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Inflation's Last Half Mile: Higher for Longer?

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Will inflation quickly return to the FOMC's target of 2 percent? I explore this question through the lens of the Verbrugge and Zaman (2023) model—the VZ model—a structural model whose forecasts are competitive with hard-to-beat forecasting models. The time it takes to get to the target depends on the persistence of inflation, and theory gives mixed signals about whether inflation persistence is currently high or low. The VZ model distinguishes between two sources of inflation persistence, extrinsic and intrinsic, and implies that inflation has high intrinsic persistence. If the extrinsic forces that have lately been pushing down inflation, notably, the resolution of supply chain issues, have run their course, then the last half mile could take several years.

During 2023, US inflation fell rapidly, with four-quarter PCE inflation coming in at 2.7 percent, beating the January 2023 Blue Chip Economic Indicators (BCEI) Consensus[1] expectation of 3.2 percent. But in 2024:Q1, quarterly inflation readings moved up. Was this just a transitory blip? Will inflation resume its rapid downward progress? The majority view among forecasters, as measured by the May 2024 Blue Chip Financial Indicators Consensus, is that inflation will indeed continue to fall apace, leaving four-quarter PCE inflation near 2 percent by the middle of next year. There are several reasons this may happen. Given that new-tenant rent inflation has been subdued for the past year, and that new-tenant rents feed into all rents with about a year lag (Adams et al., 2024), housing services inflation appears poised to fall notably. Additionally, the inflation expectations of households and firms have come down a lot over the past year.[2] But there is debate about how fast inflation will fall going forward. In particular, in 2024:Q1, quarterly PCE inflation surged to 3.4 percent, and core PCE inflation came in even higher, at 3.7 percent. Shelter inflation continued to remain quite elevated in the April CPI report; and given this report, the Cleveland Fed's nowcasting model (May 15 reading) currently predicts that quarterly PCE inflation will be near 3 percent in 2024:Q2.

This *Economic Commentary* thus asks if getting inflation from where it is now down to the Federal Open Market Committee's 2 percent target will take notably longer than most forecasters expect. To answer this question, I first review what economic theory has to say about this question. As theory does not lead to a definitive answer, I next use a recent empirical model in Verbrugge and Zaman (2023) (the VZ model) as a lens through which to view inflation dynamics. In particular, I use the model to distinguish between inflation's intrinsic dynamics, that is, how inflation generally behaves when it is not being driven by big shocks, and its extrinsic or inherited dynamics, or what happens to inflation as a result of its being hit by big shocks.[3] I also compare the VZ model's predictions to those of two other models that are considered in the forecasting literature to be "hard to beat." Neither of these other models distinguishes between intrinsic and extrinsic dynamics.

The analysis suggests that the intrinsic dynamics of inflation are very persistent. It also suggests that, going forward, inflation will be mainly governed by its intrinsic dynamics. Hence, according to this analysis, inflation could take several years to return to its target.[4]

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What Does Theory Have to Say about Persistence of Inflation?

The inflation literature identifies two categories of persistence: intrinsic persistence and inherited or extrinsic persistence (see, for example, Fuhrer, 2006, or Kurozumi and Van Zandweghe, 2023). Extrinsic persistence arises from persistence in the "external" driving forces of inflation, such as production costs or an overheated labor market. Intrinsic persistence arises from the internal dynamics of price-setting and wage-setting decisions and from the way that inflation expectations are formed. High intrinsic persistence can arise from such sources as indexation or other contract assumptions (Fuhrer and Moore, 1995; Christiano et al., 2005), strategic complementarities in price setting, wage-price spirals, or backward-looking or rule-of-thumb price setters.[5] In addition, "learning" or other "imperfect information" models of expectation formation can lead to high intrinsic persistence (Erceg and Levin, 2003; Branch and Evans, 2006); some salient information imperfections are discussed below. Inflation persistence is likely to vary over time.

A generic equation describing the dynamics of inflation helps us understand and distinguish intrinsic from extrinsic persistence. In the following equation, inflation today depends upon inflation expectations, inflation's own lags, and exogenous driving forces:

$$\pi_t = a + c\pi_{t+s}^{expect} + \sum_{j=1}^{n} b_j \pi_{t-j} + \sum_{k=1}^{m} d_k X_{k,t} + e_t \qquad (1)$$

where π stands for inflation at time t, a is a constant, c is a parameter value, there are n parameter values denoted by b_j, there are m parameter values denoted by d_k, $\pi_{(t+s)}^{expect}$ stands for the expectation of inflation s periods in the future, there are m driving forces of inflation, denoted by $X_{k,t}$, and there is a random shock e_t. If the sum of the b_j coefficients is large, or c is both large and $\pi_{(t+s)}^{expect}$ is typically close to last period's inflation reading, then inflation will have a lot of intrinsic persistence. Inflation will have a lot of extrinsic persistence over a given period if one or more of the $X_{k,t}$ is then experiencing a very persistent fluctuation and its corresponding coefficient d_k is large. In like manner, inflation can appear to be *non*persistent over a period of time if it is being driven during that period by a powerful *non*persistent driving force $X_{k,t}$.

This brings us to today. Many economists believe that the recent sharp increase and decrease in inflation was caused by *X* factors: the recent runup being caused by a sharp increase in supply constraints combined with a demand shock (Sheremirov, 2022; di Giovanni et al., 2023) and perhaps abetted by an overheated labor market, and the recent decrease largely driven by sharp improvements in supply conditions (possibly abetted by the labor market cooling that has happened so far). It is tempting to think that inflation will keep moving downward at its recent pace, but given that both the Federal Reserve Bank of New York's global supply chain pressure index and the PPI for core intermediate goods have moved from deeply negative readings to near zero or positive readings of late, it seems likely that the downward pressure from these aforementioned sources is nearly over. Absent such exogenous favorable downward forces, inflation's movements in the near future will be largely driven by its intrinsic persistence.

To understand inflation dynamics, it helps to use a good measure of inflation. Measuring inflation is not easy, and official measures are noisy. For the rest of this *Economic Commentary*, I will generally focus on trimmed-mean PCE inflation, which removes noise from headline PCE inflation (to better focus on the signal) in a statistically sound manner. Historically, it has been a more accurate indicator of the medium-term trend in inflation than has core PCE inflation (Mertens, 2016; Dolmas and Koenig, 2019; Verbrugge, 2022). For instance, when core PCE inflation and trimmed-mean PCE inflation diverge, it is core PCE inflation that adjusts to eliminate the gap (Verbrugge, 2022).

I first look at economic theory for guidance as to whether intrinsic persistence of inflation is high or low at the present moment. This theory is divided. There are two sorts of theoretical arguments suggesting that right now inflation may have low persistence. First, some theories suggest that the responsiveness of inflation to changes in labor market tightness (in other words, the Phillips curve) may be particularly strong right now; if so, continued small reductions in labor market tightness may result in large inflation decreases. Higher inflation seems to strengthen the Phillips curve (Hadjini, 2023; Dedola et al., 2023), and the Phillips curve has been found to be nonlinear in labor market tightness: inflation responds more to overheating than to slack (Filardo, 1998; Ashley and Verbrugge, 2023; Gitti, 2024), and the labor market may still be overheated today. Second, deviations of inflation expectations from the FOMC's 2 percent target may not be persistent today or even strongly anchored at that target. Why? In many imperfect information models, inattention leads inflation expectations to be more persistent (Afrouzi, 2023; Hubert and Ricco, 2018). Further, there is more attention to inflation when inflation is high (Weber et al., 2023; Korenok et al., 2023; Braitsch and Mitchell, 2023). As such, recently higher inflation may be increasing attention to inflation, hence reducing its persistence. Relatedly, when inflation is high, more households are exposed to information on monetary policy (Knotek et al., 2024), a situation which could lead them to expect a rapid return of inflation to target.

But there are also some theoretical reasons to think that today inflation may have high intrinsic persistence. Since inflation has come down so much, attention to inflation may have already waned (Weber et al., 2023; Korenok, Munro, and Chen, 2023), and the Phillips curve may have already weakened.[6] On the flip side of this argument, increased attention to inflation has a wide range of effects. One pertinent theoretical mechanism is that high inflation makes workers more likely to realize that their wage growth has not kept pace with inflation, and thus they are more likely to demand wage increases in response to recent inflation; this series of realization and demand can ignite wage-price spirals (Borio et al., 2023). The nonlinearity in the Phillips curve cuts both ways: since labor market tightness (measured, for instance, by the vacancy–unemployment ratio) has eased so much already, there may be little remaining benefit to further easing in the labor market. Other imperfect information models of inflation suggest that inflation is likely to be more persistent today (Pfauti, 2023).[7] Finally, downward rigidity in prices or wages can reduce the speed at which inflation subsides. That there are competing theories indicates that theory alone does not give us a clear answer to our question.

Empirical Evidence

As noted above, inflation in 2024:Q1 picked up. Looking at the components of core PCE, over the past three months, the deceleration in housing services prices has stalled near 6 percent; core services excluding housing inflation has picked up, averaging over 5 percent; and core goods inflation, which had previously been strongly negative, has averaged +1.3 percent. Trimmed-mean PCE inflation in 2024:Q1 was 3.6 percent. What about other inflation indicators? Wage inflation has also remained well above prepandemic levels, and above levels that some economists view as consistent with 2 percent inflation. So far in 2024, according to the May 2024 report of the National Federation of Independent Businesses survey, the proportion of respondents who reported raising prices, at 24, is nearly double the rate in 2019; likewise, the proportion of respondents planning to raise prices, at 31, is 9 percentage points higher than its average in 2019.

Persistence in inflation may be time-varying, and there is some evidence suggesting that inflation may be quite persistent today. Estimated persistence in inflation has risen of late (Almazura and Sbordone, 2023; Kiley, 2023).[8] Quantile regressions indicate that higher inflation implies higher persistence (Ghysels et al., 2018; Mitchell and Zaman, 2023). In general, higher inflation kicks off persistent effects: Blanco et al. (2022) document that, worldwide, inflation tends to stay persistently high after inflation initially surges (see also Borio et al., 2023, and Pfauti, 2023).

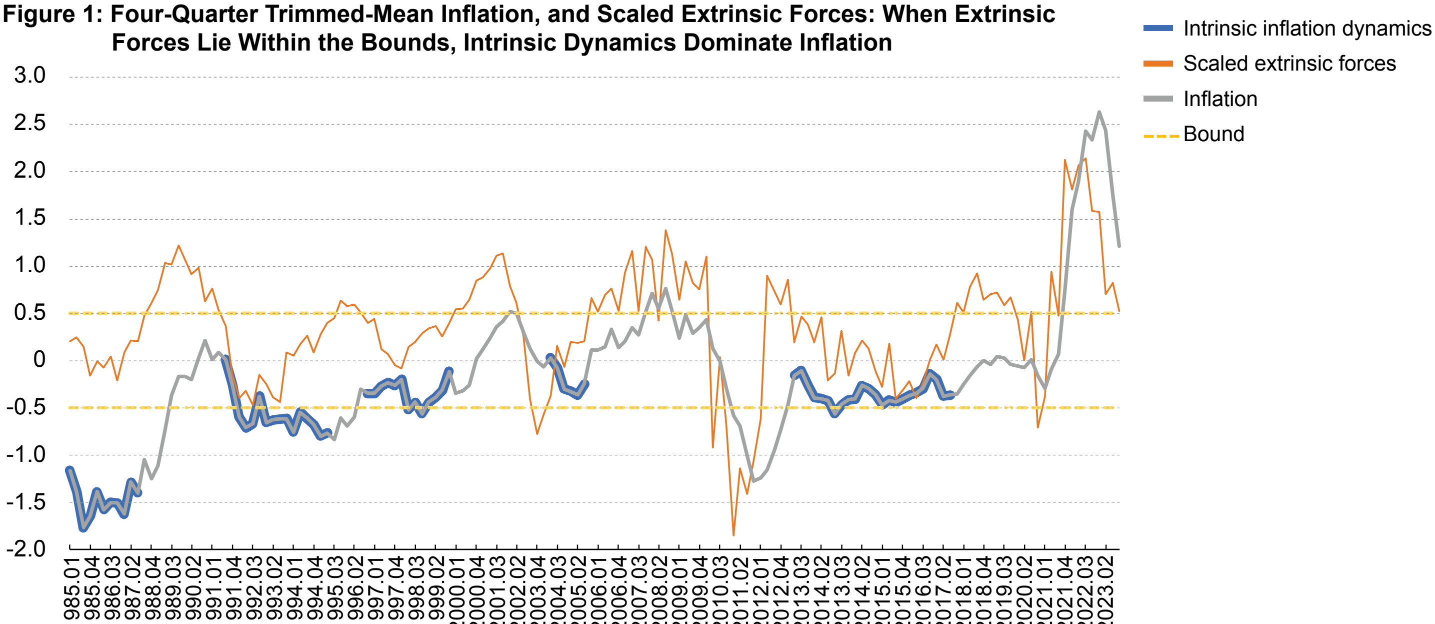
I turn to the VZ model to study the historical evidence. Doing so highlights episodes during which inflation's dynamics were dominated by its intrinsic persistence, which seems to be rather high. Then, in a simple exercise, I compare the intrinsic persistence of the VZ model to that of two other models. This comparison suggests that the VZ model's intrinsic persistence, which lies between that of the other two models, seems to be appropriate. Finally, I provide forecasts from the three models going forward.

The VZ model is a four-equation model with a nonlinear Phillips curve. Its inflation variable is trimmed-mean PCE inflation, modeled in gap form as deviations from the Survey of Professional Forecasters 10-year PCE inflation forecast. Such inflation-gap modeling follows good practice in the inflation forecasting literature (Verbrugge and Zaman, 2024) and also serves to impose anchored long-run inflation expectations (in the sense that if the model is stationary, inflation must return to its expectation). The inflation equation has three extrinsic (X) drivers: an overheated labor market driver, a recessionary labor market driver, and a supply shocks driver.[9]

The model is estimated on data from 1985–2019. Estimating the inflation equation allows me to determine the amount of "force," by quarter, that has been exerted on trimmed-mean PCE inflation by these X drivers over the entire sample. If $X_{(OLM,t-T)}$ represents the overheated labor market term, and $\hat{\beta}_{OLM}$ is the estimated coefficient, then $\hat{\beta}_{OLM} X_{(OLM,t-T)}$ represents the force exerted by the overheated labor market on inflation at time t. I add up this force to the forces associated with the other two X variables, rescale the resulting time series to provide visual clarity, and then plot this series in orange in Figure 1. This represents extrinsic force on inflation.

When extrinsic force is weak or small, then inflation is mostly determined by its intrinsic dynamics. I use an ad hoc rule of thumb to classify when extrinsic force is weak: when this force is less than one standard deviation in magnitude. In yellow dashed lines, I depict the one-standard-deviation bounds of the extrinsic force series. When the orange line lies between the yellow lines, extrinsic force is weak; and when it is outside the yellow lines, extrinsic force is strong. Thus, for example, between 1987:Q4 and 1990:Q3, extrinsic drivers were applying more than a one-standard-deviation amount of upward force on inflation; similarly, between 2008:Q4 and 2010:Q3, extrinsic drivers exerted strong downward force on inflation. Notice that over the recent period (2020:Q3–2023:Q3), extrinsic force was quite strong, but also notice that in 2023:Q4, extrinsic force returned to its normal, weak levels, suggesting that going forward, inflation will be governed by its intrinsic dynamics.

Figure 1: Four-Quarter Trimmed-Mean Inflation, and Scaled Extrinsic Forces: When Extrinsic Forces Lie Within the Bounds, Intrinsic Dynamics Dominate Inflation



Sources: Trimmed-mean PCE data, Federal Reserve Bank of Dallas; extrinsic forces, author's calculations using unemployment data from the Bureau of Labor Statistics; u* (natural rate of unemployment) computed by Saeed Zaman; PPI, intermediate materials less food and energy, Bureau of Labor Statistics

Figure 1 also plots, in light gray, the four-quarter trimmed-mean PCE inflation gap. I argue above that when extrinsic force is weak, inflation's dynamics are governed by intrinsic persistence. There are five periods during which extrinsic force was weak for more than two quarters; inflation realizations corresponding to such periods are depicted in blue. If intrinsic persistence is generally low, then we should expect the inflation gap to move quickly to zero during these periods.

So how high is intrinsic persistence? The above decomposition of history into periods when inflation is facing high extrinsic force versus low extrinsic force suggests that intrinsic persistence in inflation is rather high indeed, and, moreover, inflation seems somewhat prone to "head fakes," times when inflation moves one way but then reverses itself. Looking at things episode by episode, from 1985:Q1 to 1987:Q3, inflation showed no signs of moving towards its long-run expectation. From 1990:Q4 to 1994:Q3, inflation moved away from its expectations, and then it moved sideways. From 1996:Q1 to 1997:Q2, there was a head fake: inflation was moving up, then dropped markedly, and then rebounded. From 2002:Q4 to 2004:Q1, inflation moved further away from its long-run expectation (this episode was part of a head fake). Finally, 2011:Q4 to 2017:Q3, inflation essentially moved sideways. And more generally, over the post-Global Financial Crisis episode, inflation experienced a head fake: inflation rose sharply between 2010:Q2 and 2012:Q1 but then fell back notably by 2013:Q2.[10]

All told, this exploration of the history of trimmed-mean PCE inflation suggests two things. First, historically, head fakes are not uncommon; second, again historically, intrinsic persistence appears to be very high.

Evidence from Comparing Forecasting Models

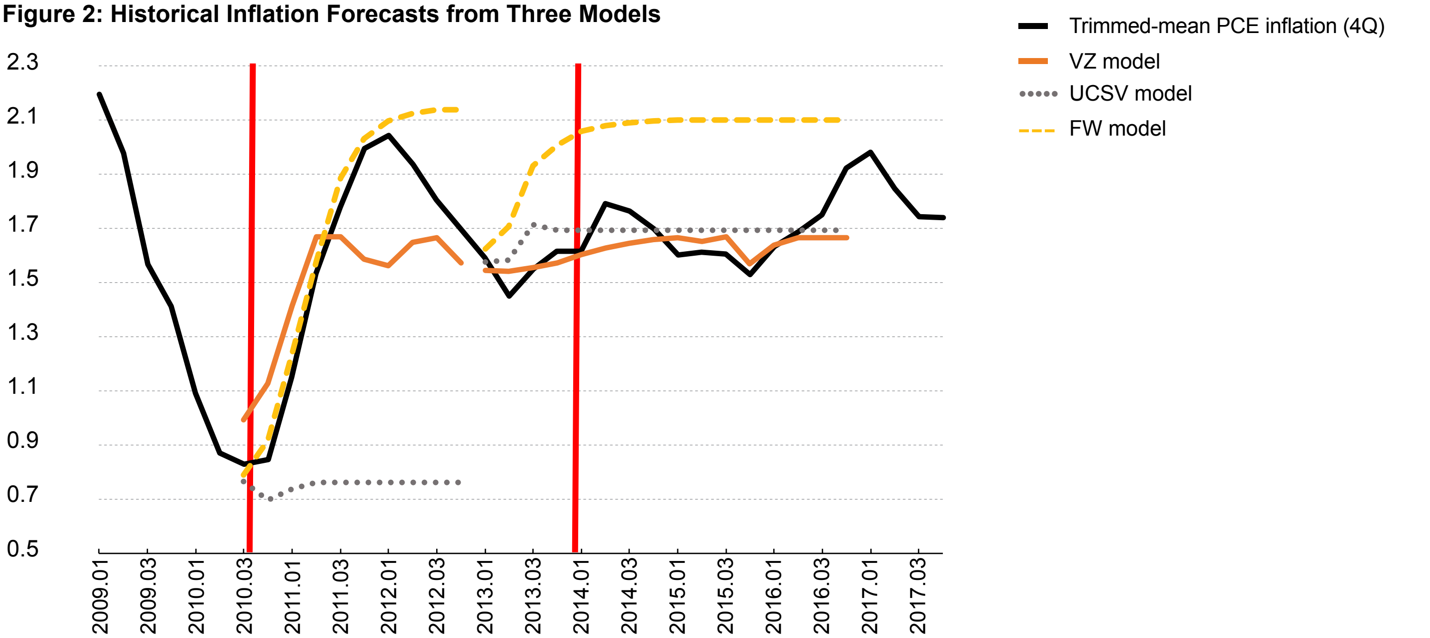
What do forecasting models tell us about the risks that inflation may remain higher for longer? Forecasting models differ on whether they condition upon or abstract from *X* factors. Each forecasting model has a different implied or inherent level of persistence of inflation that may be too high or too low. A model that abstracts from *X* factors will implicitly assume that the average historical persistence of the *X*-factor influence on inflation is actually part of inflation's inherent persistence.

In this section, I look at some representative historical forecasts from three different models over recent history (2010–2019). The purpose of this comparison is not to provide a general test of these models' forecasting ability, since standard forecast comparison tests of these models over various time periods are provided elsewhere (see, for example, Verbrugge and Zaman, 2023). Instead, these forecasts are intended to demonstrate visually each model's implied level of intrinsic persistence in inflation, something which can help inform judgments about inflation prospects going forward.

The first two models are both univariate models that are considered in the forecast literature to be hard to beat: the Stock and Watson (2007) UCSV model and the Faust and Wright (2013) model (the FW model). The third model is the aforementioned VZ model.[11]

I provide illustrative forecasts from each of the three models at two different points in this period: 2010:Q3 and 2013:Q1.[12] According to the VZ model decomposition above, at both points (and throughout their forecasts), *X* forces played little role, so at these points one can compare how each model matches the intrinsic persistence of inflation. As will be seen, using just two forecast points suffices to demonstrate the general behavior, and inherent persistence, of the three models. Figure 2 depicts the inflation realization in black. As can be seen, the UCSV forecasts, in gray, are flat, that is, close to simple random walk forecasts; this model features very high persistence that results in a very poor forecast in 2010:Q3 and a passable forecast in 2013:Q1. The FW model, in yellow, has much less persistence and projects very rapid returns to near 2 percent. In 2010:Q3, the FW forecast initially looks great—until inflation sinks back to 1.5 percent starting in early 2012. This forecast, in other words,

Figure 2: Historical Inflation Forecasts from Three Models



Sources: Trimmed-mean PCE data, Federal Reserve Bank of Dallas; author's calculations using unemployment data from the Bureau of Labor Statistics; u* (natural rate of unemployment) computed by Saeed Zaman; PPI, intermediate materials less food and energy, Bureau of Labor Statistics completely misses the head fake. The 2013:Q1 FW forecast also returns to target too quickly. In short, the FW model seems to have too little persistence over this period. In contrast, the VZ model, in orange, does fairly well in capturing the dynamics of inflation at both forecast points, including not being fooled by the head fake. The tentative conclusion I draw from this exercise is that the UCSV model may have too much intrinsic persistence, the FW model seems to have too little intrinsic persistence, and the VZ model appears to have about the right amount of intrinsic persistence.

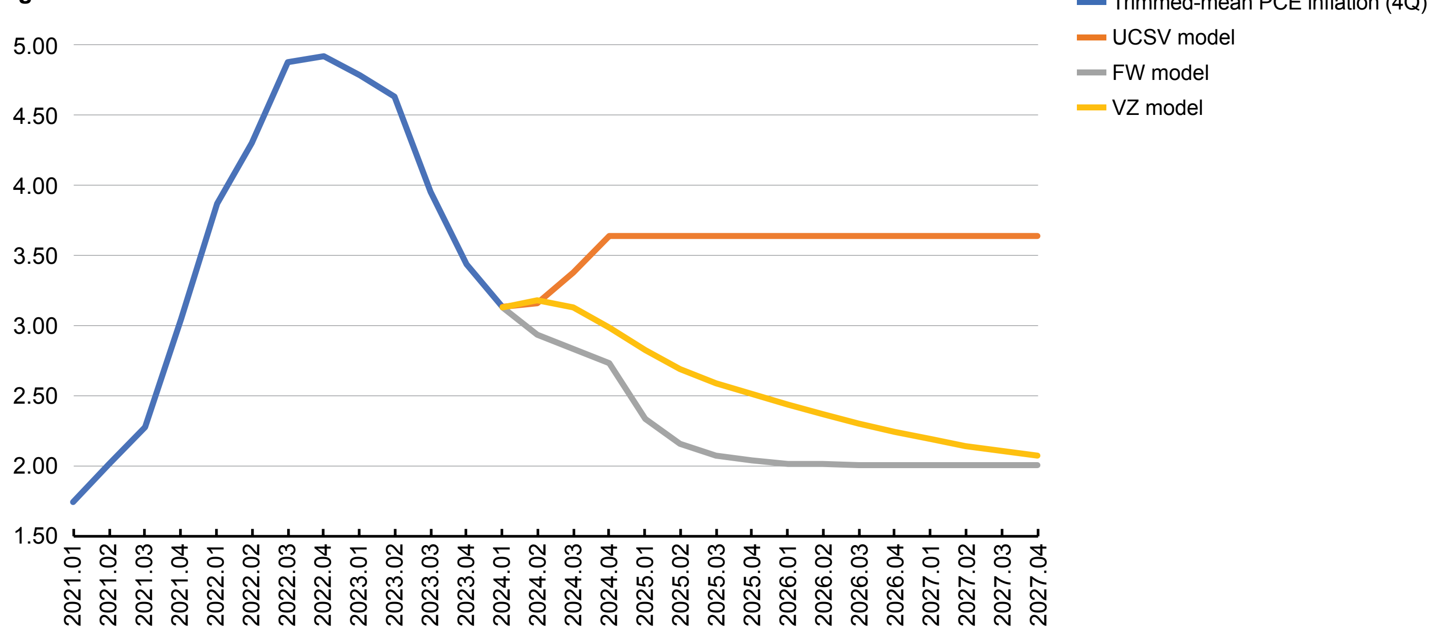
In Figure 3, I provide forecasts from these three models. Each model conditions on the 2024:Q1 inflation readings; for instance, four-quarter trimmed-mean PCE inflation was then at 3.1 percent. The VZ model conditions on the May Blue Chip Economic Indicators unemployment rate forecast, which projects that unemployment will converge to its long-run forecast by the end of 2024. In keeping with this, as noted above, the VZ model decomposition suggests that extrinsic force on inflation is fairly weak at present, so inflation may be governed by its intrinsic persistence. (As a reminder, neither the FW nor the UCSV model distinguishes between extrinsic and intrinsic persistence.)

As one would expect from Figure 2, the FW model predicts a fairly rapid decline in trimmed-mean PCE inflation, such that it sees inflation at 2.1 percent by 2025:Q2. This forecast is similar to the Blue Chip PCE inflation forecast; but recall that the FW model may have too little persistence. The UCSV model sees inflation picking up to a 3.6 percent pace, and then moving sideways; but recall that this model may have too much persistence. Finally, the VZ model predicts that inflation remains near its current level of 3.1 percent in 2024:Q2, followed by gradual deceleration in prices. In 2025:Q2, when the FW model sees inflation at 2.1 percent, the VZ model conversely sees inflation at 2.7 percent. And according to this model, inflation does not fall to near to 2 percent until mid-2027. Taken together, these model-based forecasts indicate notable upside risk to forecasts that see inflation back to 2 percent by spring of next year.

Conclusion

Inflation fell rapidly last year, and many forecasters expect it to return to the FOMC's 2 percent longer run target by spring of next year. But, as explained above, the Verbrugge and Zaman (2023) model suggests that this conclusion may be premature. There are both theoretical and empirical reasons to think that, absent *X* factors such as continued favorable supply shocks or strong productivity gains, the last half-mile could well take several years.

Figure 3: Current Inflation Forecasts from Three Models



Sources: Trimmed-mean PCE data, Federal Reserve Bank of Dallas; author's calculations using unemployment data from the Bureau of Labor Statistics; u* (natural rate of unemployment) computed by Saeed Zaman; PPI, intermediate materials less food and energy, Bureau of Labor Statistics

Endnotes

1. Wolters Kluwer Legal and Regulatory Solutions US Blue Chip Financial Forecasts.
2. Households' year-ahead inflation expectations (University of Michigan Surveys of Consumers, February 2024) came down in December from 4.5 percent to 3 percent and have remained there; firms' expectations (Cleveland Fed Survey of Firms' Inflation Expectations, January 2024) have been declining steadily since October 2022 and are now at 3.4 percent, close to their 2018 levels.
3. "How inflation generally behaves" is influenced by prevailing monetary policy. However, the VZ model does not include any interest rate variable. Thus, implicitly its predictions assume that, going forward, monetary policy will be conducted in the same way that it has been historically. Monetary policy is often represented by policy rules; see the Cleveland Fed's Simple Monetary Policy Rules (https://www.clevelandfed.org/indicators-and-data/simple-monetary-policy-rules).
4. Rapach (2024) also studies the last mile. That paper focuses on how much *tightening* will be required to finish the job and does not disagree that it might take a long time.
5. Schwartzman (2023) discusses sources of intrinsic and extrinsic persistence in more detail.
6. Taking the Crust et al. (2023) estimates at face value, current inflation levels would suggest that the Phillips curve is "still reasonably strong" at present. However, other estimates disagree; for instance, Forbes et al. (2022) find that the Phillips curve weakens considerably when inflation is below 3 percent.
7. Inflation expectations today remain a big risk. Despite decades of research, there remains debate on how inflation expectations are actually formed, whether more or better information has much influence upon household inflation expectations or moves them closer to those of professionals (D'Acunto et al., 2023; Pfajfar and Santoro, 2013; Lebow and Peneva, 2024), or, indeed, whose inflation expectations actually matter for inflation (Coibion and Gorodnichenko, 2015; Binder, 2015; Verbrugge and Zaman, 2021; Candia et al., 2023; Mitchell and Zaman, 2023; Reis, 2023).
8. Estimates from Zaman (2022) also indicate a rise in inflation persistence over the last few years.
9. The first two drivers are distinct components of the unemployment rate gap; the last driver is the PPI for core intermediate goods. See Verbrugge and Zaman (2023) for more details. The VZ inflation equation fits the data well, as will be evident below.
10. Note that all the periods identified in blue have a negative inflation gap; the inflation gap itself has been mostly negative over this period. It is possible that intrinsic persistence in inflation is lower when the inflation gap is positive.
11. Phillips curve models usually perform poorly in forecast comparisons; see, for instance, Verbrugge and Zaman (2024). However, the full VZ structural model is competitive with hard-to-beat benchmarks like the UCSV model. Its predecessor, Ashley and Verbrugge (2023), outperforms the UCSV and random-walk models on pre-COVID-19 data. None of the three models includes monetary policy variables; thus, all implicitly condition on monetary policy's being conducted in the same way that it has been historically (see endnote 3).
12. All models are estimated using data only up to the forecast point. The VZ model conditions on *X* variables, but at both forecast points, both labor supply variables exert no influence. For the purposes of this exercise, an AR(2) model was used to forecast its PPI variable. This forecast quickly mean-reverts. However, stripping the PPI variable out of the model resulted in fairly similar forecasts and does not alter the qualitative conclusions. To further explore model performance, I produced a forecast from this VZ-sans-PPI model for the 2007:Q1–2019:Q4 period. In this forecast, the model could observe the other two *X* variables but could not see any inflation data after 2006:Q4. Over the entire 12 years, the root mean squared error was a mere 0.18 percent.

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