of inflation expectations examined here became either virtually uncorrelated with subsequent inflation or *negatively correlated with* subsequent inflation. Such lack of positive (and often negative) correlation probably does imply lack of positive causation, so the disappearance of a one-for-one causal effect of inflation expectations on subsequent inflation is the second explanation for the decline in the variance and persistence of inflation since the 1970s and 1980s.[3] When examining the inflation expectations of the general public, as reflected in University of Michigan Surveys of Consumers, this explanation receives very strong empirical support from the data.

Section 2 discusses the expectations-augmented Phillips curve, the basic framework underlying the empirical analysis, and specifies the two candidate explanations for the stabilization of inflation. Section 3 discusses the data, briefly reviews the changes in the behavior of inflation, and discusses which measures of inflation expectations are likely to have a causal effect on subsequent inflation. Section 4 first describes the statistical tests of the two candidate hypotheses—from Andrews (1993), Andrews and Ploberger (1994), and Andrews, Lee and Ploberger (1996)—and then reports results largely favorable to both. Section 5 discusses potential reasons why the causal effect of inflation expectations on subsequent inflation may

[3]This explanation has received less attention in the literature. The most thorough previous treatment is in Akerlof, Dickens, and Perry (2000).

have changed in the 1990s.[4] Section 6 concludes with a reminder that it could change back, and discusses the conditions that might bring about an end to the current regime of stable inflation.

2 Basic Framework for Analysis

The empirical analysis below is based on the expectations-augmented Phillips curve of Phelps (1967) and Friedman (1968). In this equation, inflation π_t is driven by labor market slack X_t and by expected inflation $E_{t-1}(\pi_t)$, with expected inflation having a causal (and one-for-one) effect on actual inflation:

$$\pi_t = \kappa X_t + E_{t-1}(\pi_t)\,. \tag{1}$$

The New Keynesian Phillips curve $\pi_t = \kappa X_t + \beta E_t(\pi_{t+1})$ provides a similar baseline equation—see Woodford (2003). However, endogeneity is a concern in estimating the New Keynesian Phillips curve: since the expectations term is not lagged, the degree to which inflation is driving inflation expectations rather than the reverse is, at a minimum, not clear.

The first potential explanation for the decline in inflation variability and persistence in recent decades is the current conventional wisdom, which we will call the "expectations anchoring" hypothesis. In early estimates of the expectations-augmented Phillips curve, when inflation was highly variable and persistent, expectations were assumed to be adaptive, set according to a distributed lag of current and past inflation:

$$E_{t-1}(\pi_t) = \beta(L)\,\pi_t. \tag{2}$$

[4] Section 5 also includes a brief discussion of the behavior of Japanese inflation since 1990.

In an "accelerationist Phillips curve," widely viewed as a reasonably accurate model of the inflation process in the 1970s and 1980s, the sum of the βs is one. The "expectations anchoring" hypothesis posits a break in the βs, with their sum declining markedly in recent decades, so a change in inflation moves inflation expectations much less than in the past. A credible commitment of the central bank to price stability is one mechanism that could generate such an outcome, which results in a decline in the variance and persistence of inflation expectations and, through the expectations-augmented Phillips curve (1), a decline in the variance and persistence of inflation itself.

Writing at a time when data sources on inflation expectations were few and far between, when conventional wisdom posited a long-run tradeoff between inflation and unemployment, and when inflation in the United States was just beginning a long and persistent rise, Phelps (1967) and Friedman (1968) proposed a model (1) that proved a remarkably accurate description of the inflation process over the quarter century that followed, a truly amazing record of out-of-sample forecast accuracy. And while inflation expectations surely will continue to drive the behavior of inflation in environments where inflation is high and variable, expectations may not be as important in environments where inflation has been low and stable for some time. This leads to the second potential explanation for the decline in inflation variability and persistence in recent decades, what we will call the "expectations causality break" hypothesis. This hypothesis relaxes the assumption that inflation expectations have a one-for-one causal effect on actual inflation; section 5 circles back later to discuss further potential theoretical justifications for this. Instead of (1), the framework for analysis becomes:

$$\pi_t = \alpha + \kappa X_t + \theta \, \mathrm{E}_{t-1}(\pi_t) + u_t. \tag{3}$$

This "expectations causality break" hypothesis posits a break in the parameter θ governing the effect of inflation expectations on actual inflation, with θ declining markedly in recent decades. The break results in a decline in the variance of inflation and its persistence as well if the sum of the βs in (2) is positive.

In addition to (3), the paper tests for breaks in the explanatory power of inflation expectations for inflation using traditional statistical regression techniques. First, the paper examines:

$$\pi_t = \alpha + \theta \, \mathrm{E}_{t-1} (\pi_t) + u_t. \tag{4}$$

Equation (4) is the framework for tests of forecast efficiency ($\alpha = 0$ and $\theta = 1$), a concept dating back at least as far as Mincer and Zarnowitz (1969). Second, the paper tests whether inflation expectations "Granger cause" inflation in a one lag framework, testing whether $\theta \neq 0$ in:

$$\pi_t = \alpha + \rho \pi_{t-1} + \theta \, \mathrm{E}_{t-1} (\pi_t) + u_t. \tag{5}$$

The usual caveats about Granger causality apply, and raise a broader point: an estimate of $\theta \approx 1$ in (3), (4), or (5) does not imply or prove the causality of inflation expectations, because those expectations may simply passively reflect predictable variation in future inflation caused by other factors.[5] Such an estimate would be consistent with the causality assumption of the expectations-augmented Phillips curve, though.

[5]Such an interpretation is more plausible when the expectations are those of professional forecasters, who are presumably most likely to discover predictable variation in future inflation and incorporate it into their forecasts.

3 Data and Stylized Facts to Explain

3.1 Inflation

Figures 1 and 2 show quarterly year-over-year inflation measures, illustrating the main stylized fact the paper seeks to explain—the dramatic reduction in inflation variability that took hold at some point in the 1990s. Figure 1 shows total inflation measures—the headline CPI, the total PCE price index, and the GDP price index, while figure 2 shows the core CPI and core PCE price index which both exclude volatile food and energy prices. The inset boxes show standard deviations of the overlapping four-quarter percent changes from two samples, the first from 1973 to 1995 and the second from 1996 to 2015. While severe recessions and very large relative energy price movements occur in each of these two samples, the standard deviation of the total inflation measures is about three or four times smaller in the second sample than in the first.

The inset box in figure 2 shows the decline in the variability of core inflation from the first to the second sample is even more dramatic, with the standard deviations falling by a factor of six. The levels of the standard deviations in the second sample, a half percentage point or less, are remarkably low. These are sample standard deviations, and in most recent research such as Stock and Watson (2007), Cogley, Primiceri and Sargent (2010), Mertens (2011), and Clark and Doh (2014), the population standard deviation of inflation is infinite since it is assumed to have had a non-stationary component over its entire history. That is not necessarily the case in the model of Nalewaik (2015), however, since inflation is stationary in some states of the world, and spells of non-stationarity are finite in length.

In one way or another, all of the above papers find that the persistence of the inflation process declined along with its variance over the past couple of decades, so an innovation to the inflation process has less of an effect on subsequent inflation than in the 1970s and 1980s. The relative stability of inflation around its mean since the mid-1990s illustrates this stylized fact, which is important for inflation forecasting among other things. Section 4.2 provides further evidence documenting declines in the persistence and predictability of the inflation measures shown in Figures 1-2.

It is odd that comparatively little research has been devoted into studying the cause of the decline in inflation variability, since it is much larger than the decline in real activity variability from the mid-1980s to mid-2000s that prompted much research and was named the "Great Moderation." Perhaps this stems from widespread agreement that the stabilization of inflation expectations offers a plausible explanation for the stabilization of inflation.

3.2 Inflation Expectations

Figures 3 and 4 show the measures of inflation expectations studied in the paper. Figure 3 shows the median expected price change over the next year and next five-to-ten years from the University of Michigan Surveys of Consumers. These surveys are representative samples of the population of households conducted monthly, and thus represent the inflation expectations of the general public. The data shown are quarterly averages of the monthly survey results.[6] Next year (short-term) inflation expectations are available in each period from 1978 to present; five-to-ten year (long term) inflation expectations extend back as far as 1975, although the time series has numerous gaps prior to 1990Q2.[7] All available observations are employed in the regression results below to maximize statistical power, with corrections

[6]The Michigan survey does not specify the basket of goods when asking about expected price changes, and answers are reported as integers, so non-integer values are the result of sample weighting and interpolation.

[7]Each quarter with one non-missing monthly survey reading is included in the quarterly time series. Quarterly observations from 1975-1980 and 1986-1987 use only one monthly survey reading.

for missing values made to autocorrelation estimates.

Figure 4 plots the long-term Michigan measure with two other measures of long-term inflation expectations, median ten-year expected CPI inflation from the Survey of Professional Forecasters (SPF) conducted by the Federal Reserve Bank of Philadelphia, and inflation compensation over the five year period starting five years ahead computed using differences between nominal and inflation indexed (TIPS) government bond yields.[8] The sample of TIPS yields is relatively short, extending back to only 2003, while the SPF forecasts extend back to the early 1980s, but again with gaps in the sample.[9] Figure 4a shows the last four years of data on these long-term expectations measures, along with a series of mean expected increases in unit costs over the next five to ten years from the Federal Reserve Bank of Atlanta's Survey of Business Inflation Expectations.

3.3 What Measure of Inflation Expectations?

Key questions for the expectations-augmented Phillips curve (1) or the New Keynesian Phillips curve are: whose inflation expectations have a causal effect on actual inflation, over what time horizon, and why? In most economic models, firms set prices of goods and services in real terms, and since deviations from the optimal real price are costly to the firm, firms take into account expected aggregate price inflation in their pricing decisions. So the inflation expectations of the individuals setting prices of goods and services (i.e. "price setters") should drive actual inflation, according to these theories.

[8]Payouts to holders of Treasury Inflation-Protected Securities (TIPS) are indexed to the headline CPI. The SPF has forecasts of 10 year PCE price inflation as well as CPI inflation, but the length of the PCE time series is shorter, motivating the focus on the CPI.

[9]The SPF data are supplemented with data from other surveys of professional forecasters described on the Federal Reserve Bank of Philadelphia website, from which the data were downloaded.

Unfortunately, long time series on the inflation expectations of price setters are not available. What is available, broadly speaking, are the inflation expectations of the general public (from the Michigan survey), the inflation expectations of professional forecasters (typically economists), and, more recently, measures of inflation compensation derived from financial instruments whose payouts are linked to inflation. Based on several a priori considerations, the inflation expectations of the general public appear much more likely than the other candidate series to have a causal effect on actual inflation.

First, the available survey evidence suggests price setters rarely look at aggregate inflation forecasts: see Blinder et al (1998), who report that 80 percent of wholesalers and retailers never look at aggregate inflation forecasts when setting prices. This result challenges the theory on a more fundamental level, but, at a minimum, suggests that the views of professional forecasters were not important in forming the inflation expectations of price setters at that time. Second, the Federal Reserve Bank of Atlanta's Survey of Business Inflation Expectations does provide a short time series of the long-term inflation expectations of price setters, and figure 4a shows that its level lines up better with Michigan long-term inflation expectations than with the SPF or TIPS series.[10] Third, interpreting the theory more broadly, causal effects of inflation expectations on actual inflation are likely facilitated by various institutional mechanisms that arise to cope with price inflation. Many such mechanisms arise in environments of extremely high inflation like Argentina in the 1980s. One such key mechanism is indexation of wage growth to price inflation, and section 4 below examines this channel directly with Phillips curves explaining wage growth Δw_t:

$$\Delta w_t = \alpha + \kappa X_t + \theta \, \mathrm{E}_{t-1}(\pi_t) + u_t. \tag{6}$$

[10]This result is not particularly robust to the choice of long-term SPF or TIPS time series.

The expectations and desire of workers in the general public that their wages keep up with price inflation is surely a key driving force behind indexation.[11] Fourth, the expectations of the general public might matter directly for price setting, since price setters are more likely to be able to raise prices by 10 percent if their customers in the general public expect prices to rise by 10 percent.

Regarding the relevant time horizon, the theory speaks quite clearly: it is short-term inflation expectations that should matter, not long-term expectations.[12] For this reason, section 4 focuses initially on short-term inflation expectations from the University of Michigan surveys.[13] However, since the late 1990s, long-term inflation expectations appear much more stable than short-term inflation expectations, as can be seen in Figure 3, prompting conjecture that it is the stabilization of long-term inflation expectations that is responsible for the stabilization of inflation. In part for that reason, the Federal Reserve has focused much attention on long-term expectations in recent years; see, for example, the February 2015 Monetary Policy Report sent by the Board of Governors of the Federal Reserve System to the U.S. Congress. For that reason, section 4 also reports results from specifications using the long-term Michigan expectations measure as well as the other long-term measures shown

[11]See also Bewley's discussion of Akerlof, Dickens, and Perry (2000), which covers some institutional aspects of wage setting that might reflect the inflation expectations of the general public.

[12]The precise definition of the short term likely depends on the level of inflation, but in environments where institutional mechanisms like annual wage bargaining are important, a one-year horizon would seem to fit the theory best. Feedback of inflation expectations to inflation at quarterly, monthly or higher frequencies seems less plausible except in environments of very high inflation.

[13]The points above suggesting that the inflation expectations of the general public, not professional forecasters or bond traders, are most likely to have a causal effect on actual inflation are clearer when focusing on short-term inflation expectations. For example, it seems very unlikely that professional forecasters' short-term inflation forecasts actually cause those inflation outcomes to occur over the next quarter or year. It is much more likely that any positive correlation between the forecasts and realizations simply reflects short-term predictability in the inflation process known to the forecasters.

in Figure 4.

3.4 Slack and Wage Growth

The measure of slack used in the paper is the difference between the quarterly unemployment rate and estimates of the natural rate of unemployment available from the Congressional Budget Office (CBO) in March 2016. The wage growth measure used in (6) is compensation per hour in the non-farm business sector. Compensation per hour (CPH) is the only well-known, publicly available wage growth measure that is benchmarked to administrative tax records; others, like average hourly earnings and the employment cost index, are not. Unfortunately, irregular payments like bonuses add considerable volatility to compensation per hour, volatility that obscures the trend in its four-quarter percent changes over the economic expansion starting in 2009. The dashed line in Figure 7 shows this, but smoothing the data further into annual average growth rates shows a slow steady acceleration in compensation per hour over the expansion, with annual growth stepping up from 1 percent in 2009 to a 2 percent average pace from 2010-2013 and then to 2.8 percent in both 2014 and 2015.[14] The bar chart in the inset box illustrates this steady acceleration.[15]

[14]The 2015 CPH wage and salary estimates are still preliminary and subject to revision, as are the supplements to wages and salaries in prior years.

[15]The pause in this acceleration in 2013 was largely due to a pull forward of compensation into 2012 ahead of tax increases that took effect in 2013. For this reason, averaging 2012 and 2013 together gives a cleaner estimate of the underlying trend.

4 Empirical Results

4.1 Results Using Short-Term Expectations

A number of facts are consistent with the "expectations anchoring" hypothesis, including the decline in the variance of short-term Michigan inflation expectations from 2.2 percent from 1978-1995 to 0.5 percent from 1996-2015, similar in magnitude to the declines in the variances of actual inflation shown in Figures 1-2. However, Figure 5 plots short-term Michigan inflation expectations with contemporaneous year-over-year CPI inflation, and it is visually evident that short-term expectations continue to respond to current and lagged inflation. Letting t index quarters, Table 1 shows tests for breaks in the βs in the following parsimonious generalization of (2):

$$E_t^{MICH}(\pi_{t+4,t}) = \alpha + \rho E_{t-4}^{MICH}(\pi_{t,t-4}) + \beta \pi_{t-1,t-5} + u_t.$$

Here $E_t^{MICH}(\pi_{t+4,t})$ denotes the time t Michigan survey median expected price change over the next year, a function of its own value a year ago and inflation over the year through the previous quarter. The specification lags year-over-year inflation by a quarter to reduce endogeneity concerns, but this is not central to the results in Table 1; neither is the simplicity of the lag structure nor controlling for lagged expectations.

For each of the five price inflation measures shown in Figures 1-2 as well as compensation-per-hour growth, the table reports results breaking the 1979Q1 to 2015Q4 sample into two subsamples, with the break point chosen to maximize the adjusted R^2 of the specification over the full sample within a range of break points between 1988Q1 and 2006Q3, the middle

50 percent of the sample.[16] The first two rows of bolded results in each panel report regression point estimates from each subsample, with the subsample adjusted R^2 reported to the right and Newey-West (1987) standard errors computed using eight lags reported below in parentheses.[17] For fixed samples, inferences based on these standard errors are valid. Since β is the primary parameter of interest, the table attaches 1, 2, or 3 stars to statistically significant βs at the 10, 5, and 1 percent significance levels.

For completeness, the third bolded row in each panel reports estimated parameter breaks across the two subsamples, along with the full sample adjusted R^2. Standard errors are reported below, but these are not valid for assessing the statistical significance of the parameter breaks, since the break point was unknown a priori and estimated in a data dependent way; see Andrews (1993). The rightmost two columns of the table evaluate the statistical significance of the parameter breaks by reporting the Ave-F test statistic of Andrews, Lee, and Ploberger (1996) taken over the middle 50 percent of the sample. This statistic is the simple average taken over the set of Wald test statistics computed at each break point from 1988Q1 to 2006Q3.[18] Critical values for this test statistic that are robust to the unknown change point are reported in Andrews and Ploberger (1994). The column labelled "All" reports the Ave-F statistic testing for breaks in any of the three parameters (α, ρ, or β); 10, 5, and 1 percent critical values are 5.34, 6.45, and 8.83, respectively. The column labelled "β" reports the Ave-F statistic testing for a break in β only; 10, 5, and 1 percent critical values are 2.27, 3.10, and 5.24. For convenience, stars are attached to these test statistics

[16]This fraction was chosen as the closest round number (50 percent, 60 percent, etc.) ensuring parameters are estimated over reasonably long samples of about 10 years or longer.

[17]Hodrick-Hansen standard errors—see Hodrick and Hansion (1980) and Hodrick (1992)—were similar.

[18]Wald test statistics are computed using Newey-West variance-covariance matrices.

by level of statistical significance, as before.

The results are generally supportive of "expectations anchoring," with the estimates showing short-term inflation expectations moved close to one-for-one with most of the price inflation measures prior to the early 1990s, but much less afterwards, about a fifth as much for the CPI, PCE, and GDP price indexes. The effect of most inflation measures on inflation expectations remains highly statistically significant from the early 1990s to present, so expectations are not completely anchored in the second subsample. However, the parameter breaks across subsamples, including the declines in the βs, are statistically significant for most price measures using the Andrews and Ploberger (1994) critical values.

Figure 6 again plots short-term Michigan inflation expectations with CPI inflation, but shifts inflation forward four quarters to align the timing of the ex-ante expectations with the ex-post realizations. Corresponding regression results underlying the Mincer-Zarnowitz efficiency test are shown in Table 2 for all price measures and compensation-per-hour growth:

$$\pi_{t+4,t} = \alpha + \theta E_t^{MICH}(\pi_{t+4,t}) + u_t.$$

The results show only minor deviations from forecast efficiency before the early 1990s, with $\theta \approx 1$ for each inflation measure. In contrast, the deviations from forecast efficiency after the early 1990s are truly massive, with $\theta \approx 0$ for some measures and $\theta < 0$ for others, so expectations are either uncorrelated or *negatively* correlated with subsequent inflation. Section 5 discusses possible explanations for this recurring theme of $\theta < 0$, but the negative correlation using either total inflation or compensation-per-hour growth is visually apparent in Figures 6 and 7. The contrast with the early 1980s, when short-term Michigan inflation expectations predicted the declines in total inflation and compensation-per-hour growth with remarkable accuracy, is stark. As a result, the Ave-F test statistics show the breaks across subsamples are all highly statistically significant, with test statistics more than ten times the 1 percent critical values in some cases.[19]

Table 3 adds one lag of inflation, $\pi_{t,t-4}$, to the regression to test whether short-term Michigan inflation expectations Granger cause the inflation measures, and whether that Granger causality has changed over time. As in Table 2, the best-fitting break point in most of these regressions is in the early-1990s, and prior to the break, inflation expectations Granger cause each price inflation measure as well as compensation-per-hour growth with high statistical significance. After the break, inflation expectations either do not Granger cause or negatively Granger cause each measure, and the breaks across subsamples are highly statistically significant. Finally, Table 4 shows estimates of the modified expectations-augmented Phillips curve (3), estimated on quarterly data using the Michigan survey measure of expected inflation over the next year and average labor market slack over that year, $X_{t+4,t}$:

$$\pi_{t+4,t} = \alpha + \kappa X_{t+4,t} + \theta E_t^{MICH}(\pi_{t+4,t}) + u_t.$$ [20]

The slope of the Phillips curve, κ, declines after the early 1990s for all price inflation measures but not compensation-per-hour growth. The declines across subsamples in the effect of short-term inflation expectations on subsequent inflation continue to be universal and highly statistically significant.

In sum, the results in Tables 1-4 using Michigan expected inflation over the next year

[19] The 10, 5, and 1 percent critical values of the Ave-F statistic testing for breaks in either α or θ are 3.92, 4.95, and 7.25, respectively.

[20] Adding lagged inflation to this equation, as in "hybrid" New Keynesian Phillips curves assuming the expectations of some agents are adaptive, produced results similar to those shown in Table 4.

are consistent with breaks in both "expectations anchoring" and "expectations causality." While the most likely break points appear to be sometime in the early 1990s, the precise date is unimportant, with any break date in the 1990s yielding similar results. The statistical significance of tests rejecting an "expectations causality break" is very strong, considerably stronger than the statistical significance of tests rejecting a break in "expectations anchoring." In addition, for some total inflation measures and for compensation-per-hour growth, the sign of "expectations causality" changes from positive to negative after the early 1990s.

4.2 Results Using Long-Term Expectations

With fewer usable observations on long-term than on short-term inflation expectations, tests for breaks in this subsection examine a narrower range of break points over the middle 30 percent of each sample. The range of possible break dates varies slightly in Tables 5-11, but the range always starts in either 1995 or 1996 and ends in either 2004 or 2005. Table 5 begins by testing for a break in "expectations anchoring" using Michigan expected inflation over the next five to ten years, $E_t^{MICH}(\pi_{t+20-40,t})$. Results again mostly reject the hypothesis of no change in "expectations anchoring," with the effect of price inflation on long-term inflation expectations falling by a factor of between three and seven, depending on the inflation measure. Given the limited variability since the mid-to-late-1990s shown in Figure 3, this result is not surprising. However, the effect on long-term expectations of most price inflation measures remains highly statistically significant in the second subsample, again indicative of incomplete expectations anchoring.

The limited number of non-overlapping five or ten year periods in the sample makes specifications based on a precise alignment of long-term inflation expectations with long-term inflation realizations impractical, but it is possible to examine the predictive power and potential causality of long-term expectations for inflation over a range of shorter forecast horizons. Correlograms are one way to summarize this information, done for core PCE price inflation in Figure 8. Prior to the mid-1990s, long-term Michigan inflation expectations were most highly correlated with inflation over the next year and positively correlated with year-over-year inflation two and three years ahead, results consistent with causality. However, since the mid-1990s, long-term inflation expectations are uncorrelated with inflation over the next year and negatively correlated with year-over-year inflation two and three years ahead, results not at all consistent with causality and suggestive of an "expectations causality break". Results using other inflation measures were similar.

Table 6 shows results from Granger causality regressions of the year-over-year change in each price or wage measure on its own lag and the long-term Michigan expectations measure at the start of the change. The best-fitting break points in these regressions occur mostly in 1997, later than in the specifications using short-term expectations. Since the timing of the expectations and realizations is not aligned, there is no presumption that $\theta \approx 1$, but that is the case for some inflation measures in the pre-break samples. That expectations coefficient turns negative in the post-break sample for each measure except the core CPI, with $\theta \approx -3$ for the total CPI, PCE, and GDP price indexes as well as compensation-per-hour growth. Table 7 examines a similar specification using long-term Michigan inflation expectations to predict average price and wage inflation over the next two years, controlling for one lag of year-over-year inflation. The results are similar to those in Table 6, except that the θ coefficients are estimated with greater precision so the breaks across subsamples are more highly statistically significant.

Tables 8 and 9 examine expectations-augmented Phillips curves explaining inflation over the next year and over the next two years using long term Michigan inflation expectations and labor market slack.[21] The best-fitting break-points tend to occur earlier in these Phillips curve specifications than in the Granger causality specifications, and are the earliest date in the range under consideration in some cases.[22] So, while specifying a precise break date is difficult, the specifications all show highly statistically significant parameter breaks in these Phillips curves that most likely occured at some point in the 1990s. As before, the characteristic feature of these parameter breaks is a large decline in θ from positive and close to one in the pre-break samples to around zero or strongly negative in the post-break samples. This is apparent in all the point estimates shown except those for the core CPI, where the reported θ estimates remain positive and statistically significant in the post-break sample. However, the Ave-F test statistics evaluate statistical significance using all break dates under consideration, and Figure 9 shows smaller values of θ for all break dates other than the one chosen to maximize full sample R^2. That criterion is not necessarily the most useful for all purposes; the model that best describes core CPI inflation in 2016, rather than over the full sample, may be a model estimated over a sample starting after the late 1990s when $\theta \approx 0$.

The statistical significance of many of the post-break results in Tables 6 to 9 may be somewhat surprising, given the limited variation in long-term Michigan inflation expectations since the late 1990s. Figure 10 isolates that period and narrows the scale, showing that the measure does fluctuate, and not all of those fluctuations are noise or measurement error since the regressions in Table 5 show they are correlated with actual inflation. While the ratio of sampling error to total variance might be relatively high in the post-break samples,

[21] Hybrid specification that add lagged inflation to these equations yielded similar results.

[22] The range of break-points considered is 1995Q1 to 2004Q3 in Table 8, and 1995Q4 to 2004Q4 in Table 9.

causing a larger bias towards zero in the coefficients estimated over those samples, most of those coefficients are negative, so correcting for attentuation bias would likely result in larger negative coefficients and larger "expectations causality breaks."[23]

Keeping in mind the discussion of causality in section 3.3, Tables 10-12 examine the predictive power of the other long-term measures shown in Figure 4. Tables 10 and 11 show Granger causality regressions and expectations-augmented Phillips curves explaining inflation over the next year with long-term inflation forecasts from the SPF.[24] Like the results using Michigan expectations in Table 6, the R^2 in Table 10 show stark declines in inflation predictability and persistence since the late 1990s, but in contrast to the earlier results, Table 10 shows no statistically significant declines in θ across subsamples. The Phillips curve estimates in Table 11 do show declines in θ when using the core CPI and core PCE price measures, but the evidence favorable to declines in θ is, overall, much more mixed for the SPF than for the Michigan long-term measure.

Regarding TIPS long-term inflation compensation, Table 12 shows Granger causality regressions and expectations-augmented Phillips curves estimated using the short 2003 to 2015 sample of available data. The low R^2 in the Granger causality regressions in the top panel again illustrate the lack of predictability and persistence in the recent inflation estimates, with the TIPS measure providing little to no help in that regard.[25] Conditioning on labor market slack in the Phillips curves in the second panel yields results that echo those

[23]In addition, while the non-measurement error variance in the pre-break samples is relatively high, the sampling error variance is likely relatively high as well since fewer monthly surveys, often one per quarter rather than three, are averaged to produce quarterly observations. Akerlof, Dickens, and Perry (2000) also report relatively large sampling error variances in the earlier Michigan surveys.

[24]Results from regressions predicting two-year average inflation were similar.

[25]For more, see Bauer and McCarthy (2015).

found for Michigan long-term inflation expectations: the values of θ are either close to zero, or, when statistically significant, negative. As with the Michigan measure, the statistically significant negative θ values appear for the total inflation measures and for compensation-per-hour growth. The next section discusses possible explanations.

5 "Expectations Causality Break:" Discussion

5.1 Possible explanations for the change from $\theta \approx 1$ to $\theta \approx 0$

Likely due at least in part to successful monetary policy, inflation was relatively low and stable throughout most of the 1990s, as can be seen in Figures 1 and 2. These changes in the behavior of inflation over a lengthy period of time may have themselves been the source of the disappearance of a causal positive effect of inflation expectations on actual inflation. In particular, the sustained low level of inflation may have led to the causality break, a hypothesis discussed at length in Akerlof, Dickens, and Perry (2000), who state: "... when inflation is low, it may be at most a marginal factor in wage and price decisions, and decisionmakers may ignore it entirely."[26] Participants in the University of Michigan Consumer Surveys will answer when asked how much they expect prices to increase in the short and long term, but those answers may not be an important factor in price- and wage-setting decisions in a low-inflation environment, so $\theta \approx 0$. However, as Akerlof, Dickens, and Perry (2000) put it: "if inflation increases, ... people will switch their behavior to take inflation into full account." In other words, $\theta \approx 1$ in a high-inflation environment. Results from the psychology liter-

[26] Bernanke and others equate this hypothesis with a price stability notion attributed to Alan Greenspan. For example, according to Bernanke (2015): "...Greenspan's informal definition of price stability: an inflation rate low enough that households and businesses did not take it into account when making economic decisions."

ature and regression results in Akerlof, Dickens, and Perry (2000) and Brainard and Perry (2000) are consistent with this hypothesis. The rise in the fraction of union wage contracts indexed to price inflation in the 1970s and the subsequent decline in the late 1980s is broadly consistent also.[27] Finally, the dispersion of price changes across goods and services increases when inflation is low—see Luo and Villar (2016), suggesting idiosyncratic considerations are more dominant in pricing decisions when inflation is relatively low.

While the general public and price setters may be rationally inattentive to aggregate inflation when the level of inflation is low, more recent theoretical work suggests that this rational inattention may stem from a low variance of aggregate inflation as well. Namely, building on the seminal work on rational inattention of Sims (2003), Mackowiak and Wiederholt (2009) construct a model where price setters are inattentive to aggregate inflation shocks if the variance of aggregate shocks is small relative to the variance of idiosyncratic shocks, and Fulton (2016) extends that model to a multisector environment. An important feature of these models is that price setters are not inattentive to everything, just variables that are relatively unimportant to them, as is the case for aggregate inflation when its variance is small. While these papers do not calibrate their models to changes in the variance of aggregate inflation over time, it is possible that the relative stability of inflation in the 1990s may have fostered rational inattention that helped lock in that stability in the face of larger shocks in the 2000s.

One final hypothesis worth mentioning is that the exogenous effect of inflation expectations on inflation may still be governed by $\theta = 1$, but monetary policy reactions to fluctuations in inflation expectations may have roughly offset that exogeneous effect. This might be possible if expectations do not respond quickly to those endogeneous monetary policy

[27] See Holland (1995).

responses, perhaps because the relevant expectations move somewhat sluggishly under some circumstances. The next section discusses this hypothesis further.

5.2 Possible explanations for $\theta < 0$

In this regard, it is important to note that the R^2 in the post-break samples are mostly quite low, so the statistical evidence that $\theta < 0$ is much weaker than the statistical evidence that $\theta \neq 1$. So, even though the negative θs are statistically significant in many specifications, one explanation is that these results are simply due to chance. Figure 10 examines the negative correlation more closely, plotting long-term Michigan inflation expectations with GDP price inflation over the next two years. The high readings on inflation expectations in mid-2008 certainly stand out, and were followed by relatively low inflation over the next two years. Similarly, many of the low readings on inflation expectations, from 1998-1999 and from 2002-2004, for example, were followed by relatively high inflation over the next two years. So the negative correlation does appear somewhat systematic.

Another explanation is that increases in inflation and inflation expectations have had largely negative effects on economic activity in recent times, effects that produce later reversals in price inflation and nominal wage growth.[28] This hypothesis runs contrary to economic theories in which declines in households' inflation expectations cause them to delay durable goods purchases, but the evidence in Bachmann, Berg, and Sims (2015) suggests the opposite is true, if anything. Money illusion, implied by $\theta \neq 1$, is one explanation for such empirical results; see Shafir, Diamond, and Tversky (1997) and Akerlof, Dickens, and Perry (1996, 2000) for further discussion. In an environment where expected inflation and realized inflation largely do not pass through into wage growth, as is implied by Tables 2-4, their

[28]See Nalewaik (2015) for more evidence and discussion.

predominant effect may be to reduce the expected and realized purchasing power of households. Responses to the University of Michigan Surveys do suggest that the general public thinks in this way.

One last possibility is a variant of the last hypothesis discussed in the previous subsection. Namely, the negative correlation between inflation expectations and subsequent inflation realizations may have been the result of monetary policy overreactions to fluctuations in inflation expectations in recent decades. One version of this hypothesis is that the exogenous effect of inflation expectations on inflation is governed by $\theta = 0$, perhaps due to rational inattention, but monetary policy reacts to offset fluctuations in inflation expectations assuming $\theta = 1$, and those policy overreactions result in $\theta < 0$. To the extent that the quickest price effects of monetary policy work through energy and other commodity prices, the negative θ readings should be most pronounced when using total rather than core inflation, the result found in section 4. And to the extent that monetary policy reacts more to long-term rather than short-term inflation expectations, specifications using the former should produce larger negative values for θ. Comparing Table 4 with Table 8 shows that this is, in fact, the case.[29]

5.3 The Case of Japan

The "expectations causality break" hypothesis posits that inflation expectations in the United States have not had a positive causal effect on subsequent inflation in recent decades. Whether this hypothesis holds in other countries is an open question, but the long spell of

[29]Some of these negative post-break θs in Table 8 and Table 9 are actually larger in absolute value than the positive pre-break θs, implying the "expectations causality break" in the effect of long-term expectations on inflation has actually increased the variance of inflation, perhaps due to monetary policy overreactions. In those specifications, only "expectations anchoring" is a valid explanation for the decline in the variance of inflation.

deflation in Japan starting in the late 1990s might be interpreted as evidence against the hypothesis if inflation expectations were critical in explaining that deflation. However, as illustrated in Figure 11, the four-quarter moving average of the Japanese unemployment rate explains virtually all of the meaningful variation in year-over-year Japanese core inflation since 1990, leaving little to be explained by an increasingly deflationary mindset in Japan.[30] The movements in the Japanese unemployment rate, shown on an inverted scale, appear relatively modest compared to recent movements in the U.S. unemployment rate. However, the increase in the Japanese unemployment rate from 2 percent in 1990 to above 5 percent in the 2000s appears to have been large enough to generate deflation because of a relatively steep Japanese Phillips curve, with a slope of around minus one.

Multiple economic downturns within a relatively short period of time appear responsible for Japanese deflation: one downturn in the early-to-mid-1990s, another after the Asian financial crisis in the late 1990s, and another after the bursting of the dot com bubble in the U.S. in the early 2000s. Factors external to Japan were likely important drivers of those last two downturns and the downturn in 2008 that pushed Japan deeper into deflation, so domestic Japanese inflation expectations appear unlikely to have played a strong causal role in generating the increases in labor market slack that appear to have driven down inflation. And while the effective lower bound on nominal interest rates may have slowed the Japanese recovery from these shocks, a variety of other factors may have as well, including problems in the banking sector inhibiting bank lending, labor market rigidities, unfavorable demographic trends, etc.

After controlling for labor market slack, price inflation in Japan and the U.S. both ap-

[30]The core series plotted excludes food and energy prices and strips out the effect of consumption tax increases.

pear stationary around a mean in recent decades. This observation prompts an important question: if inflation over the past couple of decades no longer follows a random walk as it did in earlier decades, but is best characterized as a stationary process with a mean, what factors determine that mean? If the "expectations causality break" hypothesis is correct, inflation expectations no longer have a positive causal effect on actual inflation, so inflation targets and other central bank policies directly aimed at influencing inflation expectations have no effect on mean inflation. Instead, structural factors or other fundamentals might drive mean inflation, and more research into which of these factors are most important could be useful. Determining the mean is clearly important for inflation forecasting, and absent a better understanding of its determinants, the best estimate of the mean is likely to be just that, the mean of inflation taken over the period where inflation has been stable—see Nalewaik (2015). Controlling for labor market slack is sensible when projected slack differs substantially from its average level over the sample used to estimate mean inflation, as might be the case for Japan.

6 Conclusion: The Importance of Regime Changes

This paper has examined two candidate hypotheses explaining the declines in the variance and persistence of price inflation in recent decades, stylized facts that are very important for inflation forecasting and risk assessments. Both explanations relate to inflation expectations: the "expectations anchoring" hypothesis posits a decline in the effect of current and lagged inflation on inflation expectations, while the "expectations causality break" hypothesis posits a decline in the effect of inflation expectations on actual subsequent inflation. The first hypothesis is widespread conventional wisdom, while the second hypothesis—that the inflation expectations of the general public had an important causal effect on actual wage and price setting in the 1970s and 1980s but not from the 1990s to present—has received comparatively little attention in the economics literature.

The evidence favorable to the second hypothesis is particularly strong, but the paper finds evidence supportive of both, and both may have contributed to the decline in the variance and persistence of inflation. Inflation expectations are more anchored than before, but they are not completely anchored—they still move with inflation to a limited degree. However, those movements in inflation expectations now appear inconsequential since they no longer have any predictive content for subsequent inflation realizations. If anything, the opposite pattern has taken hold in recent decades, as relatively high inflation expectations have been followed by relatively low inflation realizations, and vice versa.

The small literature discussing the "expectations causality break" hypothesis is largely concerned with issues such as whether a stable long-run tradeoff between inflation and unemployment exists—see Akerlof, Dickens, and Perry (2000) and Brainard and Perry (2000). On that issue, it is important to acknowledge that these breaks could reverse. Modelling that formally using a Markov-switching model with non-absorbing regimes shows that a transition out of the current regime of low and stable inflation is inevitable, in the sense that its probability approaches one as the horizon lengthens to infinity. If the perspective offered by such a model is correct, a stable tradeoff between inflation and unemployment certainly does not exist in the very long run, since inflation expectations will drive inflation again at some point in the future. Delaying that as long as possible seems a sensible long-run goal for monetary policy.

However, the results in the paper show that a transition out of the current regime of stable inflation would have to satisfy two components of a joint hypothesis: (1) the effect of current and lagged inflation on inflation expectations would have to increase markedly again, and (2) inflation expectations would have to start exerting a strong causal effect on actual inflation again. The requirement that this second condition be met—that the "expectations causality break" reverse—does offer another layer of redundancy, insulating the regime of stable inflation from shocks to inflation expectations and perhaps entrenching it more than has been heretofore appreciated.

In a world where regime transitions are possible, the key is understanding the conditions under which a regime transition is likely. When are the two components of the above joint hypothesis likely to come to pass, bringing about an end to the current regime of stable inflation? Since the variability and persistence of inflation would be much higher after such a regime transition, assessments of its likelihood could be informed by probabilities of a high-variance, high-persistence inflation regime estimated directly from the behavior of inflation, as in the Markov-switching models of Nalewaik (2015). Those models show a transition out of the high-variance, high-persistence inflation regime occured sometime in the 1990s, in agreement with the most likely break dates in this paper. The model estimates show it would take PCE price inflation above 3.3 percent or CPI inflation above 4.0 percent for several years to produce a transition back into the high-variance, high-persistence inflation regime, although uncertainty surrounds those point estimates, of course.[31]

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[31]While several years of near-zero inflation also can produce elevated transition probabilities in the symmetrically-constructed Markov-switching models, elevated probabilities from low inflation should be viewed much more skeptically outside of a severe recession, for several reasons. First, if Akerlof, Dickens, and Perry (2000) are correct that the transition into the stable inflation regime in the 1990s was facilitated by rational inattention to low inflation, it seems highly unlikely that further low inflation will prompt a return to attention and a transition out of the stable inflation regime. Second, versions of the Markov-switching models estimated on annual data extending back to the first half of the 20th century show the last transition into the high-variance, high-persistence regime from low inflation was in the Great Depression, so it is not clear such a transition is possible outside of a severe recession. Third, downward nominal wage rigidity, which could feed through to downward rigidities in price inflation—see Akerlof, Dickens, and Perry (1996)—might make it unlikely that inflation could follow a random walk below certain levels, as would have to be the

While the samples are too short and the transitions too few to estimate Markov-switching models using inflation expectations, the logic of those models and the characteristics of the different regimes can help evaluate the likelihood of each component of the joint hypothesis discussed above. For example, the first component of the joint hypothesis implies close to one-for-one pass through of inflation into short-term Michigan inflation expectations (see Table 1). Figure 5 shows that this came much closer to happening in 2008 and in 2011 than in 2015: in 2008 and 2011, short-term expectations and CPI inflation both spiked up to around 4 or 5 percent, but in 2015, short-term expectations moved very little when CPI inflation spiked down to around 0 percent. The second component of the joint hypothesis implies movements in short-term inflation expectations should cause one-for-one movements in inflation over the next year (see Tables 2-4). The movements in expectations in 2015 were too small to be used for evaluation, but Figure 6 shows the second component of the joint hypothesis clearly did not hold after the spikes up in expectations in 2008 and 2011—inflation moved down over the next year, in fact.

Although theory predicts that it is short-term inflation expectations that should be causal for subsequent inflation, similar analyses could be performed using long-term inflation expectations. Inferences about the first component of the joint hypothesis are apt to be less precise when using long-term Michigan inflation expectations, however, because the differences across regimes are less stark (see Table 5). And the long-term inflation forecasts of professional forecasters cannot be employed to evaluate the likelihood of the second component of the joint hypothesis, since the paper finds no statistically significant breaks in that relation. That result suggests that we should look to the inflation expectations of the general

case after a transition to the high-variance, high-persistence regime. And fourth, such a transition seems particularly unlikely to be caused by low inflation driven by positive supply shocks, which typically boost the economy and drive inflation back up in later periods.

public to explain the decline in the variance and persistence of inflation in recent decades, since it was the positive effect of their expectations on subsequent inflation that disappeared over that time period.

Table 1: Estimates of $E_t^{MICH}(\pi_{t+4,t}) = \alpha + \rho E_{t-4}^{MICH}(\pi_{t,t-4}) + \beta\pi_{t-1,t-5} + u_t$

		α	ρ	β	R^2	Ave-F, $\frac{tbrk}{T} \in [0.25, 0.75]$ All	β
CPI	Pre-199004	**1.58**	**-0.35**	**0.82*****	0.85		
		(0.33)	(0.27)	(0.20)			
	Post-199004	**2.26**	**0.12**	**0.14*****	0.13		
		(0.28)	(0.07)	(0.04)			
	Post - Pre	**0.68**	**0.47**	**-0.69**	0.85	21.92***	8.46***
		(0.44)	(0.28)	(0.20)			
Core CPI	Pre-199004	**0.37**	**-0.23**	**0.88*****	0.75		
		(0.47)	(0.33)	(0.31)			
	Post-199004	**2.53**	**0.18**	**-0.03**	0.01		
		(0.29)	(0.11)	(0.06)			
	Post - Pre	**2.16**	**0.40**	**-0.92**	0.78	19.26***	5.12**
		(0.56)	(0.35)	(0.31)			
PCE price	Pre-199004	**0.74**	**-0.46**	**1.20*****	0.82		
		(0.38)	(0.34)	(0.36)			
	Post-199004	**2.21**	**0.11**	**0.21*****	0.18		
		(0.29)	(0.07)	(0.06)			
	Post - Pre	**1.48**	**0.57**	**-0.99**	0.84	12.66***	4.96**
		(0.46)	(0.35)	(0.36)			
Core PCE	Pre-198801	**0.46**	**0.81**	**0.03**	0.66		
		(0.56)	(0.27)	(0.33)			
	Post-198801	**2.19**	**0.08**	**0.30*****	0.25		
		(0.28)	(0.08)	(0.07)			
	Post - Pre	**1.73**	**-0.73**	**0.27**	0.73	16.86***	0.39
		(0.62)	(0.29)	(0.34)			
GDP price	Pre-199004	**0.87**	**-0.06**	**0.85****	0.72		
		(0.46)	(0.36)	(0.42)			
	Post-199004	**2.36**	**0.09**	**0.17*****	0.07		
		(0.28)	(0.08)	(0.04)			
	Post - Pre	**1.49**	**0.15**	**-0.68**	0.76	10.70***	2.55*
		(0.53)	(0.37)	(0.43)			
Comp. per hour	Pre-198901	**-0.79**	**0.05**	**0.83***	0.74		
		(0.82)	(0.42)	(0.45)			
	Post-198901	**2.14**	**0.28**	**0.01**	0.07		
		(0.42)	(0.13)	(0.03)			
	Post - Pre	**2.93**	**0.22**	**-0.81**	0.76	15.06***	2.25
		(0.93)	(0.44)	(0.45)			

Note: *, **, *** denote 10, 5, and 1 percent statistical significance of βs and Ave-Fs.

Table 2: Estimates of $\pi_{t+4,t} = \alpha + \theta E_t^{MICH}(\pi_{t+4,t}) + u_t$

		α	θ	R^2	Ave-F, $\frac{tbrk}{T} \in [0.25, 0.75]$ All	θ
CPI	Pre-200603	**-0.98**	**1.34*****	0.80		
		(0.55)	(0.18)			
	Post-200603	**5.40**	**-1.10*****	0.15		
		(1.30)	(0.36)			
	Post - Pre	**6.38**	**-2.45**	0.78	29.00***	24.80***
		(1.41)	(0.41)			
Core CPI	Pre-199304	**0.43**	**1.14*****	0.87		
		(0.32)	(0.10)			
	Post-199304	**1.80**	**0.11**	0.00		
		(0.40)	(0.13)			
	Post - Pre	**1.37**	**-1.03**	0.92	94.55***	36.24***
		(0.51)	(0.16)			
PCE price	Pre-199103	**0.19**	**1.00*****	0.83		
		(0.48)	(0.13)			
	Post-199103	**3.18**	**-0.42**	0.05		
		(0.90)	(0.31)			
	Post - Pre	**2.99**	**-1.42**	0.84	36.02***	25.74***
		(1.02)	(0.33)			
Core PCE	Pre-199304	**0.90**	**0.84*****	0.91		
		(0.30)	(0.05)			
	Post-199304	**1.66**	**0.02**	-0.01		
		(0.39)	(0.13)			
	Post - Pre	**0.76**	**-0.82**	0.94	90.62***	35.73***
		(0.49)	(0.14)			
GDP price	Pre-199103	**-0.11**	**0.99*****	0.90		
		(0.30)	(0.06)			
	Post-199103	**2.08**	**-0.04**	-0.01		
		(0.57)	(0.20)			
	Post - Pre	**2.19**	**-1.03**	0.88	42.84***	35.18***
		(0.64)	(0.20)			
Compensation per Hour	Pre-199204	**1.84**	**0.88*****	0.74		
		(0.43)	(0.09)			
	Post-199204	**5.78**	**-0.86****	0.05		
		(1.36)	(0.39)			
	Post - Pre	**3.93**	**-1.75**	0.62	31.42***	18.31***
		(1.45)	(0.40)			

Note: *, **, *** denote 10, 5, and 1 percent statistical significance of θs and Ave-Fs.

Table 3: Estimates of $\pi_{t+4,t} = \alpha + \rho\pi_{t,t-4} + \theta E_t^{MICH}(\pi_{t+4,t}) + u_t$

						Ave-F, $\frac{tbrk}{T} \in [0.25, 0.75]$	
		α	ρ	θ	R^2	All	θ
CPI	Pre-199103	**-1.24**	**-0.80**	**2.43*****	0.82		
		(0.70)	(0.24)	(0.41)			
	Post-199103	**4.72**	**0.31**	**-1.05****	0.13		
		(1.26)	(0.17)	(0.48)			
	Post - Pre	**5.96**	**1.11**	**-3.48**	0.82	40.20***	29.34***
		(1.47)	(0.29)	(0.64)			
Core CPI	Pre-199102	**1.14**	**-0.52**	**1.69*****	0.91		
		(0.18)	(0.08)	(0.11)			
	Post-199102	**0.51**	**0.60**	**0.11**	0.64		
		(0.34)	(0.07)	(0.14)			
	Post - Pre	**-0.63**	**1.12**	**-1.58**	0.95	86.33***	39.13***
		(0.38)	(0.10)	(0.18)			
PCE price	Pre-199102	**0.35**	**-0.56**	**1.58*****	0.86		
		(0.45)	(0.24)	(0.27)			
	Post-199102	**3.58**	**0.43**	**-0.85****	0.15		
		(0.94)	(0.18)	(0.35)			
	Post - Pre	**3.22**	**0.99**	**-2.43**	0.86	34.40***	21.45***
		(1.05)	(0.30)	(0.44)			
Core PCE	Pre-198902	**1.55**	**-0.06**	**0.83*****	0.94		
		(0.35)	(0.10)	(0.07)			
	Post-198902	**0.71**	**0.79**	**-0.13**	0.76		
		(0.38)	(0.10)	(0.17)			
	Post - Pre	**-0.83**	**0.85**	**-0.96**	0.96	32.90***	14.93***
		(0.53)	(0.14)	(0.19)			
GDP price	Pre-199102	**-0.05**	**-0.10**	**1.09*****	0.90		
		(0.33)	(0.12)	(0.10)			
	Post-199102	**1.70**	**0.62**	**-0.33****	0.35		
		(0.37)	(0.15)	(0.16)			
	Post - Pre	**1.75**	**0.72**	**-1.42**	0.91	70.53***	46.58***
		(0.49)	(0.20)	(0.19)			
Comp. per hour	Pre-199304	**2.28**	**-0.47**	**1.38*****	0.76		
		(0.50)	(0.13)	(0.15)			
	Post-199304	**4.82**	**0.29**	**-0.83****	0.15		
		(1.16)	(0.10)	(0.34)			
	Post - Pre	**2.55**	**0.76**	**-2.21**	0.64	34.86***	20.55***
		(1.25)	(0.18)	(0.37)			

Note: *, **, *** denote 10, 5, and 1 percent statistical significance of θs and Ave-Fs.

Table 4: Estimates of $\pi_{t+4,t} = \alpha + \kappa X_{t+4,t} + \theta E_t^{MICH}(\pi_{t+4,t}) + u_t$

		α	κ	θ	R^2	Ave-F, $\frac{tbrk}{T} \in [0.25, 0.75]$ All	θ
CPI	Pre-199304	**0.17**	**-0.83**	**1.31*****	0.87		
		(0.49)	(0.20)	(0.13)			
	Post-199304	**4.53**	**-0.25**	**-0.69***	0.19		
		(1.11)	(0.13)	(0.36)			
	Post - Pre	**4.36**	**0.59**	**-2.00**	0.84	44.94***	28.71***
		(1.21)	(0.24)	(0.38)			
Core CPI	Pre-199304	**0.88**	**-0.45**	**1.14*****	0.91		
		(0.36)	(0.14)	(0.07)			
	Post-199304	**1.68**	**-0.25**	**0.22****	0.45		
		(0.33)	(0.03)	(0.11)			
	Post - Pre	**0.79**	**0.20**	**-0.92**	0.95	132.95***	53.72***
		(0.49)	(0.14)	(0.13)			
PCE price	Pre-199103	**0.48**	**-0.39**	**1.02*****	0.86		
		(0.42)	(0.16)	(0.10)			
	Post-199103	**3.15**	**-0.08**	**-0.39**	0.06		
		(0.90)	(0.11)	(0.29)			
	Post - Pre	**2.67**	**0.30**	**-1.41**	0.85	44.35***	28.01***
		(0.98)	(0.20)	(0.31)			
Core PCE	Pre-199304	**0.92**	**-0.02**	**0.84*****	0.91		
		(0.28)	(0.10)	(0.04)			
	Post-199304	**1.61**	**-0.09**	**0.07**	0.11		
		(0.40)	(0.05)	(0.13)			
	Post - Pre	**0.69**	**-0.07**	**-0.78**	0.95	109.45***	38.19***
		(0.49)	(0.11)	(0.14)			
GDP price	Pre-199103	**0.05**	**-0.22**	**1.00*****	0.91		
		(0.30)	(0.09)	(0.05)			
	Post-199103	**2.03**	**-0.15**	**0.02**	0.08		
		(0.59)	(0.09)	(0.18)			
	Post - Pre	**1.98**	**0.07**	**-0.98**	0.90	79.41***	55.23***
		(0.64)	(0.13)	(0.18)			
Compensation per hour	Pre-199204	**2.07**	**-0.25**	**0.89*****	0.76		
		(0.55)	(0.19)	(0.08)			
	Post-199204	**5.49**	**-0.72**	**-0.56****	0.37		
		(0.90)	(0.18)	(0.26)			
	Post - Pre	**3.42**	**-0.47**	**-1.45**	0.72	75.26***	36.29***
		(1.07)	(0.26)	(0.28)			

Note: *, **, *** denote 10, 5, and 1 percent statistical significance of θs and Ave-Fs.

Table 5: Estimates of $E_t^{MICH}(\pi_{t+20-40,t}) = \alpha + \rho E_{t-4}^{MICH}(\pi_{t+16-36,t-4}) + \beta\pi_{t-1,t-5} + u_t$

		α	ρ	β	R^2	Ave-F, $\frac{tbrk}{T} \in [0.35, 0.65]$ All	β
CPI	Pre-199603	**1.92**	**0.22**	**0.31****	0.77		
		(0.51)	(0.20)	(0.12)			
	Post-199603	**1.67**	**0.38**	**0.05*****	0.36		
		(0.23)	(0.07)	(0.01)			
	Post - Pre	**-0.24**	**0.15**	**-0.26**	0.87	10.61***	3.76**
		(0.56)	(0.21)	(0.13)			
Core CPI	Pre-199603	**1.79**	**0.13**	**0.39****	0.75		
		(0.35)	(0.20)	(0.16)			
	Post-199603	**1.91**	**0.29**	**0.06**	0.18		
		(0.29)	(0.10)	(0.04)			
	Post - Pre	**0.13**	**0.16**	**-0.34**	0.85	11.57***	4.10**
		(0.45)	(0.22)	(0.17)			
PCE price	Pre-199603	**2.21**	**0.08**	**0.46*****	0.79		
		(0.51)	(0.21)	(0.15)			
	Post-199603	**1.57**	**0.41**	**0.06*****	0.36		
		(0.25)	(0.08)	(0.02)			
	Post - Pre	**-0.64**	**0.33**	**-0.40**	0.88	13.67***	7.34***
		(0.56)	(0.22)	(0.15)			
Core PCE	Pre-200001	**1.84**	**0.14**	**0.45*****	0.80		
		(0.34)	(0.11)	(0.07)			
	Post-200001	**1.68**	**0.33**	**0.14****	0.26		
		(0.35)	(0.10)	(0.06)			
	Post - Pre	**-0.17**	**0.20**	**-0.31**	0.85	17.52***	12.80***
		(0.49)	(0.15)	(0.09)			
GDP price	Pre-199603	**1.97**	**0.22**	**0.35*****	0.73		
		(0.43)	(0.12)	(0.10)			
	Post-199603	**1.56**	**0.41**	**0.07*****	0.33		
		(0.30)	(0.10)	(0.02)			
	Post - Pre	**-0.41**	**0.18**	**-0.28**	0.85	17.62***	7.13***
		(0.52)	(0.15)	(0.10)			
Comp. per hour	Pre-199603	**1.47**	**0.42**	**0.19****	0.70		
		(0.42)	(0.14)	(0.08)			
	Post-199603	**1.70**	**0.39**	**0.01**	0.17		
		(0.32)	(0.11)	(0.01)			
	Post - Pre	**0.23**	**-0.03**	**-0.18**	0.83	6.17*	1.72
		(0.52)	(0.17)	(0.08)			

Note: *, **, *** denote 10, 5, and 1 percent statistical significance of βs and Ave-Fs.

Table 6: Estimates of $\pi_{t+4,t} = \alpha + \rho\pi_{t,t-4} + \theta E_t^{MICH}(\pi_{t+20-40,t}) + u_t$

		α	ρ	θ	R^2	Ave-F, $\frac{tbrk}{T} \in [0.35, 0.65]$ All	θ
CPI	Pre-199703	**-0.97**	**0.32**	**0.84*****	0.68		
		(0.75)	(0.10)	(0.24)			
	Post-199703	**10.46**	**0.04**	**-2.90***	0.04		
		(4.95)	(0.18)	(1.73)			
	Post - Pre	**11.44**	**-0.27**	**-3.74**	0.63	5.12	2.57**
		(5.00)	(0.21)	(1.75)			
Core CPI	Pre-200203	**-1.04**	**0.34**	**0.88*****	0.86		
		(0.40)	(0.10)	(0.17)			
	Post-200203	**-0.89**	**0.07**	**0.91**	0.04		
		(1.74)	(0.14)	(0.67)			
	Post - Pre	**0.15**	**-0.27**	**0.03**	0.88	3.09	0.05
		(1.78)	(0.17)	(0.69)			
PCE price	Pre-199703	**-0.94**	**0.41**	**0.68*****	0.76		
		(0.54)	(0.08)	(0.15)			
	Post-199703	**9.88**	**0.12**	**-2.88****	0.08		
		(3.76)	(0.20)	(1.31)			
	Post - Pre	**10.82**	**-0.29**	**-3.56**	0.72	6.70*	4.00**
		(3.81)	(0.21)	(1.32)			
Core PCE	Pre-199702	**-0.94**	**0.51**	**0.61*****	0.88		
		(0.36)	(0.06)	(0.08)			
	Post-199702	**2.68**	**0.40**	**-0.59**	0.10		
		(1.35)	(0.22)	(0.53)			
	Post - Pre	**3.63**	**-0.11**	**-1.20**	0.91	5.91*	2.63*
		(1.40)	(0.23)	(0.53)			
GDP price	Pre-199704	**-1.47**	**0.40**	**0.78*****	0.84		
		(0.36)	(0.06)	(0.11)			
	Post-199704	**8.50**	**0.67**	**-2.73*****	0.42		
		(1.75)	(0.17)	(0.63)			
	Post - Pre	**9.97**	**0.27**	**-3.52**	0.83	22.56***	21.63***
		(1.79)	(0.18)	(0.64)			
Comp. per hour	Pre-200102	**0.83**	**0.41**	**0.50****	0.44		
		(1.07)	(0.11)	(0.21)			
	Post-200102	**9.81**	**0.15**	**-2.57**	0.04		
		(5.37)	(0.10)	(1.88)			
	Post - Pre	**8.97**	**-0.25**	**-3.07**	0.50	5.22	2.72*
		(5.46)	(0.15)	(1.89)			

Note: *, **, *** denote 10, 5, and 1 percent statistical significance of θs and Ave-Fs.

Table 7: Estimates of $\pi_{t+8,t} = \alpha + \rho\pi_{t,t-4} + \theta E_t^{MICH}(\pi_{t+20-40,t}) + u_t$

		α	ρ	θ	R^2	Ave-F, $\frac{tbrk}{T} \in [0.35, 0.65]$ All	θ
CPI	Pre-199704	**0.14**	**0.27**	**0.63*****	0.51		
		(0.76)	(0.11)	(0.22)			
	Post-199704	**8.23**	**-0.02**	**-2.04*****	0.09		
		(2.21)	(0.13)	(0.73)			
	Post - Pre	**8.09**	**-0.29**	**-2.67**	0.61	16.43***	10.85***
		(2.29)	(0.17)	(0.75)			
Core CPI	Pre-200204	**-0.49**	**0.30**	**0.76*****	0.77		
		(0.43)	(0.13)	(0.16)			
	Post-200204	**1.72**	**-0.01**	**0.06**	-0.04		
		(1.10)	(0.11)	(0.44)			
	Post - Pre	**2.21**	**-0.31**	**-0.70**	0.83	11.98***	2.13
		(1.19)	(0.17)	(0.47)			
PCE price	Pre-199704	**0.06**	**0.44**	**0.42*****	0.62		
		(0.64)	(0.10)	(0.13)			
	Post-199704	**8.25**	**0.05**	**-2.24*****	0.17		
		(1.89)	(0.16)	(0.66)			
	Post - Pre	**8.19**	**-0.39**	**-2.65**	0.71	21.38***	10.17***
		(2.00)	(0.18)	(0.67)			
Core PCE	Pre-199702	**-0.36**	**0.53**	**0.44*****	0.78		
		(0.56)	(0.08)	(0.07)			
	Post-199702	**3.86**	**0.32**	**-0.94****	0.17		
		(0.92)	(0.19)	(0.39)			
	Post - Pre	**4.22**	**-0.20**	**-1.38**	0.88	31.23***	9.29***
		(1.06)	(0.21)	(0.40)			
GDP price	Pre-199801	**-0.71**	**0.40**	**0.59*****	0.69		
		(0.47)	(0.08)	(0.10)			
	Post-199801	**9.51**	**0.41**	**-2.89*****	0.41		
		(2.05)	(0.16)	(0.74)			
	Post - Pre	**10.22**	**0.01**	**-3.48**	0.75	29.40***	16.80***
		(2.08)	(0.18)	(0.74)			
Comp. per hour	Pre-200104	**1.52**	**0.46**	**0.24**	0.47		
		(1.17)	(0.09)	(0.24)			
	Post-200104	**10.17**	**0.12**	**-2.66****	0.08		
		(3.81)	(0.04)	(1.25)			
	Post - Pre	**8.65**	**-0.33**	**-2.90**	0.55	11.52***	4.70**
		(3.92)	(0.09)	(1.26)			

Note: *, **, *** denote 10, 5, and 1 percent statistical significance of θs and Ave-Fs.

Table 8: Estimates of $\pi_{t+4,t} = \alpha + \kappa X_{t+4,t} + \theta E_t^{MICH}(\pi_{t+20-40,t}) + u_t$

		α	κ	θ	R^2	Ave-F, $\frac{tbrk}{T} \in [0.35, 0.65]$ All	θ
CPI	Pre-199701	**-1.75**	**-0.73**	**1.54*****	0.69		
		(0.64)	(0.29)	(0.20)			
	Post-199701	**10.66**	**-0.31**	**-2.83****	0.17		
		(4.09)	(0.14)	(1.38)			
	Post - Pre	**12.41**	**0.42**	**-4.37**	0.66	7.35**	6.13***
		(4.13)	(0.32)	(1.40)			
Core CPI	Pre-199504	**-1.23**	**-0.45**	**1.45*****	0.76		
		(0.62)	(0.24)	(0.15)			
	Post-199504	**-0.90**	**-0.21**	**1.08*****	0.61		
		(0.88)	(0.04)	(0.30)			
	Post - Pre	**0.33**	**0.23**	**-0.37**	0.87	7.69**	3.11**
		(1.03)	(0.24)	(0.32)			
PCE price	Pre-199701	**-1.77**	**-0.34**	**1.34*****	0.68		
		(0.65)	(0.24)	(0.17)			
	Post-199701	**9.10**	**-0.16**	**-2.47****	0.12		
		(3.16)	(0.11)	(1.08)			
	Post - Pre	**10.88**	**0.18**	**-3.82**	0.69	7.95**	7.25***
		(3.21)	(0.26)	(1.09)			
Core PCE	Pre-199501	**-0.92**	**-0.09**	**1.16*****	0.66		
		(0.79)	(0.20)	(0.15)			
	Post-199501	**1.14**	**-0.09**	**0.22**	0.12		
		(1.07)	(0.05)	(0.35)			
	Post - Pre	**2.06**	**0.00**	**-0.95**	0.84	12.33***	8.67***
		(1.24)	(0.20)	(0.37)			
GDP price	Pre-200001	**-2.44**	**-0.12**	**1.38*****	0.75		
		(0.51)	(0.22)	(0.14)			
	Post-200001	**7.19**	**-0.29**	**-1.69****	0.37		
		(2.31)	(0.09)	(0.76)			
	Post - Pre	**9.64**	**-0.17**	**-3.07**	0.75	14.68***	13.92***
		(2.37)	(0.24)	(0.78)			
Compensation per hour	Pre-199501	**-1.03**	**-0.45**	**1.46*****	0.51		
		(1.69)	(0.26)	(0.32)			
	Post-199501	**10.43**	**-0.77**	**-2.18*****	0.41		
		(2.44)	(0.15)	(0.81)			
	Post - Pre	**11.46**	**-0.32**	**-3.64**	0.55	14.04***	11.80***
		(3.23)	(0.30)	(0.92)			

Note: *, **, *** denote 10, 5, and 1 percent statistical significance of θs and Ave-Fs.

Table 9: Estimates of $\pi_{t+8,t} = \alpha + \kappa X_{t+8,t} + \theta E_t^{MICH}(\pi_{t+20-40,t}) + u_t$

		α	κ	θ	R^2	Ave-F, $\frac{tbrk}{T} \in [0.35, 0.65]$ All	θ
CPI	Pre-199702	**-1.03**	**-0.96**	**1.40*****	0.59		
		(0.81)	(0.30)	(0.21)			
	Post-199702	**8.67**	**-0.28**	**-2.12*****	0.33		
		(1.66)	(0.08)	(0.55)			
	Post - Pre	**9.70**	**0.68**	**-3.51**	0.69	20.34***	19.02***
		(1.78)	(0.31)	(0.58)			
Core CPI	Pre-199504	**-0.45**	**-0.65**	**1.29*****	0.66		
		(0.86)	(0.23)	(0.17)			
	Post-199504	**-0.02**	**-0.22**	**0.78****	0.69		
		(1.01)	(0.03)	(0.35)			
	Post - Pre	**0.43**	**0.43**	**-0.52**	0.85	15.27***	10.60***
		(1.12)	(0.24)	(0.35)			
PCE price	Pre-199504	**-0.66**	**-0.71**	**1.18*****	0.52		
		(1.03)	(0.28)	(0.21)			
	Post-199504	**5.48**	**-0.14**	**-1.19***	0.15		
		(1.94)	(0.09)	(0.63)			
	Post - Pre	**6.13**	**0.56**	**-2.37**	0.69	23.27***	21.18***
		(1.94)	(0.29)	(0.62)			
Core PCE	Pre-199504	**-0.35**	**-0.39**	**1.09*****	0.56		
		(1.03)	(0.23)	(0.19)			
	Post-199504	**2.26**	**-0.09**	**-0.16**	0.15		
		(0.96)	(0.06)	(0.31)			
	Post - Pre	**2.61**	**0.31**	**-1.25**	0.81	46.14***	30.45***
		(1.16)	(0.23)	(0.31)			
GDP price	Pre-199601	**-1.20**	**-0.60**	**1.23*****	0.55		
		(0.89)	(0.26)	(0.18)			
	Post-199601	**7.08**	**-0.19**	**-1.71*****	0.33		
		(2.04)	(0.09)	(0.65)			
	Post - Pre	**8.28**	**0.42**	**-2.94**	0.69	31.57***	30.33***
		(2.09)	(0.28)	(0.65)			
Compensation	Pre-199504	**-0.80**	**-0.67**	**1.39*****	0.46		
per hour		(1.88)	(0.31)	(0.35)			
	Post-199504	**8.08**	**-0.77**	**-1.36*****	0.63		
		(1.61)	(0.14)	(0.51)			
	Post - Pre	**8.88**	**-0.10**	**-2.75**	0.59	18.10***	14.74***
		(2.59)	(0.35)	(0.65)			

Note: *, **, *** denote 10, 5, and 1 percent statistical significance of θs and Ave-Fs.

Table 10: Estimates of $\pi_{t+4,t} = \alpha + \rho\pi_{t,t-4} + \theta E_t^{SPF}(\pi_{t+40,t}) + u_t$

		α	ρ	θ	R^2	Ave-F, $\frac{tbrk}{T} \in [0.35, 0.65]$ All	θ
CPI	Pre-200103	**0.97**	**0.59**	**0.07**	0.69		
		(0.59)	(0.17)	(0.26)			
	Post-200103	**-4.51**	**-0.19**	**2.92**	0.02		
		(7.21)	(0.17)	(2.96)			
	Post - Pre	**-5.48**	**-0.78**	**2.84**	0.57	9.00**	0.78
		(7.23)	(0.24)	(2.97)			
Core CPI	Pre-200203	**-0.13**	**0.42**	**0.56****	0.81		
		(0.26)	(0.21)	(0.22)			
	Post-200203	**1.05**	**0.14**	**0.23**	-0.01		
		(1.61)	(0.16)	(0.72)			
	Post - Pre	**1.19**	**-0.28**	**-0.33**	0.83	1.93	0.19
		(1.63)	(0.26)	(0.76)			
PCE price	Pre-199903	**-0.14**	**0.59**	**0.27**	0.78		
		(1.03)	(0.31)	(0.48)			
	Post-199903	**-3.32**	**-0.14**	**2.26**	0.03		
		(5.00)	(0.17)	(2.01)			
	Post - Pre	**-3.18**	**-0.74**	**1.99**	0.66	10.66***	0.77
		(5.11)	(0.35)	(2.07)			
Core PCE	Pre-199903	**-1.56**	**0.23**	**0.95*****	0.88		
		(0.52)	(0.18)	(0.26)			
	Post-199903	**-0.58**	**0.23**	**0.78**	0.11		
		(1.24)	(0.17)	(0.48)			
	Post - Pre	**0.98**	**-0.00**	**-0.17**	0.89	7.13**	1.51
		(1.35)	(0.25)	(0.55)			
GDP price	Pre-199901	**-1.13**	**0.42**	**0.64****	0.82		
		(0.57)	(0.24)	(0.29)			
	Post-199901	**-2.80**	**0.44**	**1.60**	0.27		
		(2.58)	(0.14)	(1.05)			
	Post - Pre	**-1.68**	**0.02**	**0.97**	0.76	4.20	0.94
		(2.65)	(0.28)	(1.09)			
Comp. per hour	Pre-199703	**-0.85**	**0.23**	**0.92****	0.54		
		(1.30)	(0.16)	(0.35)			
	Post-199703	**-8.40**	**0.17**	**4.57*****	0.21		
		(2.21)	(0.11)	(0.92)			
	Post - Pre	**-7.54**	**-0.06**	**3.65**	0.40	5.85*	3.40*
		(2.48)	(0.19)	(0.97)			

Note: *, **, *** denote 10, 5, and 1 percent statistical significance of θs and Ave-Fs.

Table 11: Estimates of $\pi_{t+4,t} = \alpha + \kappa X_{t+4,t} + \theta E_t^{SPF}(\pi_{t+40,t}) + u_t$

		α	κ	θ	R^2	Ave-F, $\frac{tbrk}{T} \in [0.35, 0.65]$ All	θ
CPI	Pre-200203	**-2.30**	**-0.95**	**1.61*****	0.73		
		(0.72)	(0.20)	(0.22)			
	Post-200203	**-1.55**	**-0.31**	**1.71**	0.10		
		(9.11)	(0.22)	(3.65)			
	Post - Pre	**0.75**	**0.64**	**0.10**	0.61	12.23***	0.44
		(9.14)	(0.30)	(3.66)			
Core CPI	Pre-199702	**-2.18**	**-0.71**	**1.63*****	0.84		
		(0.60)	(0.18)	(0.17)			
	Post-199702	**2.23**	**-0.22**	**-0.01**	0.52		
		(0.53)	(0.03)	(0.20)			
	Post - Pre	**4.41**	**0.48**	**-1.64**	0.89	18.29***	11.70***
		(0.80)	(0.18)	(0.26)			
PCE price	Pre-199903	**-2.74**	**-0.50**	**1.48*****	0.79		
		(0.69)	(0.17)	(0.20)			
	Post-199903	**-0.41**	**-0.19**	**1.03**	0.10		
		(6.41)	(0.14)	(2.58)			
	Post - Pre	**2.33**	**0.31**	**-0.45**	0.68	13.79***	0.74
		(6.45)	(0.21)	(2.59)			
Core PCE	Pre-199904	**-2.51**	**-0.29**	**1.43*****	0.90		
		(0.47)	(0.11)	(0.14)			
	Post-199904	**0.58**	**-0.13**	**0.53**	0.33		
		(1.63)	(0.04)	(0.67)			
	Post - Pre	**3.09**	**0.17**	**-0.91**	0.91	19.58***	4.82**
		(1.69)	(0.12)	(0.68)			
GDP price	Pre-199904	**-2.97**	**-0.54**	**1.51*****	0.86		
		(0.60)	(0.14)	(0.18)			
	Post-199904	**-1.77**	**-0.24**	**1.66**	0.33		
		(3.82)	(0.09)	(1.58)			
	Post - Pre	**1.20**	**0.30**	**0.14**	0.80	22.49***	1.46
		(3.86)	(0.17)	(1.59)			
Comp. per hour	Pre-199703	**-1.95**	**-0.64**	**1.54*****	0.59		
		(1.17)	(0.21)	(0.25)			
	Post-199703	**-2.61**	**-0.64**	**2.69*****	0.45		
		(2.05)	(0.16)	(0.75)			
	Post - Pre	**-0.66**	**-0.00**	**1.15**	0.54	6.96**	1.34
		(2.30)	(0.26)	(0.78)			

Note: *, **, *** denote 10, 5, and 1 percent statistical significance of θs and Ave-Fs.

Table 12: Granger Causality Tests and Phillips Curve Estimates using Treasury Inflation-Protected Securities (TIPS) Inflation Compensation over the five year period starting five years ahead

	$\pi_{t+4,t} = \alpha + \rho\pi_{t,t-4} + \theta E_t^{TIPS}(\pi_{t+40,t+21}) + u_t$			
	α	ρ	θ	R^2
CPI	**3.08**	**-0.07**	**-0.32**	-0.04
	(1.70)	(0.27)	(0.90)	
Core CPI	**0.49**	**0.22**	**0.41***	0.06
	(0.63)	(0.14)	(0.24)	
PCE price	**2.83**	**-0.00**	**-0.39**	-0.04
	(1.19)	(0.29)	(0.69)	
Core PCE	**1.20**	**0.34**	**-0.03**	0.07
	(0.34)	(0.21)	(0.19)	
GDP price	**-0.23**	**0.59**	**0.41**	0.30
	(1.52)	(0.21)	(0.68)	
Comp. per Hour	**5.09**	**0.24**	**-1.23**	0.04
	(2.55)	(0.21)	(1.00)	
	$\pi_{t+4,t} = \alpha + \kappa u_{t+4,t} + \theta E_t^{TIPS}(\pi_{t+40,t+21}) + u_t$			
	α	κ	θ	R^2
CPI	**5.09**	**-0.38**	**-0.98***	0.11
	(1.56)	(0.23)	(0.59)	
Core CPI	**2.02**	**-0.22**	**0.09**	0.51
	(0.70)	(0.05)	(0.27)	
PCE price	**4.32**	**-0.29**	**-0.83***	0.12
	(1.14)	(0.17)	(0.44)	
Core PCE	**2.56**	**-0.19**	**-0.22**	0.46
	(0.51)	(0.05)	(0.21)	
GDP price	**2.17**	**-0.33**	**0.13**	0.34
	(1.15)	(0.11)	(0.43)	
Comp. per Hour	**7.89**	**-0.58**	**-1.74*****	0.35
	(1.51)	(0.09)	(0.56)	

Note: *, **, *** denote 10, 5, and 1 percent statistical significance of θs.

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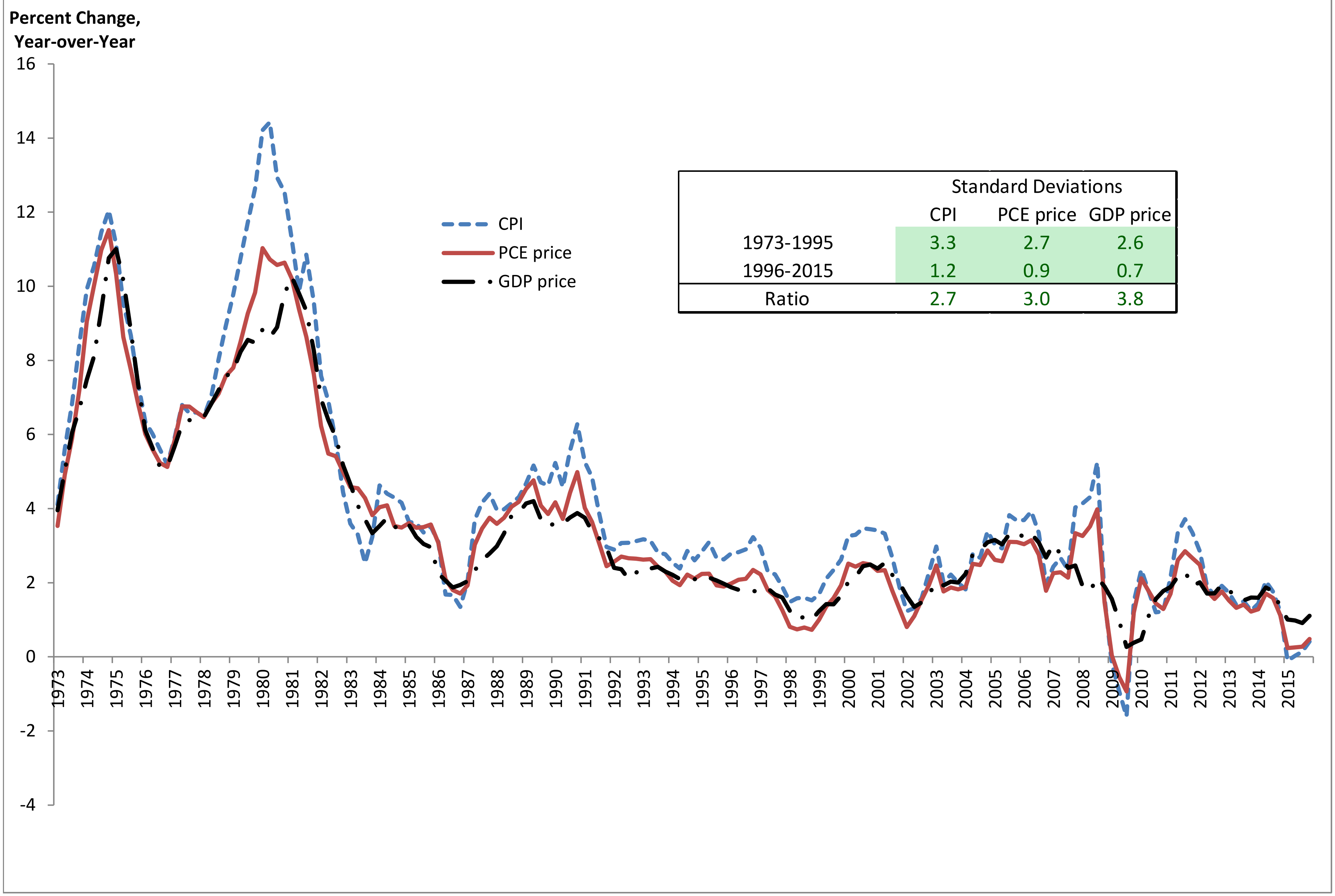
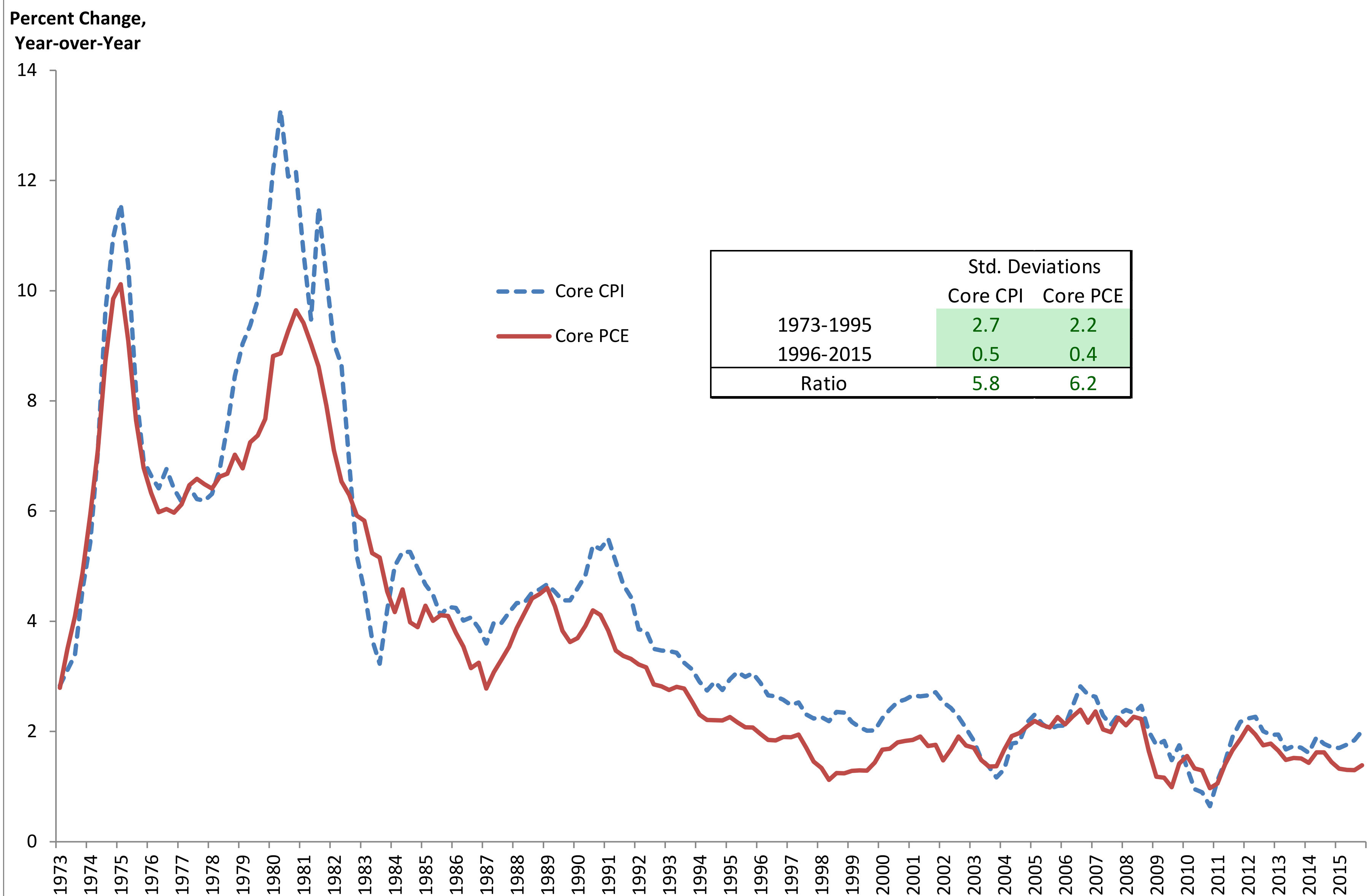
Figure 1: Total Inflation Measures



	Standard Deviations		
	CPI	PCE price	GDP price
1973-1995	3.3	2.7	2.6
1996-2015	1.2	0.9	0.7
Ratio	2.7	3.0	3.8

Figure 2: Core Inflation Measures



	Std. Deviations	
	Core CPI	Core PCE
1973-1995	2.7	2.2
1996-2015	0.5	0.4
Ratio	5.8	6.2

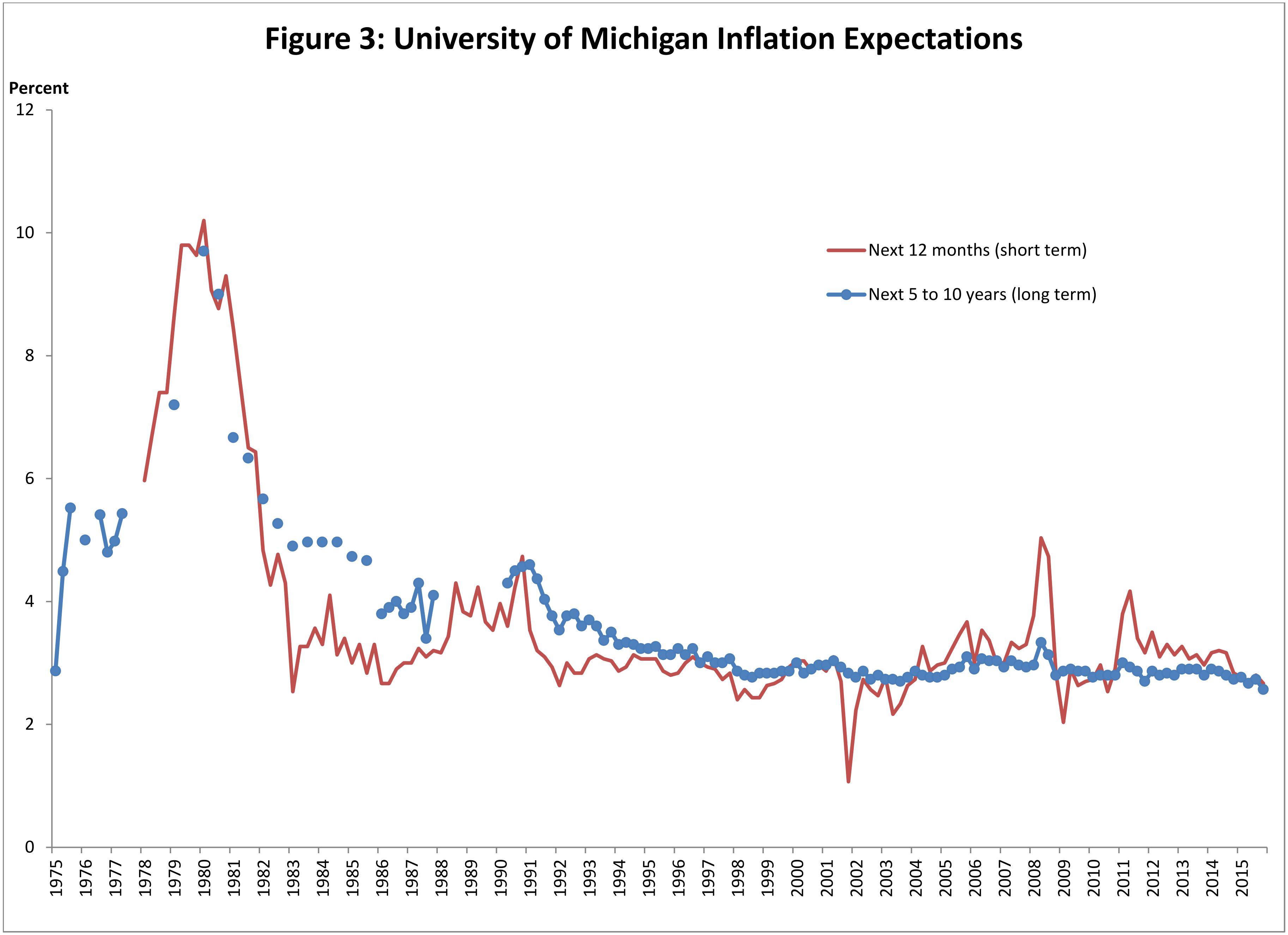


Figure 3: University of Michigan Inflation Expectations
Percent
12
10
8
6
4
2
0
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Next 12 months (short term)
Next 5 to 10 years (long term)

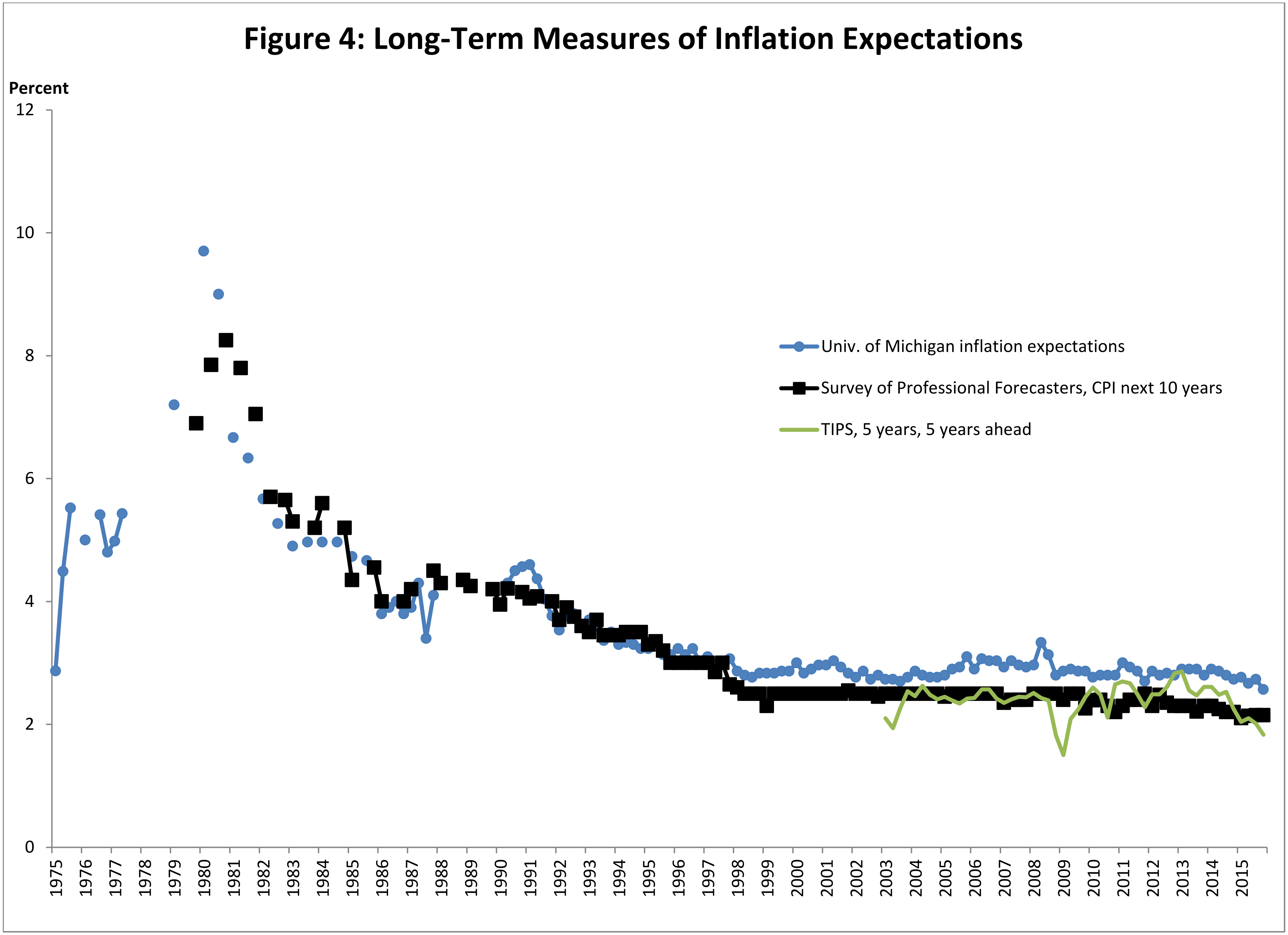


Figure 4: Long-Term Measures of Inflation Expectations
Percent
12
10
8
6
4
2
0
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
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1996
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2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Univ. of Michigan inflation expectations
Survey of Professional Forecasters, CPI next 10 years
TIPS, 5 years, 5 years ahead

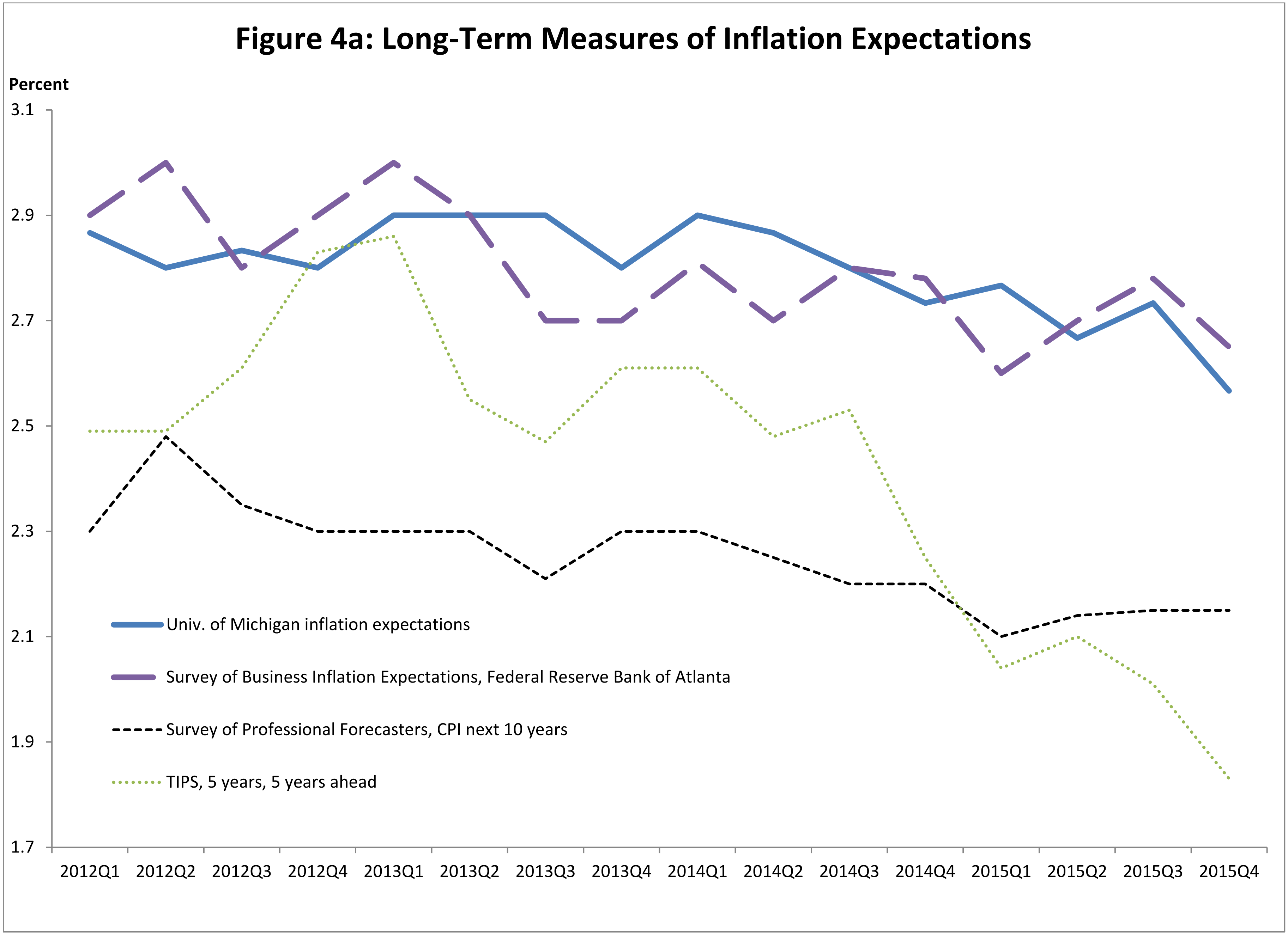


Figure 4a: Long-Term Measures of Inflation Expectations
Percent
3.1
2.9
2.7
2.5
2.3
2.1
1.9
1.7
Univ. of Michigan inflation expectations
Survey of Business Inflation Expectations, Federal Reserve Bank of Atlanta
Survey of Professional Forecasters, CPI next 10 years
TIPS, 5 years, 5 years ahead
2012Q1
2012Q2
2012Q3
2012Q4
2013Q1
2013Q2
2013Q3
2013Q4
2014Q1
2014Q2
2014Q3
2014Q4
2015Q1
2015Q2
2015Q3
2015Q4

Figure 5: Short-Term Michigan Inflation Expectations and CPI Inflation over the Past Year

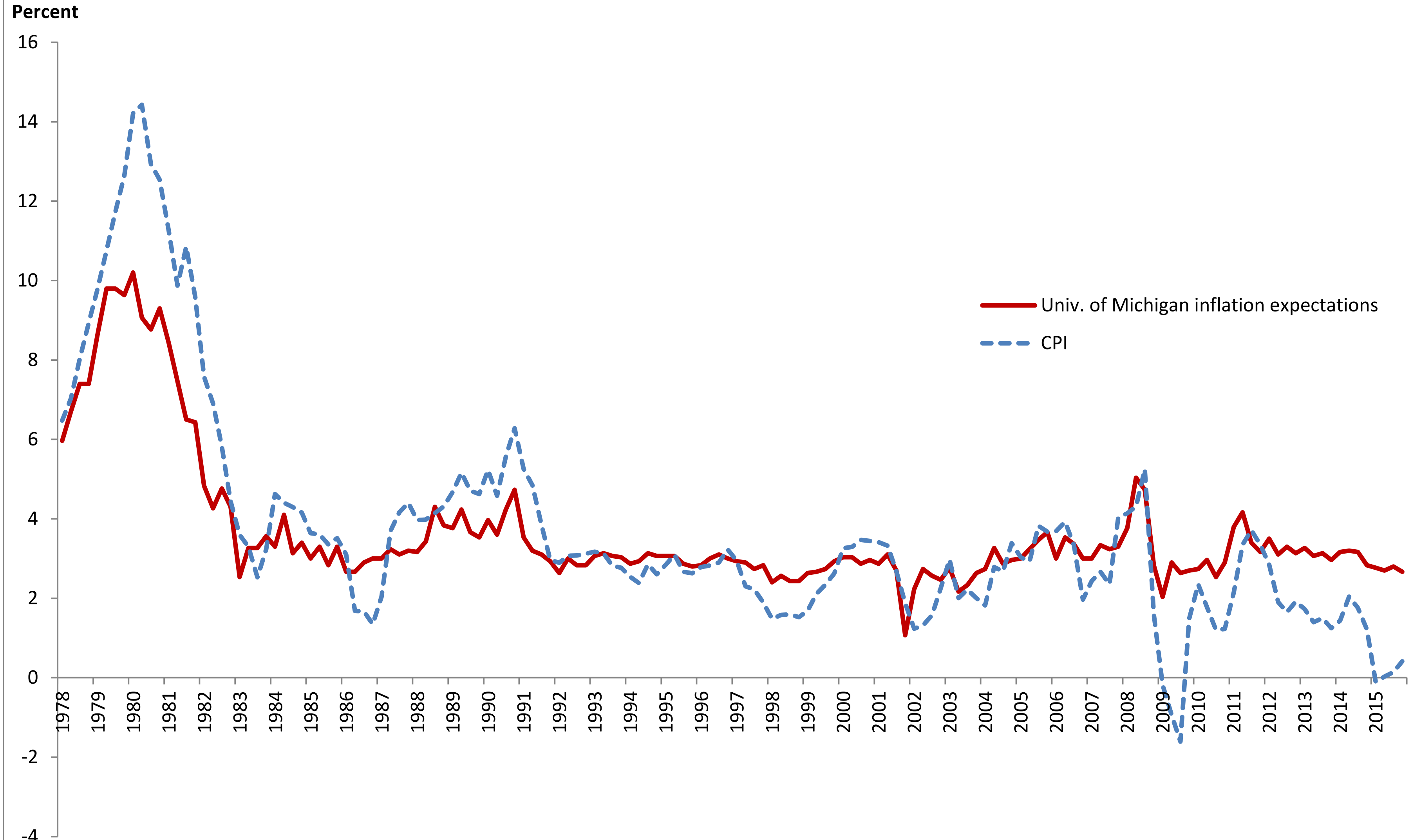


Figure 6: Short-Term Michigan Inflation Expectations and CPI Inflation over the Next Year

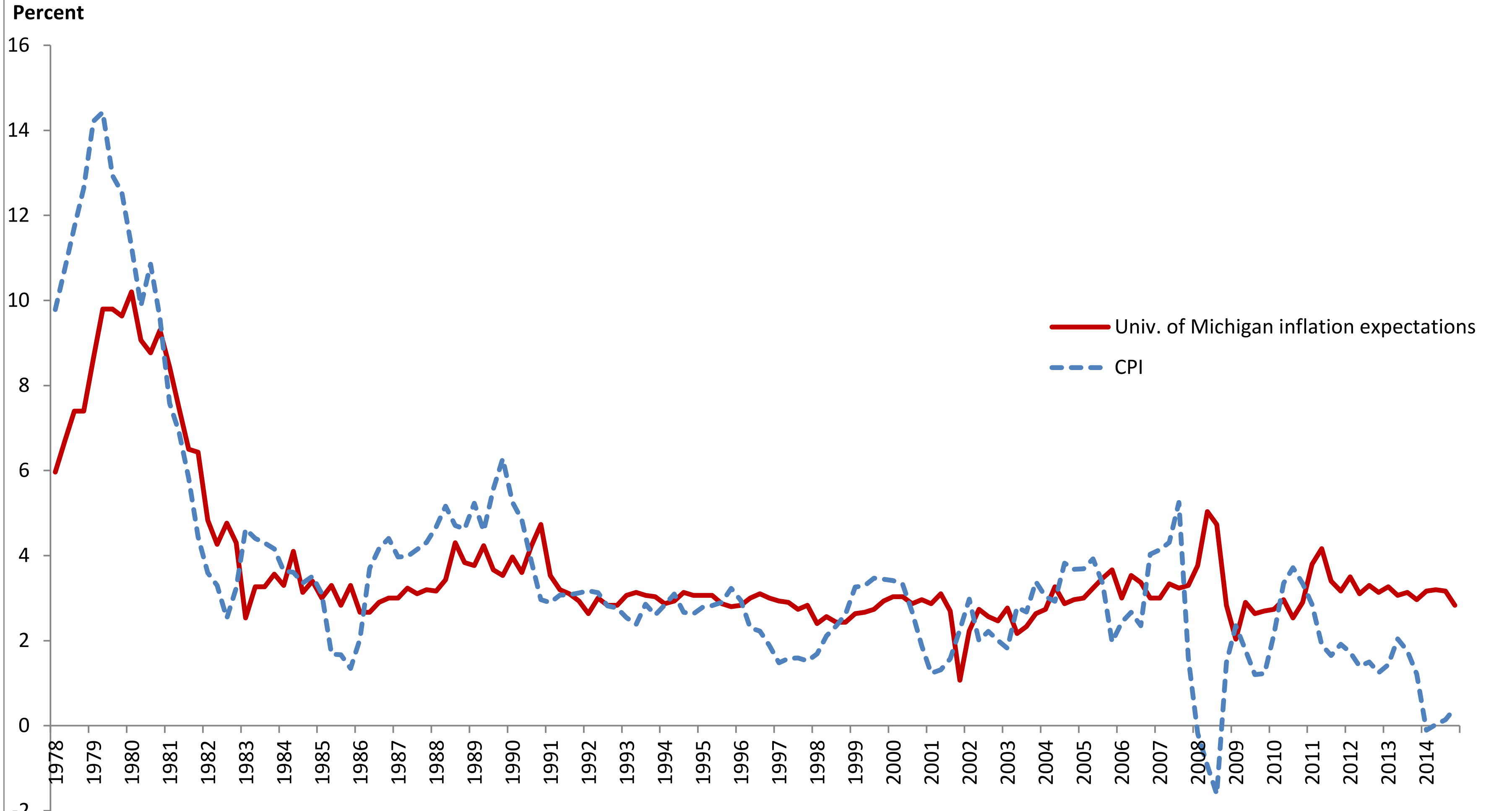
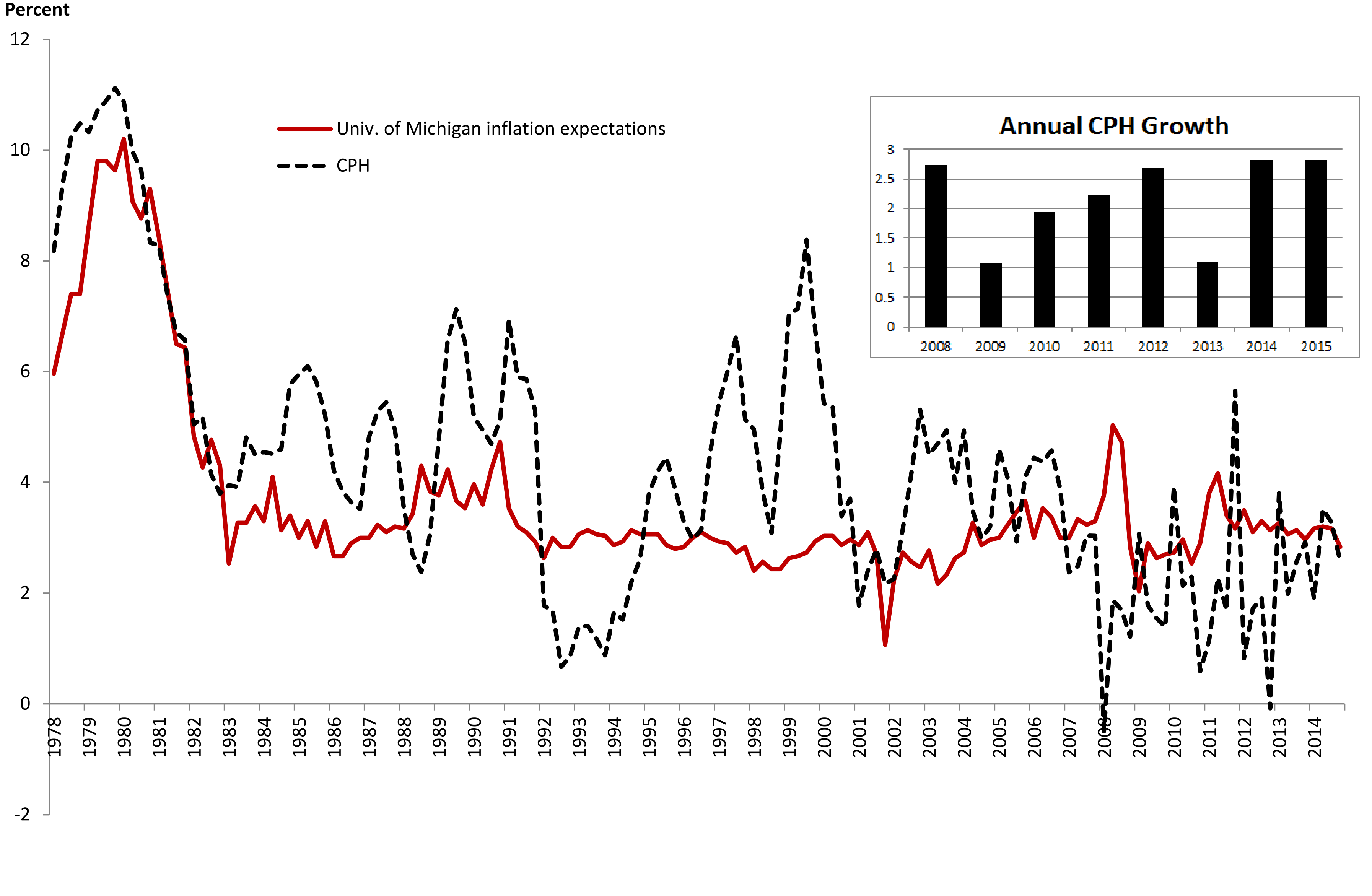


Figure 7: Short-Term Michigan Inflation Expectations and Compensation per Hour (CPH) Growth over the Next Four Quarters



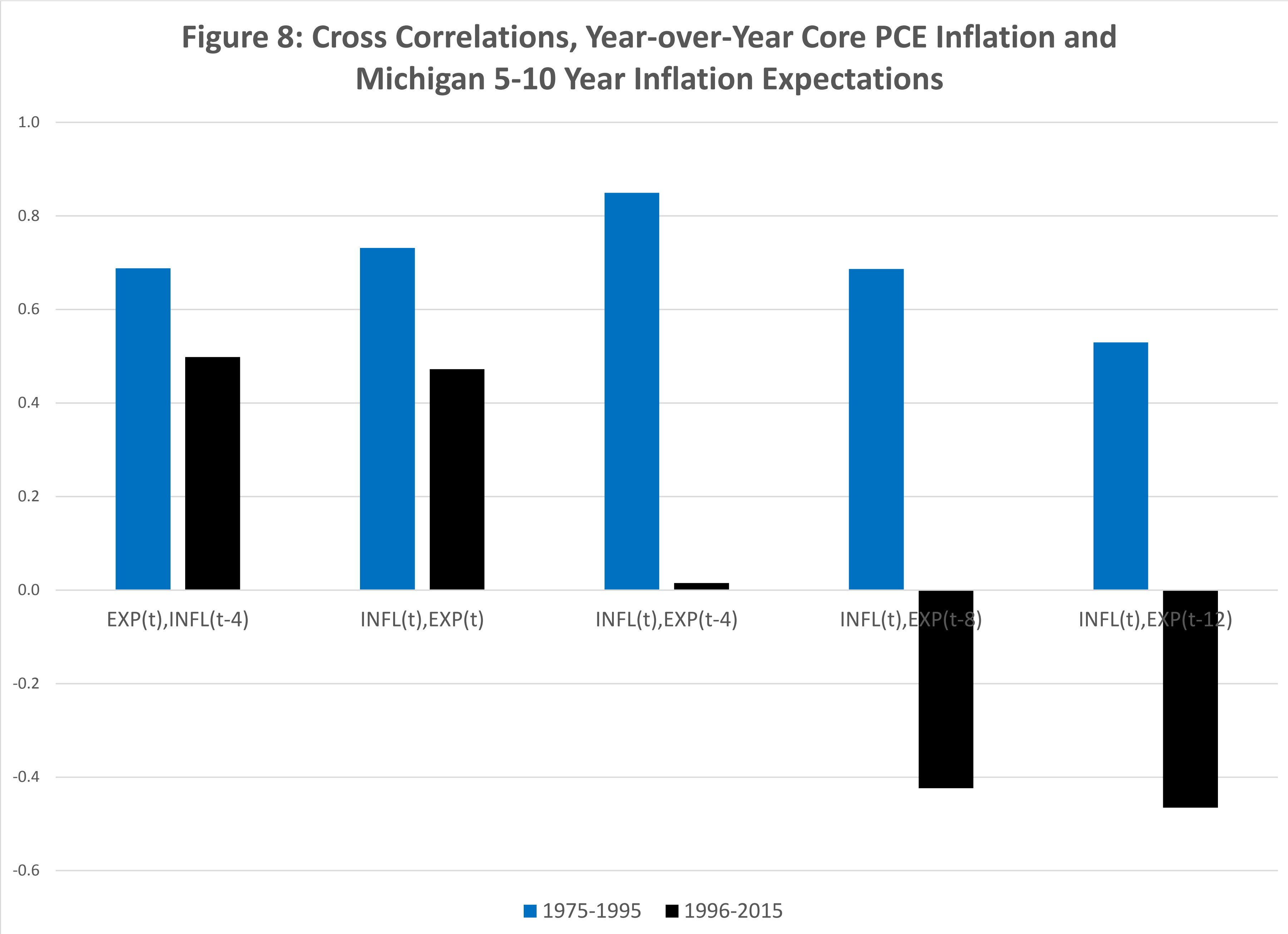


Figure 8: Cross Correlations, Year-over-Year Core PCE Inflation and Michigan 5-10 Year Inflation Expectations
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
EXP(t),INFL(t-4)
INFL(t),EXP(t)
INFL(t),EXP(t-4)
INFL(t),EXP(t-8)
INFL(t),EXP(t-12)
1975-1995
1996-2015

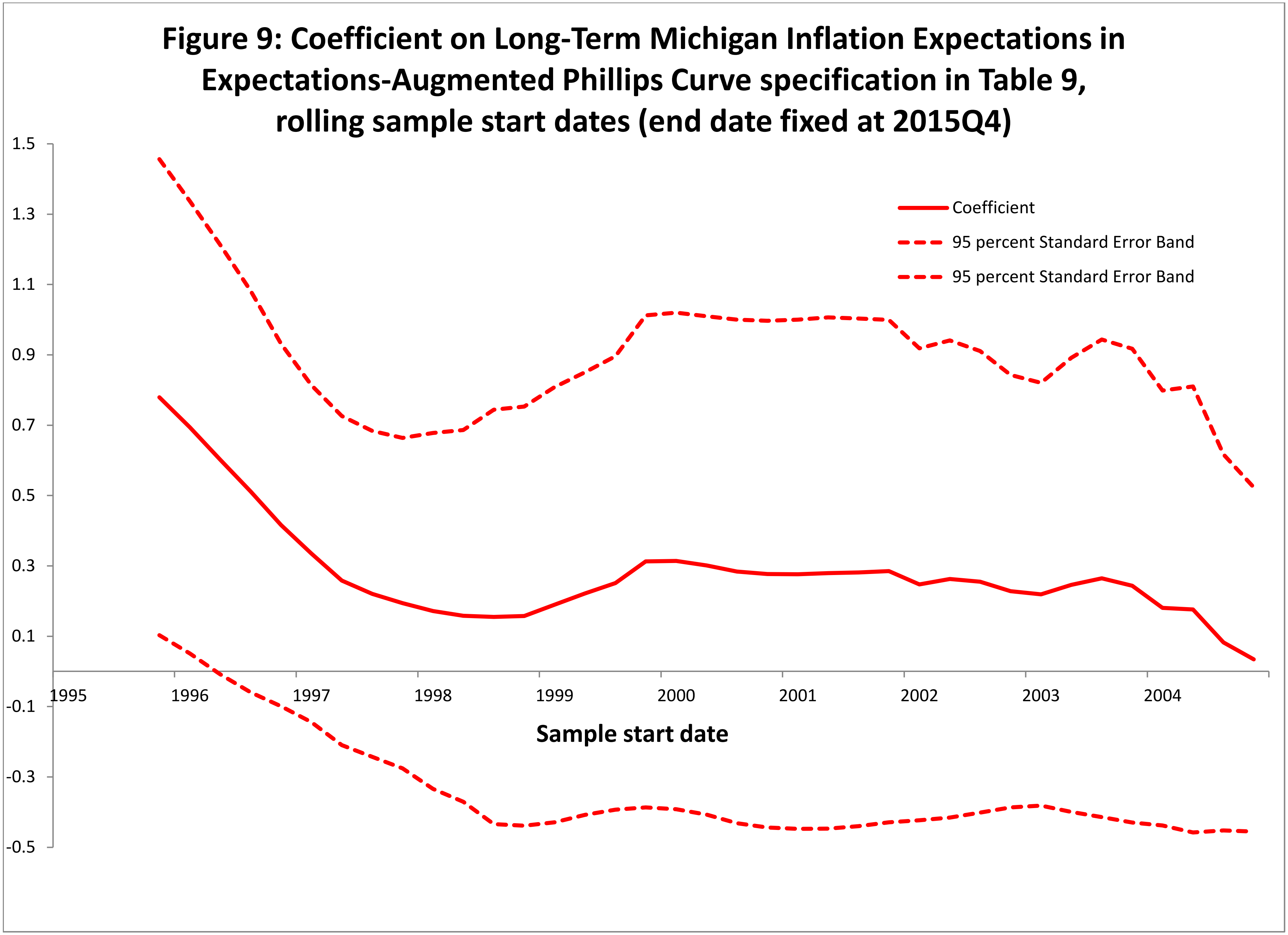


Figure 9: Coefficient on Long-Term Michigan Inflation Expectations in Expectations-Augmented Phillips Curve specification in Table 9, rolling sample start dates (end date fixed at 2015Q4)
1.5
1.3
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
-0.3
-0.5
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Sample start date
Coefficient
95 percent Standard Error Band
95 percent Standard Error Band

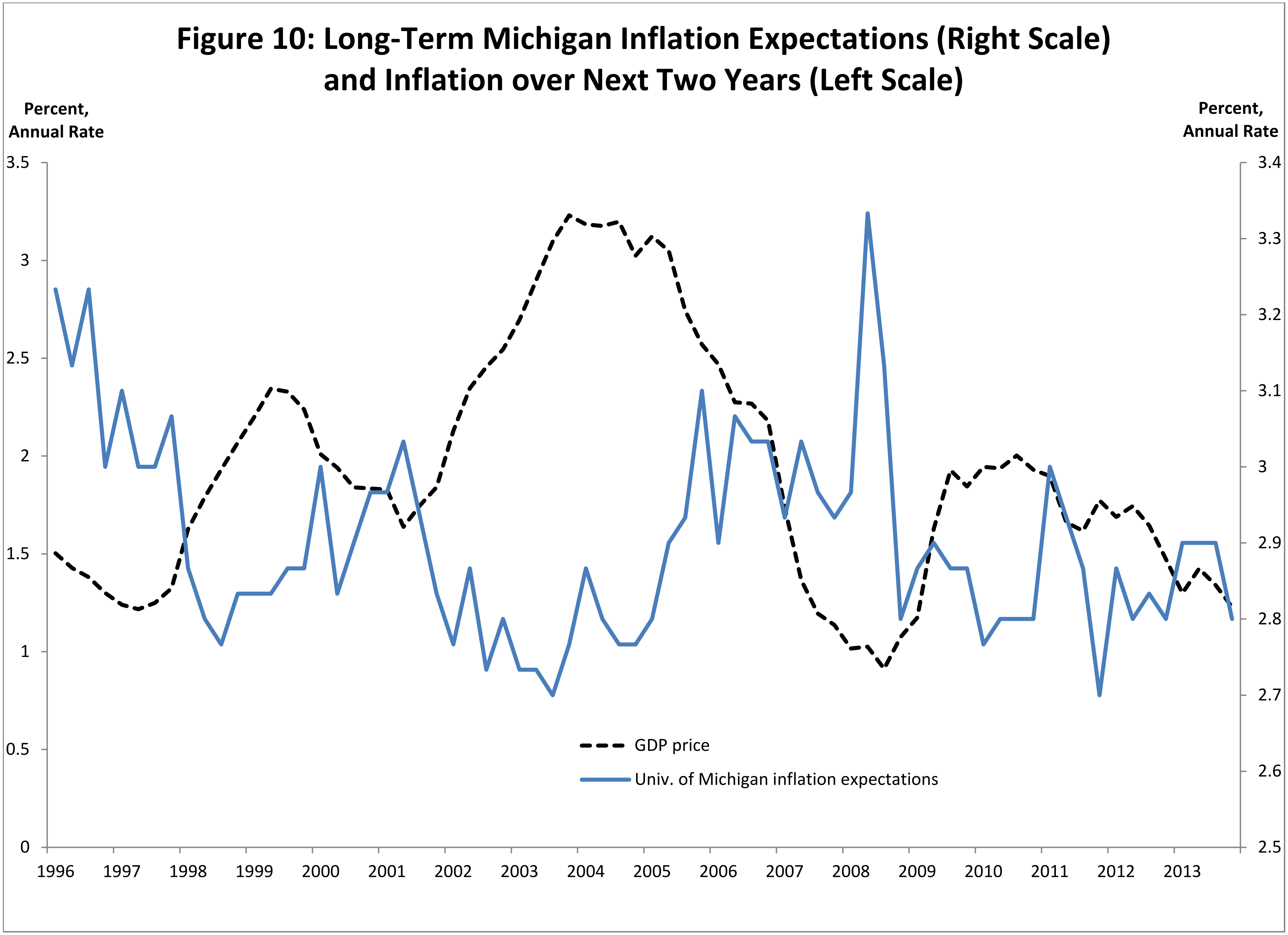


Figure 10: Long-Term Michigan Inflation Expectations (Right Scale)
and Inflation over Next Two Years (Left Scale)
Percent,
Annual Rate
Percent,
Annual Rate
3.5
3
2.5
2
1.5
1
0.5
0
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
GDP price
Univ. of Michigan inflation expectations

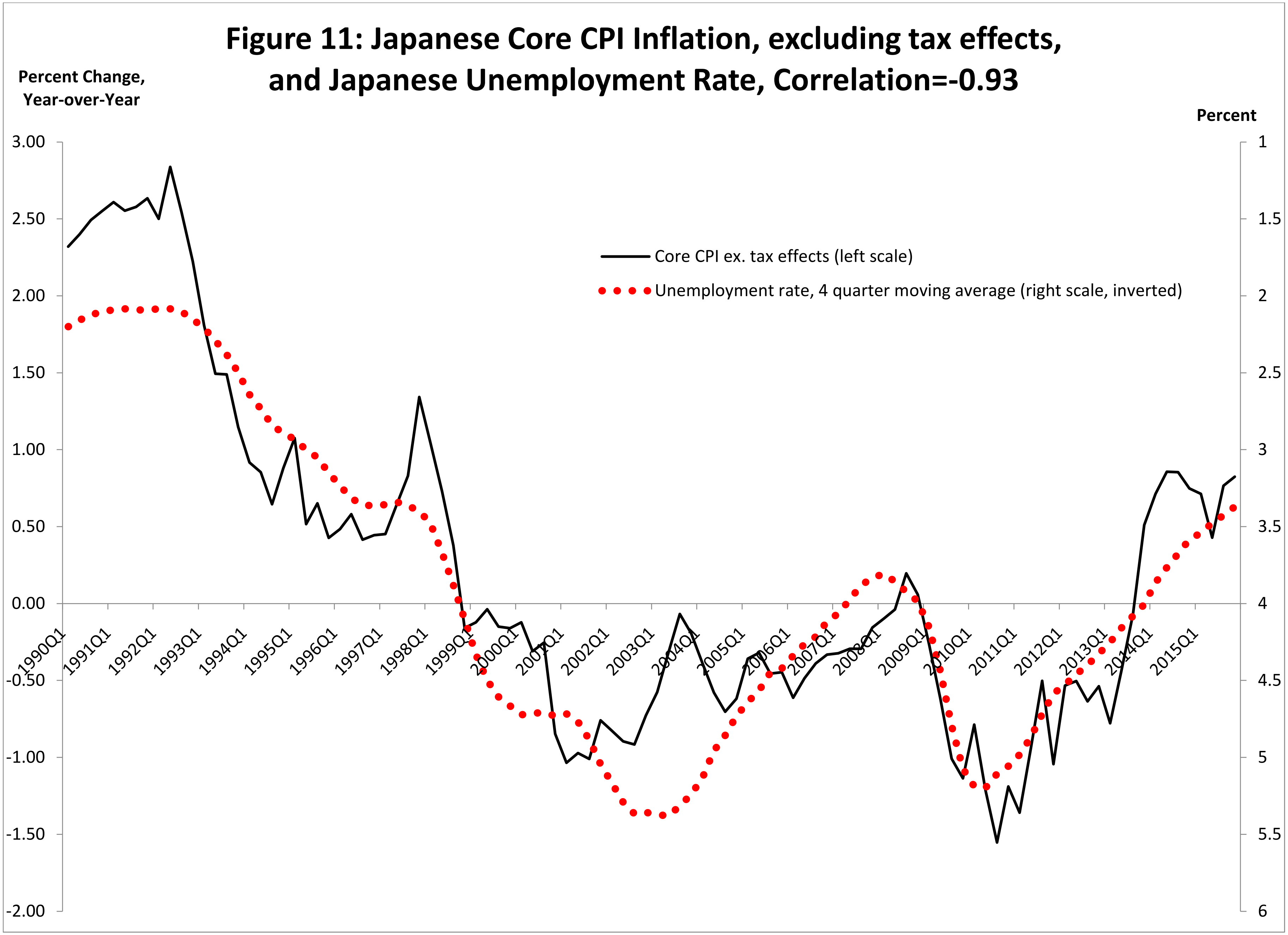


Figure 11: Japanese Core CPI Inflation, excluding tax effects, and Japanese Unemployment Rate, Correlation=-0.93
Percent Change, Year-over-Year
Percent
Core CPI ex. tax effects (left scale)
Unemployment rate, 4 quarter moving average (right scale, inverted)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
1990Q1
1991Q1
1992Q1
1993Q1
1994Q1
1995Q1
1996Q1
1997Q1
1998Q1
1999Q1
2000Q1
2001Q1
2002Q1
2003Q1
2004Q1
2005Q1
2006Q1
2007Q1
2008Q1
2009Q1
2010Q1
2011Q1
2012Q1
2013Q1
2014Q1
2015Q1