US Economic Viewpoint

What lies beneath: underlying inflation and the confidence to cut

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Confidence to cut depends on underlying inflation

Understanding "underlying inflation" and where it is heading is important as the Fed determines when to start easing. If it keeps declining, the first rate cut should be in June as we expect. If it stalls, the Fed may be forced to delay. Getting a clear signal on underlying inflation can be hard as standard measures contain biases. We present an alternative approach.

Standard measures of underlying inflation have flaws

Underlying inflation is the rate of inflation that should prevail when the economy is "normalized", with output equal to potential and unemployment equal to the natural rate. Economists generally assess it through several well-known approaches that strip out volatile components. These include core inflation, trimmed mean measures of inflation, and sticky versus flexible price indices. Each excludes volatile categories to reveal the rate of "underlying inflation". We think these measures are useful but flawed.

We prefer a holistic approach

We think a better 'mousetrap' for estimating underlying inflation – free of bias – can be constructed with actual and expected inflation data while controlling for the business cycle through a standard Phillips curve equation. We extract information from available price data and do not exclude volatile components. We think this avoids the biases that can prevent standard measures from giving clear signals.

Getting there: underlying PCE inflation now at 2.8%

Our estimate of underlying PCE (personal consumption expenditure) inflation has fallen from a peak of 4.5% annualized in late 2021 to 2.8% today, based on data through 4Q 2023. Even after accounting for the cyclical position of the economy – where employment appears modestly above its maximum sustainable level – trends in actual inflation have moved underlying inflation lower. In addition, low and stable inflation expectations have played an important role in limiting the initial rise in underlying inflation and supported its subsequent decline.

Reaching 2.3-2.6% by mid-year would support cuts in June

If trends continue, underlying PCE inflation could fall to 2.3-2.6% by mid-year, supporting a first Fed cut in June. But the risk that it stops declining – or reaccelerates – is worth monitoring since the US economy continues to surprise to the upside. A more forward-looking Fed might put more weight on the signal from low inflation expectations and cut earlier, but this Fed is data-dependent and wants more evidence from actual price changes. Easing before June appears unlikely without evidence the economy is sharply weakening.

Underlying inflation: what is it?

Understanding where "underlying inflation" is and where it is heading is of utmost importance as the Fed decides when to ease its policy rate to engineer a soft landing for the US economy. After all, the Fed typically sets policy in a forward-looking manner, directing overshoots and undershoots of inflation back to the 2.0% target. This means it must know whether movements in inflation are driven by persistent or transitory forces – the latter should largely be ignored – and where inflation may settle when the economy is at full employment.

> Underlying inflation is the rate of inflation that would be achieved when the economy is functioning normally and running at capacity, with output equal to potential and unemployment equal to the natural rate.

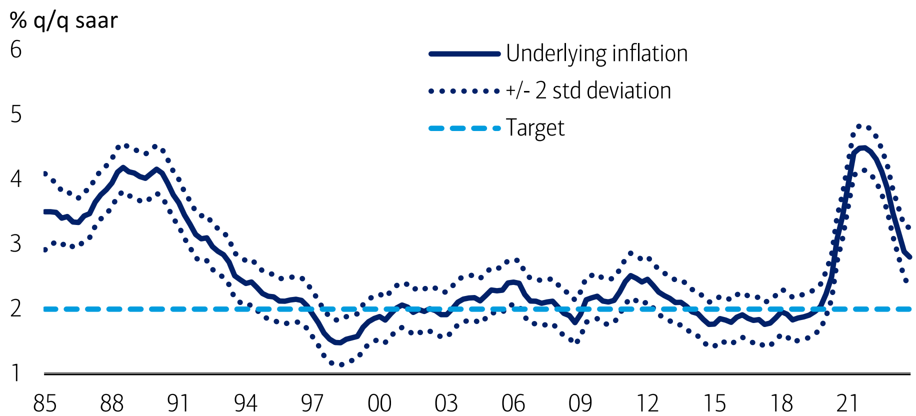
By this definition, underlying inflation is like the so-called "star variables" for the economy: potential growth, the natural rate of unemployment, and the real neutral policy rate. It cannot be observed directly and must be inferred or estimated from actual data. Since each data point is some combination of cycle and trend, policymakers need a methodology for separating transitory and cyclical price pressures from trend, or underlying, price pressures.

We present standard measures of underlying inflation and their pros and cons, and conclude their advantages outweigh their disadvantages. However, we also outline our preferred measure, which is a holistic approach to estimating underlying inflation that takes into account actual observations on inflation, long-run inflation expectations, and the cyclical position of the economy. We believe it offers a better picture of underlying inflation pressures, free of the biases that are present in standard measures.

Bottom line: Underlying PCE inflation at 2.8%

As we detail in this report, our estimate of underlying PCE inflation has fallen from a peak of 4.5% annualized in late 2021 to 2.8% today (Exhibit 1), based on data through 4Q 2023. Even after accounting for the cyclical position of the economy – where employment appears modestly above its maximum sustainable level – trends in actual inflation have moved underlying inflation lower. If trends continue, underlying PCE inflation could fall to 2.3-2.6% by mid-year, supporting a first Fed cut in June.

Exhibit 1: Underlying inflation versus the Fed's 2% inflation target (%, q/q saar)
Underlying PCE inflation has fallen below 3.0%



Source: Federal Reserve, BofA Global Research

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Standard measures: pros and cons

"Off-the-shelf" measures of underlying inflation include core inflation, trimmed mean inflation, sticky versus flexible price indices, and long-run inflation expectations. They are transparent, but the question is whether they fully capture the definition of underlying inflation.

Underlying inflation is generally assessed through several well-known approaches which focus on stripping out volatile components from actual inflation. These are:

- **Measures of core inflation.** The standard measures of core CPI and PCE inflation strip out food and energy prices. Core PCE includes food services inflation while core CPI does not. Removing food and energy is typically rationalized for two reasons: movements in these components tend to be volatile (eg. contain more noise than signal) and determined by global forces largely beyond the control of Federal Reserve policymakers. It is thought that core inflation gives a better reading on underlying inflation than movements in the aggregate headline index.

- **"Trimmed mean" measures of inflation.** These exclude components of the CPI or PCE price index with the most extreme movement in any given month. Normally this is done by excluding both the upper and lower most extreme movements, with the hope that remaining components give a clearer picture of underlying inflation. The most well-known trimmed mean indices are produced by the Federal Reserve Bank of Cleveland and Federal Reserve Bank of Dallas.[1]

- **Sticky versus flexible inflation.** The Federal Reserve Bank of Atlanta has developed sticky versus flexible price indices and the Bureau of Economic Analysis (BEA) produces a "market-based" headline PCE price index and a core measure excluding food and energy. These separate components with observable price measures (that reset with greater frequency) from other components which are imputed (and move more slowly).[2] There is some evidence that these measures can outperform traditional measures of core inflation in forecasting future inflation.[3]

- **Inflation expectations.** Measures of long-term inflation expectations from surveys and market-based indicators are widely used to assess underlying inflation. These include expectations from the University of Michigan Consumer Survey, the Survey of Professional Forecasters, and market-implied measures from differences between the yields on nominal and inflation-indexed Treasury securities. They are conceptually like the definition of underlying inflation since households, survey respondents, and financial markets have incentives to look through transitory disturbances in inflation, while focusing on long-term trends.

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[1] The Cleveland Fed's trimmed mean CPI index eliminates 8% of the weighted components with the highest and lowest one-month price changes. The mean is calculated from the remaining components," making the 16% trimmed mean CPI much less volatile than either the CPI or the core CPI. For the Dallas Fed's trimmed PCE inflation index, 24% of the weight from the lower tail and 31% of the weight in the upper tail are trimmed. According to the Dallas Fed, these proportions have been chosen based on historical data to give the best fit between the trimmed mean inflation rate and proxies for the true core PCE inflation rate. They report the resulting inflation measure outperforms the conventional "excluding food and energy" measure as a gauge of underlying inflation.

[2] Research by the Federal Reserve finds that the frequency of price changes increased during the pandemic. They find that the frequency and size of price changes rose in 2019-2020 and remained elevated through 2021. See Montag, Hugh and Daniel Villar, 2023, "Price-setting during the Covid era," FEDS Notes, Board of Governors of the Federal Reserve System, August 29.

[3] See Bognanni, Mark, "A Forecasting Assessment of Market-Based PCE Inflation", Federal Reserve Bank of Cleveland EC 2020-1, January 2020.

Transparent and simple, but flawed

The advantage of the traditional measures of underlying inflation is their transparency and simplicity. Three of them begin with the well-known CPI and PCE price indices and either exclude volatile measures that are likely to be noisy or separate imputed measures from those that have observable prices. They also have some empirical validity in that measures of core inflation and trimmed means are often shown to be better predictors of future inflation outcomes, suggesting their signal content is higher than the headline index itself.

Long-run inflation expectations, meanwhile, have the advantage of being conceptually similar to the Fed's mandate of stable prices over the medium term, and they may be less susceptible to cyclical swings in the economy.

It should come as little surprise that stripping out volatile components results in a smoother series that has greater correlation with movements in headline inflation over time. After all, volatile components are likely to have low persistence. Notwithstanding their respective advantages, we think each of the standard measures has flaws which compromises their ability to serve as unbiased measures of underlying inflation.

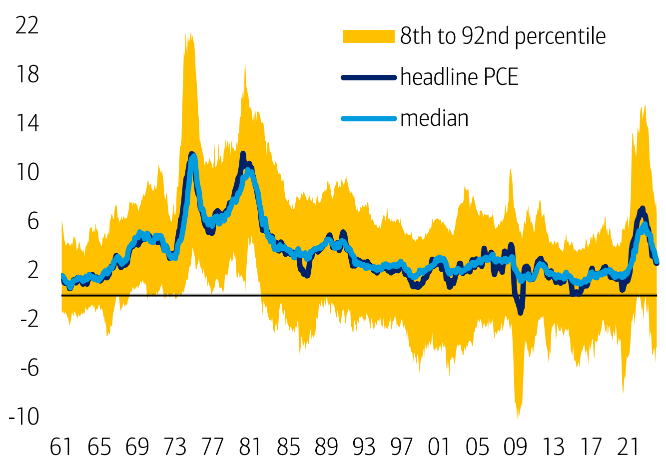
Stripping out volatile components could lead to bias

Is stripping out volatile components the right approach? One important flaw is that the standard measures mentioned above are likely to be influenced by the cyclical position of the economy. We think this is true even for long-run inflation expectations. In addition, the removal of volatile components could lead to a different mean rate of inflation for smoothed series relative to the mean of the excluded components. Failure to adjust for these factors could result in unwanted bias in the estimate of underlying inflation. Put simply, excluding the volatile components may generate a false signal about where underlying inflation is, complicating the policymaking process.

For example, imagine a situation where PCE inflation is comprised of a volatile and stable component. Assume the volatile component accounts for 20% of the index, while the stable component accounts for the remaining 80%. Further assume that the volatile component fluctuates around an average of zero each month, with large range of possible disturbances in either direction. Finally, assume that the rate of change in the remaining 80% always averages 2% annually. This is like the behavior of core goods and core services inflation in the decades prior to the pandemic: core goods prices oscillated around zero while core services inflation ran at low, stable rates of inflation.

Exhibit 2: Distribution of monthly inflation in PCE components (8th to 92nd percentile changes, % y/y)

Changes to monthly PCE inflation exhibit negative skew



Source: BEA, Haver Analytics, BofA Global Research

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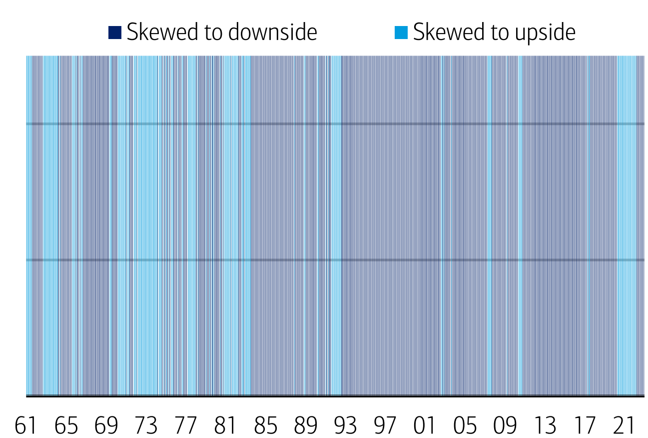
Exhibit 3: Months in which change in monthly PCE inflation exhibited negative or positive skew

Persistent negative skew in PCE price changes emerged in the mid-1980s



Source: BEA, Haver Analytics, BofA Global Research

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Excluding the volatile components will strip out changes in goods prices and the relative weights will imply underlying inflation close to 1.6%. Should policymakers view this as reflecting underlying inflation trends, they could embark on a policy error.[4] In other words, assuming the stable components that are averaging 2.0% rates of growth are a signal that overall inflation will average 2.0% would be an error. Actual inflation would run below this rate and the Fed may risk keeping policy overly tight.

> Trimmed mean measures of inflation create bias if the distribution of price outcomes is skewed (asymmetric). Symmetric trimming of the upper and lower tails create bias in estimates of underlying inflation.

Whether or not trimmed mean measures of inflation provide important signals about underlying inflation depends on the skewness of the distribution of inflation outcomes. The motivation behind these measures is the view that high frequency changes in prices of CPI and PCE subcomponents have fat tails (probability distributions with a high probability of extreme outcomes). Trimming these observations would lead to a more stable measure of inflation that has greater predictive power. However, if price changes are skewed – where, for example, the distribution of price changes is skewed to the upside – then symmetric trimming of the upper and lower tails would lead to downward bias in underlying inflation.

Research by the Cleveland Fed shows that monthly PCE inflation observations tend to have negative skew, leading to potential upside bias to trimmed mean PCE measure.[5] We demonstrate this in Exhibits 2 and 3. In Exhibit 2 we plot the 8th and 92nd percentiles for trimmed mean PCE and in Exhibit 3 we shade the months in which the distribution of outcomes is skewed to the upside or downside. Between the late 1980s and the global pandemic, the distribution of price changes was largely skewed to the downside, suggesting that symmetric trimming of price changes would lead to upside bias in underlying inflation from trimmed mean measures.

As shown in Exhibit 5, this upside bias appeared to affect PCE inflation more than CPI, with trimmed mean PCE running ahead of core PCE for over two decades prior to the pandemic. The negative skewness may well be driven by recessions, putting downward pressure on tradeable goods prices. Without a mechanism to control for this, policymakers may be receiving the wrong signal about underlying inflation trends.[6]

This situation changed during the pandemic beginning in April 2021 when inflationary pressures began to build on the back of adverse supply shocks to global goods trade and domestic labor supply. The distribution of inflation outcomes was skewed to the upside. Removing these volatile components meant trimmed PCE inflation ran below core PCE as price pressures built. We don't know for sure, but a reliance on trimmed mean measures of inflation could have been one factor that made the Fed late to realize that inflation pressures were building.

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[4] Academic research suggests that whether measures of core inflation are good predictors of future inflation is, in part, related to the time period under consideration. Longer time periods return greater correlation, while shorter time periods can see substantial divergence. See Carroll, Daniel and Randal Verbrugge, "Behavior of a New Median PCE Measure: A Tale of Tails," Federal Reserve Bank of Cleveland, July 2019. That said, several of the shorter periods considered include the oil prices shocks which could justify the removal of energy and food prices.

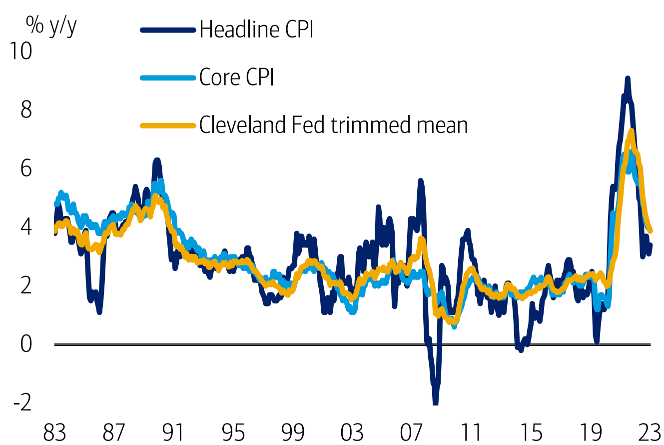
[5] See Carroll, Daniel and Randal Verbrugge, "Behavior of a New Median PCE Measure: A Tale of Tails," Federal Reserve Bank of Cleveland, July 2019.

[6] The Federal Reserve Bank of Dallas attempts to correct for this by trimming asymmetrically – 24% of the weight from the lower tail and 31% of the weight in the upper tail are trimmed – but this may prove insufficient when the distribution of price outcomes is changing. This would mean asymmetric trimming, which is based on historical data, may not align with what is needed going forward. See "the 2009 revision to the trimmed mean PCE inflation series", Federal Reserve Bank of Dallas.

Since March 2023, the distribution of price changes has shifted back to the downside as core goods prices have fallen consistently in recent months while services inflation has remained stickier. Measures of trimmed mean inflation are again running ahead of core PCE inflation.

Without a process that corrects for skewness, measures of trimmed mean inflation may contain bias in their estimate of underlying inflation. For much of the last several decades this has meant measures of trimmed mean inflation may have run higher than underlying inflation. This has again become the case as the economy emerges from the pandemic and goods prices give back prior outsized gains. A straight reliance on measures of trimmed mean inflation as a gauge of underlying inflation could raise the risk that the Fed stays too tight for too long.

Exhibit 4: Headline CPI, core CPI, and trimmed mean CPI (% y/y)
The distribution of monthly price changes in CPI inflation has been more symmetric, leading trimmed mean CPI to run in line with core CPI inflation



Source: BEA, Haver Analytics, BofA Global Research. Note: The 16% trimmed-mean CPI eliminates components showing extreme monthly price changes - in this case, 8 percent of the weighted components with the highest and lowest one-month price changes are eliminated and the mean is calculated from the remaining components.

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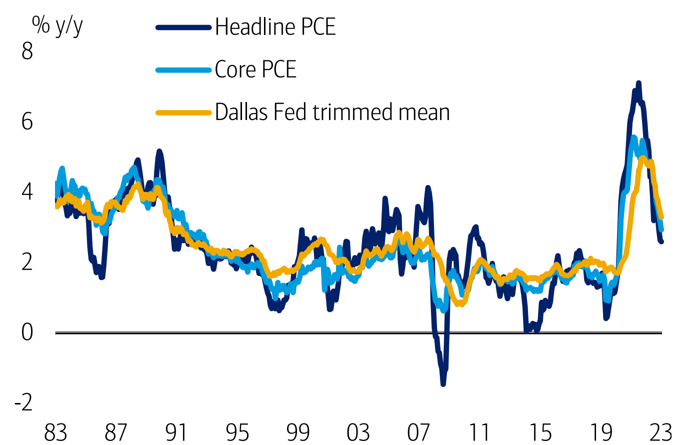
Exhibit 5: Headline PCE, core PCE, and trimmed mean PCE (% y/y)
Given the presence of negative skew in monthly price changes in PCE inflation, trimmed mean PCE has generally run above core PCE inflation



Source: BEA, Haver Analytics, BofA Global Research. Note: The Federal Reserve Bank of Dallas trimmed mean for PCE trims asymmetrically – 24% of the weight from the lower tail and 31% of the weight in the upper tail are trimmed. We plot the Dallas Fed trimmed mean here since the Cleveland Fed does not produced a trimmed mean for PCE inflation, only for CPI inflation.

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Expectations are not perfect signals either

We also find good reasons to think long-run inflation expectations send imperfect signals about underlying inflation. Beginning with the University of Michigan Survey on Consumers, respondents are asked, "by what percent per year do you expect prices to go up/down on average during the next 5 to 10 years?". For much of the two decades leading up to – and initially through – the global financial crisis, survey respondents replied that inflation was expected to remain low and stable around 3.0%. Following the financial crisis, household expectations began to dip lower, before rising again after the global pandemic. Recently, they have begun to turn lower.

It is not clear whether the price changes that households have in mind are similar to those included in CPI and PCE. In other words, the weights which households use to base their response are different than those in the officially constructed indices. For example, it is widely known that the survey outcome – even the 5 to 10y ahead survey response – is highly correlated to movements in gasoline prices and other items that households purchase frequently like milk and groceries.[7]

Gasoline prices change frequently and are highly observable to the average household in a country where driving remains the most important means of transportation. This suggests households "visually register" changes in gasoline prices more frequently than, for example, new and used cars or household appliances which they purchase less

[7] See Malmendier, Michael Weber, and Francesco D'Acunto, "Exposure to frequent price changes shapes inflation expectations," VoxEU CEPR, 15 November 2019.

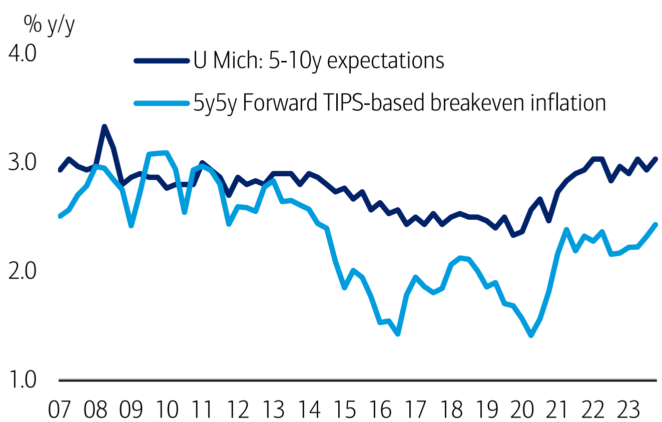
frequently. If excluding energy prices is correct when moving from headline to core measures of inflation, why would we rely on expectations measures that are highly influenced by changes in volatile energy prices?

Inflation expectations are not perfect, either. Measures of household expectations are correlated with movements in gasoline prices, professional forecasters might simply reflect the Fed's goals, and market-based measures include more than just inflation expectations.

A criticism of the central tendency from the Survey of Professional Forecasters is that the survey respondents are aware of the Fed's stated 2% inflation target, are more likely to use model-based procedures to estimate inflation (and use this target as an input to their forecasts, ensuring that inflation converges to 2% over time), and may also have worked within the Federal Reserve System (potentially biasing their assessment of Fed credibility). The risk is that these survey respondents will be biased in their expectations and say inflation will run at 2% "because the Fed wants it to." That may be right, on average, over time, but the experience of the last three years when professional forecasters largely missed the surge in inflation suggests bias can lead to errors.

Finally, market-based measures of inflation derived from the yield differentials between nominal and inflation-indexed Treasuries (TIPS) contain more information than just market participants' expectations for inflation outcomes. For example, breakeven yields between TIPS and their nominal counterparts include inflation expectations, an illiquidity risk premium on TIPS, and inflation risk premia (eg. whether the distribution of potential inflation outcomes is rising or falling). In addition, TIPS-based breakevens are based on market views of changes in CPI, which differs from the Fed's preferred PCE inflation measure. Extracting a clean reading on expectations for PCE-based inflation from market yields can be difficult.

Exhibit 6: Household and market inflation expectations (% y/y)
Household and market inflation expectations have rebounded from pandemic lows and are generally in line with 2% inflation outcomes



Source: University of Michigan, Haver Analytics, BofA Global Research
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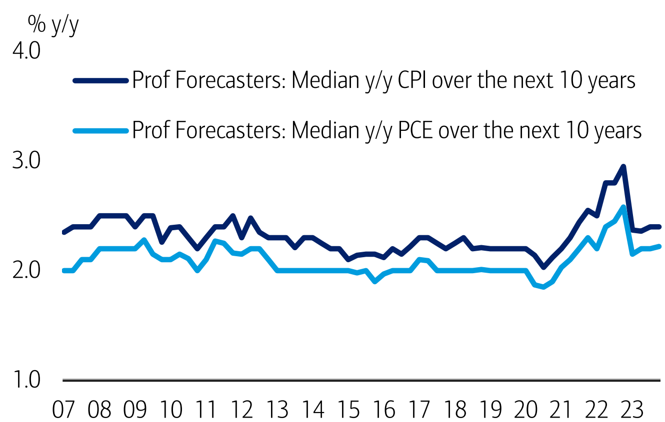
Exhibit 7: Survey of Professional Forecasters: Long-term forecasts
Expectations of long-term inflation from professional forecasters have come back down following the pandemic



Source: Federal Reserve Bank of Philadelphia, Haver Analytics, BofA Global Research
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Building a better mousetrap

We think the advantages of these standard approaches to underlying inflation outweigh their disadvantages, and we continue to promote their use. That said, we think there are better methods to obtain an unbiased measure of underlying inflation.

Our approach is to treat underlying inflation as an unobserved variable and extract information from available price data, which act as "signals". In forming our estimate, we do not exclude information from volatile components.[8] Nor do we exclude inflation expectations. Instead, we let the framework optimally weight information from a variety of sources. In addition, our framework considers the cyclical position of the US economy through the Phillips curve. We believe our approach can avoid the biases that cloud the ability of the standard measures to give clear signals on underlying inflation.

Our estimate of underlying inflation is accomplished through a multi-variate state space framework which decomposes movements in observable variables into trend and cycle estimates. Applied to inflation, the framework takes observable data on inflation and inflation expectations and separates cyclical inflation from its trend, the latter of which we call underlying inflation. We have used this framework to estimate the natural rate of unemployment, potential growth, and the neutral rate of interest (see Structurally higher US interest rates? Think again). Readers interested in the details of this process can refer to link above and the appendix to this report.

> We think a better mousetrap for estimating underlying inflation can be constructed using actual and expected inflation data while controlling for the business cycle through a standard Phillips curve equation.

Our system for estimating underlying inflation includes the following signal equations:[9]

- Two signal equations are based on Phillips curves for core PCE and core CPI inflation. They relate changes in current core inflation to past changes, cyclical pressures from the unemployment rate gap, and import prices. In both equations we interpret the long-run expected rate of inflation as "underlying inflation" for core PCE prices.

- Four signal equations from measures of inflation expectations from the University of Michigan Consumer Survey, the median 10-year ahead expectation for PCE price inflation from the Survey of Professional Forecasters, the median 10-year ahead expectation for CPI price inflation from the Survey of Professional Forecasters, and the breakeven measure of inflation five-to-ten years ahead implied by yields on the difference between nominal Treasury bonds and TIPS.

We constrain the two Phillips curve equations such that core PCE inflation will converge to its long-run expected level if the gap between the unemployment rate and its natural level and the gap between import inflation and core PCE inflation is zero. This constraint is consistent with the definition of underlying inflation above, whereby we seek to

[8] In some of our estimates we exclude food and energy prices, while in others we include energy prices. The results presented in this paper under the "full information" set of inputs excludes food and energy prices. Including energy prices increases the peak estimate of underlying inflation during the pandemic, but does not change the thrust of the overall analysis and conclusions.

[9] We apply our framework to quarterly data from 1Q 1985 to the present. One feature of our framework, and the Kalman filter that underlies its implementation, is that it can still be applied when data gaps are present. Hence, including 5y5y TIPS-based breakevens, which did not appear until 1Q 1999, is possible even though we start our sample period as of 1985. This also helps when we apply the data from the Survey of Professional Forecasters and University of Michigan survey since both have data gaps in in the 1980s. The Survey of Professional Forecasters' series for core PCE inflation did not begin until 2007.

estimate the rate of inflation expected to prevail when output is equal to potential and unemployment is equal to the natural rate.

We also include a level adjustment factor in the CPI-based Phillips curve to allow for the historical gap between core CPI and core PCE price inflation based on the different weights in the two indices. We also do this since the Fed's inflation target is written in terms of PCE inflation and because there is information in CPI that is relevant for PCE inflation.

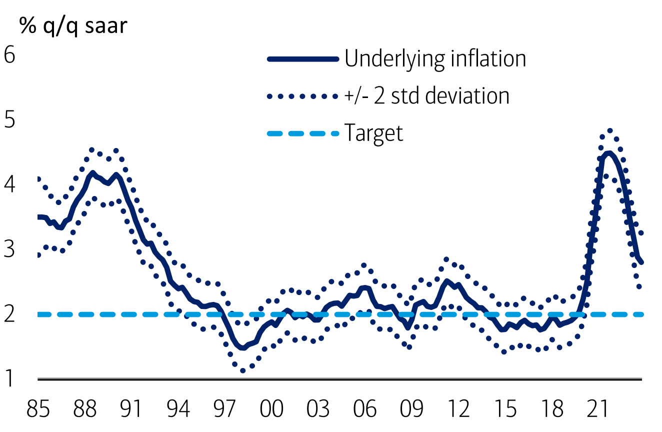
Full information set: underlying inflation falls to 2.8%

We begin by showing the results of our estimate of underlying inflation using all six signal equations that use information from actual prices in a Phillips curve setting and inflation expectations (Exhibit 8). We also plot the 95% confidence interval (+/- 2 standard deviations) and the Fed's 2% inflation target.

Underlying inflation was on a downward trend in the 1980s as the Fed sought to reverse the inflation episode of the previous decade, though underlying inflation remained above the 2% target entering the early 1990s (the Fed did not begin to implicitly target inflation around 2% until the 1990s and only implemented an official 2% target in 2012). By the mid-1990s, underlying inflation settled near 2% and stayed there until the onset of the global pandemic. During this 25-year period, underlying inflation ranged between 1.5% and 2.5%. For much of 2014-18 following the global financial crisis, underlying inflation was running modestly below the 2% target, prompting the Fed's "lower-for-longer" policy rate stance to push inflation up from below.

As the pandemic hit, global supply chains became constrained, willingness to supply labor fell, and government policy tilted in the direction of large-scale public transfers. This led to increases in actual and expected inflation, pushing our estimate of underlying PCE inflation from 2.0% in December 2019 to a peak of 4.5% at the end of 2021.[10] The 95% confidence interval pointed to underlying inflation as high as 4.8%. These were the highest readings on underlying inflation since the mid-1980s.

Exhibit 8: Underlying inflation versus the Fed's 2% inflation target (%, q/q saar)
Underlying inflation has fallen back below 3.0%



Source: Federal Reserve, BofA Global Research

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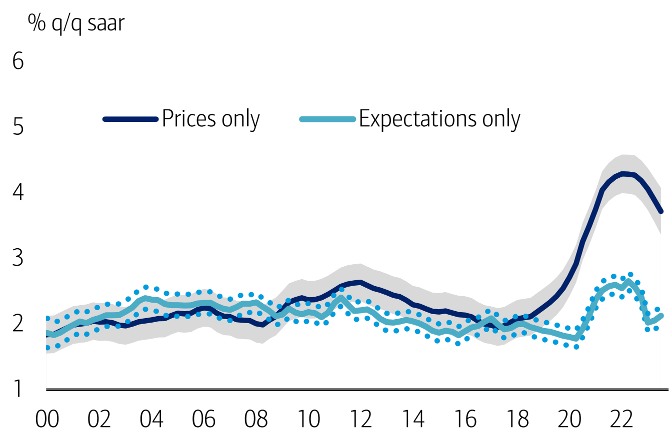
Exhibit 9: Underlying inflation using price data only and expectations data only (% q/q saar)
Low inflation expectations have helped anchor underlying inflation



Source: BofA Global Research. Note: Gray shaded area and dashed line indicate +/- 2 std deviation

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[10] In the model where we include energy prices, underlying inflation rises even higher to 6.1% at its peak in 3Q23. Hence, incorporating information from energy prices makes the peak in underlying inflation higher and later.

Since then, however, underlying inflation has trended lower on account of falling goods prices and softening core services inflation. Based on data through 4Q 2023, underlying inflation has fallen to 2.8%. Even after accounting for the cyclical position of the economy – where employment appears modestly above its maximum sustainable level – trends in actual inflation have moved underlying inflation lower. In addition, inflation expectations have remained low and stable.

Consumer inflation expectations from the University of Michigan Survey on Consumer Confidence have risen to levels that in the past have been consistent with 2% PCE inflation outcomes, after having moved lower in the years prior to the pandemic. In this case, higher long-run expectations are a good outcome since consumer inflation expectations had fallen to their lowest recorded level since the beginning of the survey in the early 1980s, causing us to question whether they were becoming unanchored to the downside, making it harder for the Fed to achieve its goals.

> Underlying inflation has come down rapidly, driven by disinflation in actual prices and – importantly – low and stable inflation expectations. Previously earned inflation-fighting credibility is helping the Fed reduce rates of inflation today.

The role of low and stable inflation expectations

Framework estimates suggest that low and stable inflation expectations have played a key role in holding underlying inflation down. To highlight the relative contribution of long-run inflation expectations versus measured prices to estimates of underlying inflation, we estimate two different versions of our underlying inflation framework.

In one version we estimate underlying inflation using only information from measured prices and the Phillips curve signal equations, while a second version uses only information from inflation expectations. We refer to these as the “prices only” estimate and the “expectations only” estimate of underlying inflation. Results are plotted in Exhibit 9. As we detail in the appendix to this report, we see our “prices only” estimate as similar in spirit to the New York Fed’s Multivariate Core Trend Inflation measure.

The prices only estimate of underlying inflation rose sharply during the pandemic, rising to 4.25% by mid-2022, before falling back to 3.7% as of December 2023. In contrast, the “expectations only” estimate of underlying inflation remained more stable, rising from about 2.0% to 2.5% at its peak. It stands at 2.2% currently.

When weighing these two signals, our estimate of underlying inflation places weight on both measured inflation through the Phillips curve equations and proxies for inflation expectations. The peak rate of underlying inflation at 4.5% appears to reflect both stronger incoming data on actual prices plus the temporary rise in inflation expectations from 2020 to 2022.

That said, underlying inflation at 2.8% appears to reflect the anchoring of inflation expectations at mandate-consistent levels. The drop in underlying inflation from its peak in the full information model has been larger than the drop in underlying inflation from the “prices only” estimate. The remainder must come from the retracement in inflation expectations in 2023. With expectations playing their role as anchor, underlying inflation has diminished more rapidly than has measured inflation. In other words, the credibility the Fed earned in its response to the last major inflation surge in the 1970s helped suppress the initial rise in underlying inflation in the early phase of the pandemic and is currently helping underlying inflation decelerate.

Implications for a data-dependent Fed

Following the global financial crisis, but before the onset of the global pandemic, we argued that underlying inflation had moved to a lower trajectory (modestly below 2.0%) beginning in 2015. This was just around the time the Fed was guiding financial markets to a lift-off from the zero lower bound, which eventually happened in December 2015.

We felt initiating a tightening cycle when inflation was running below 2% could reduce Fed credibility, push inflation expectations even lower, and make it more difficult for the Fed to deliver on low-for-long promises in future zero lower bound episodes. There is some evidence this was the case with the expectations-only estimate of underlying inflation falling to 1.96% from 2016-2019, after averaging 2.1% from 2010-2015. We don't want to overstate this decline since both numbers are within the margin of error, but it does appear that inflation expectations were drifting below mandate-consistent levels as the Fed considered lift-off.

> Following the global financial crisis, a Fed that wanted to lift off the zero lower bound while underlying inflation was running below 2% risked credibility and a policy error. Could an overly data-dependent Fed make a similar mistake this time around by waiting too long to ease?

Pace of underlying inflation decline supports mid-year cut

In the current environment, the Fed is seeking greater confidence that inflation is converging toward 2% on a sustainable basis. We don't know exactly what it has in mind with this guidance in terms of thresholds for inflation outcomes that would give it the confidence it seeks, but the behavior of our estimates of underlying inflation suggests significant progress on reducing inflation has been made. Over the last four quarters, our estimate of the year-on-year percent change in underlying inflation has fallen by about 25bp per quarter. Should that continue, underlying inflation could be around 2.3% by mid-year, opening the door for the long-anticipated easing cycle to begin.

That said, the rate of decline in underlying inflation moderated in 4Q 2023, falling only about 10bp. Should this be maintained, underlying inflation would be closer to 2.6% by mid-year. Together with 3m and 6m annualized rates of inflation and low inflation expectations, we think this outcome would still support our outlook for an easing cycle that begins in June.

But further deceleration needed to avoid risk of delay

Should underlying inflation stop declining, either because core goods prices stop falling or services inflation picks up, then the Fed may be forced to delay the start of its easing cycle beyond June. We also cannot rule out that a strong economy leads to some reacceleration in inflation pressures, leading some Fed members to contemplate further rate hikes. We think this remains a low probability outcome, but the recent upside surprise to January CPI inflation has kept this scenario alive in financial markets. These are risks worth monitoring in an environment where growth in US economic activity continues to surprise to the upside.

A more forward-looking Fed might ease earlier

Our estimates underscore the policy dilemma faced by the Fed in setting appropriate policy during a pandemic that has injected a lot of noise into economic data. The model – which includes two variants of the Phillips curve, the Fed's traditional tool for thinking about trade-offs in its dual mandate – was likely "surprised" by (1) limited disinflation when the unemployment rate surged in early 2020, (2) how strongly inflation accelerated even as the unemployment rate was coming down in 2021, and (3) how much inflation fell in 2022 and 2023 without a rise in unemployment.

The explanation behind these surprises is straightforward as much of the inflation observed in the US has come from shocks to global supply chains and domestic labor supply.[11] At first, the negative supply shock shifted the short-run Phillips curve outward, meaning the US can see higher rates of inflation for a given unemployment rate. As supply constraints have eased, the reverse has been true, and inflation has plunged despite employment being at or above its maximum level.

The bifurcation between our prices-only and expectations-only measures is a complication for a data-dependent Fed. The “greater confidence” it seeks likely means it overemphasizes the signal from our prices-only measure and the evolution of realized inflation data. The emphasis on the realized data also means the Fed is making policy decisions on data that is inherently backward-looking.

A forward-looking Fed, on the other hand, should have confidence that stable inflation expectations will continue to act as an anchor in the price formation process. After all, its own forecasts have inflation returning to 2.0% over time and those rely on assumptions that long-run inflation expectations are anchored at mandate-consistent levels. A Fed that put more weight on its forecasts as pandemic-induced distortions fade might be inclined to ease policy rates earlier than later, including as soon as March.

That said, this Fed continues to downplay frameworks and forecasts in favor of actual data outturns. Having been buffeted by the violent turns in the US economy and the limited ability of standard economic models to capture them in real time, we understand this inclination. In its quest for greater certainty about inflation returning to target, the committee continues to emphasize the composition of disinflation – skewed heavily toward declining goods prices and away from stickier services prices – and wage growth. It is less willing to put its confidence in inflation expectations and the strong probability that shelter inflation will ultimately follow asking rents lower.

However, ignoring models and frameworks has its own perils. If models are the science of economics, the art of economics is data watching. It may be appealing to think we can cast aside frameworks and forecasts in favor of relying solely on the data under our feet, but this can be a recipe for error. Extracting the proper signal from economic data that is late, revised, and noisy means you may need a lot of data before you can draw conclusions. By then, the risk is the Fed moves too late, keeping its policy stance too-tight for too-long and temporarily undershooting the 2% target.

[11] An alternative explanation is that the natural rate of unemployment rose so that we saw more inflation for every unemployment rate. It may be the case that the framework can’t tell the difference, raising questions over how much faith we – and policymakers – can place in model estimates of underlying inflation. That said, we use the CBO’s estimate for the natural rate of unemployment when forming our estimates and this declined throughout the pandemic.

Appendix: The state-space framework for estimating underlying inflation

In this appendix, we outline the state-space framework we use for estimating underlying inflation. The state-space framework consists of equations that relate observable signals to unobserved state variables of importance. In this case, the signals are taken from observable data on inflation and inflation expectations, while the unobserved state variable is underlying inflation. The framework also includes an equation that describes the evolution of the unobserved state variable over time. All data inputs are quarterly averages, with inflation measured as an annualized rate of change. We estimate the model from 1985 to the present.

Our system for estimating underlying inflation includes five signal equations. Two signals are inferred from expectations-augmented Phillips curve equations for core PCE and core CPI inflation, which relate changes in current core inflation to past changes, cyclical pressures from the unemployment rate gap, and import prices. In both equations we interpret the long-run expected rate of inflation as "underlying inflation" for core PCE prices. We constrain these equations such that core PCE inflation will converge to its long-run expected level if the gap between the unemployment rate and its natural level and the gap between import inflation and core PCE inflation is zero. Finally, we include a level adjustment in the CPI-Phillips curve to allow for the long-run divergence between core CPI and core PCE price inflation. We do this since the Fed's inflation target is written in terms of PCE inflation and our goal is to extract information from CPI that is relevant for PCE prices. Hence, some accounting for the persistent wedge between the two indices, which derives from differential weights, is needed.

The first two signal equations are:

$$\pi_t^{PCE} = (1 - a_1 - a_2)\pi_t^* + a_1\pi_{t-1}^{PCE} + a_2\pi_{t-2}^{PCE} + a_u(u_t - u_t^{NR}) + a_{M1}s_t^M\left(\pi_t^M - \pi_{t-1,4q}^{PCE}\right) +$$
$$a_{M2}s_{t-1}^M\left(\pi_{t-1}^M - \pi_{t-2,4q}^{PCE}\right) + a_e e_t^2 + e_t^1$$
$$\pi_t^{CPI} = (1 - c_1 - c_2)(\pi_t^* + \pi^{CPI}) + c_1\pi_{t-1}^{CPI} + c_2\pi_{t-2}^{CPI} + c_u(u_t - u_t^{NR})$$
$$+c_M s_t^M\left(\pi_t^M - \pi_{t-1,4q}^{CPI}\right) + c_{M2}s_{t-1}^M\left(\pi_{t-1}^M - \pi_{t-2,4q}^{CPI}\right) + e_t^2$$

where e_t^1 and e_t^2 are uncorrelated mean-zero random disturbances that are serially uncorrelated with constant variance. We include the disturbance for core CPI inflation (e_t^2) in the equation for core PCE inflation because many components of CPI are used as source data for estimates of PCE inflation. The same is not true in reverse. Hence, CPI-related disturbances can translate into PCE and we want our signal equations to take advantage of this information. The variable π_t^M is defined as the rate of inflation in non-petroleum import prices from the Bureau of Labor Statistics, while s_t^M is the nominal share of non-petroleum imports in US GDP. The terms $\pi_{t-1,4q}^{PCE}$ and $\pi_{t-1,4q}^{CPI}$ represent the four-quarter rates of inflation in core PCE prices and the core CPI. Finally, $u_t - u_t^{NR}$ measures the unemployment rate gap, where u_t is the U3-unemployment rate and u_t^{NR} is the natural rate of unemployment.

The remaining signal equations are derived from measures of inflation expectations from the University of Michigan Consumer Survey (π_t^{MICH}), the median 10-year ahead expectation for PCE price inflation from the Survey of Professional Forecasters (π_t^{PCESPF}), the median 10-year ahead expectation for CPI price inflation from the Survey of Professional Forecasters (π_t^{CPISPF}), and the breakeven measure of inflation five-to-ten years ahead implied by yields on the difference between nominal Treasury bonds and TIPS (π_t^{TIPS}). These are:

$$\pi_t^{MICH} = (1 - b_1 - b_2)\pi_t^* + b_1\pi_{t-1}^{MICH} + b_2\pi_{t-2}^{MICH} + e_t^3$$
$$\pi_t^{PCESPF} = (1 - d_1 - d_2)\pi_t^* + d_1\pi_{t-1}^{PCESPF} + d_2\pi_{t-2}^{PCESPF} + e_t^4$$
$$\pi_t^{CPISPF} = (1 - f_1 - f_2)(\pi_t^* + \pi^{CPI}) + f_1\pi_{t-1}^{CPISPF} + f_2\pi_{t-2}^{CPISPF} + e_t^5$$

$$\pi_t^{TIPS} = (1 - g_1 - g_2)(\pi_t^* + \pi^{CPI}) + g_1\pi_{t-1}^{TIPS} + g_2\pi_{t-2}^{TIPS} + e_t^6$$

As is the case above, the error terms in the four expectations signal equations are independent and serially uncorrelated, mean-zero random disturbances. Each has constant variance.

Each of the expectations signal equations is assumed to take on an autoregressive form which implies inflation will converge to its underlying trend in the absence of disturbances. When disturbances are present, expectations can diverge from underlying inflation. Note that the equations for CPI and TIPS both contain the level factor adjustment between core PCI and core CPI.

Finally, our state-space framework requires two additional equations that describe the evolution of the unobservable state variables (underlying inflation and the natural rate of unemployment). We assume that each follows a random walk according to:

$$\pi_t^* = \pi_{t-1}^* + v_t^1$$

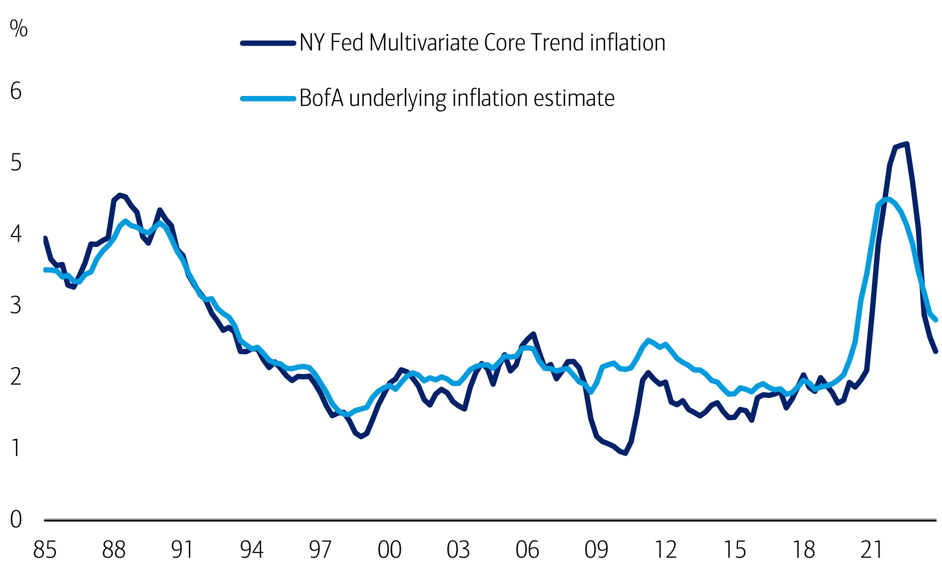
$$u_t^{NR} = u_{t-1}^{NR} + v_t^2$$

where the error terms are independent and serially uncorrelated, mean-zero random disturbances. Each has constant variance.

Appendix: New York Fed Multivariate Core Trend (MCT) Inflation median

The Federal Reserve Bank of New York's Multivariate Core Trend Inflation measure is constructed using a dynamic factor model with time-varying parameters for the seventeen major sectors of the PCE price index. The model decomposes each sector's inflation as the sum of a common trend, a sector-specific trend, a common transitory shock, and a sector-specific shock. The trend in PCE inflation is constructed as the sum of the common and the sector-specific trends weighted by their expenditure shares. Data from all seventeen of the PCE's sectors are used to construct the trend in PCE inflation, except for the volatile food and energy components.

Exhibit 10: BofA underlying inflation and NY Fed Multivariate Core Trend Inflation (%)
The NY Fed measure is somewhat more volatile and is more heavily influenced by cyclical movements



Source: Federal Reserve Bank of New York, Haver Analytics, BofA Global Research

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In our view, the advantage of the NY Fed's Multivariate Core Trend Inflation measure is that it seeks to extract an estimate of trend inflation that avoids some of the pitfalls of the standard measures. That said, we think it has a few key disadvantages. First, factor models can be complex and lack transparency. Second, the framework is based on a prices-only construct and does not incorporate inflation expectations. It is more akin to our “prices only” estimate in Exhibit 9. Third, it appears to be more volatile and influenced by cyclical variations in the economy. In particular, it shows a noticeable decline following the global financial crisis.

As a result, we think the NY Fed’s measure is best see as where inflation trends are presently – or were recently – while our estimate focuses on where inflation may settle in once shocks to the economy fade and the economy is a full employment. Both estimates are useful in their own right, but we see our estimate as more closely aligned with the Fed’s policymaking framework.

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