Comment on "The Dominant Role of Expectations and Broad-Based Supply Shocks in Driving Inflation" (Beaudry, Hou and Portier, NBER Macro Annual 2024)

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1 Overview

This paper tackles one of the most—if not *the* most—important business cycle questions of the post pandemic period in the United States. Why did inflation rise so much? Beaudry, Hou and Portier offer an important and convincing answer in two steps. First, they show that the flat and linear Phillips Curve, which accurately characterized the relationship between inflation and real activity before 2020, continues to fit the data well after 2020. According to the Phillips Curve, the proximate cause of rising inflation was a rise in inflation expectations. Second, the authors advance a theory of why inflation expectations rose. They consider a model with incomplete information and bounded rationality. When supply shocks hit many sectors at the same time—a "broad based supply shock"—then inflation expectations rise. Inflation itself rises too, via the Phillips Curve.

This comment has two parts. First, I summarize the context of the paper and its main findings, while replicating the main results of the paper. Second, I discuss the scope of the contributions. I argue that the choice of inflation expectations is critical, and the results hint at an important role for fiscal policy. I expect that Beaudry, Hou and Portier's paper will become central to the fast-growing literature on the post-pandemic inflation.

2 Inflation Dynamics Before and After 2020

2.1 Background: Inflation Dynamics Before 2020

This paper studies the New Keynesian Phillips Curve, the relationship

$$\pi_t = \beta \pi^e_{t,t+1} - \kappa \tilde{u}_t + \varepsilon_t \tag{1}$$

between inflation π_t, inflation expectations $\pi^e_{t,t+1}$, the current gap between unemployment and its "natural rate" under flexible prices $\tilde{u}_t$, and supply shocks ε_t.

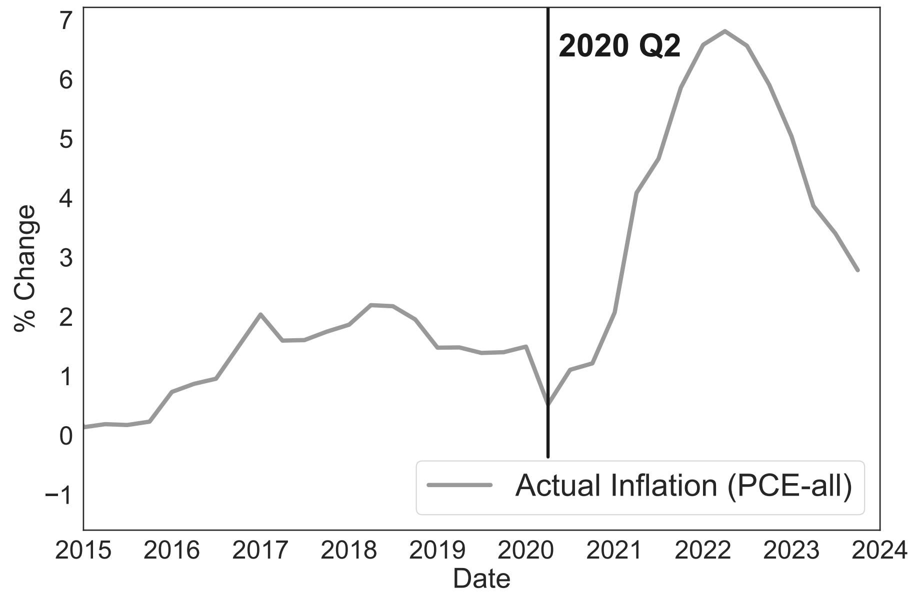
Before 2020, a consensus formed that the Phillips Curve was positively sloped but flat. That is, the comovement between real activity and inflation was weak. Equivalently, the "slope" coefficient κ in equation (1) was positive but near zero. A variety of methods arrived at this result. For instance Hazell, Herreno, Nakamura, and Steinsson (2022) found a flat Phillips Curve using state level inflation data. Various limited- and full-information time series methods applied to aggregate data arrived at the same conclusion—for instance Blanchard (2016), Ball and Mazumder (2019), Stock and Watson (2020) and Del Negro, Lenza, Primiceri, and Tambalotti (2020) amongst others.

The flat Phillips Curve is appealing because it makes sense of the major inflation episodes between 1978 and 2020 in a unified framework. Consider the so-called "Missing Disinflation" during the Great Recession. Inflation failed to fall by much even as unemployment rose dramatically (Coibion and Gorodnichenko, 2015). The flat Phillips Curve rationalizes the data, given a weak relationship between unemployment and inflation. Or, consider the "Missing Reinflation" of the late 1990s and late 2010s. Robust expansions led to low unemployment, yet inflation failed to increase much. The flat Phillips curve makes sense of the data via the decoupling of inflation and real activity. The flat Phillips Curve can also explain the "Volcker Disinflation", the large fall in inflation in the early 1980s. Through the lens of equation (1), disinflations happen via large falls in inflation expectations, which indeed happened in the early 1980s.

2.2 The Flat Phillips Curve: Post Hoc Theorizing?

The flat Phillips Curve can successfully explain past data. But this success may not be reassuring. History is full of examples in which some version of the Phillips Curve successfully explains past data, but then fails to explain the latest inflation episode. One apt term is "post hoc theorizing". A theory may well be able to rationalize the data it was designed to explain, without making sense of newer data. Ball and Mazumder (2019) discuss this danger in a wonderful quote that summarizes the troubled history of Phillips Curve estimation:

Figure 1: Inflation Before and After 2020



Notes: this figure plots headline personal consumption expenditures (PCE) inflation from 2015Q1 to 2023Q3, where inflation is the percent difference in the price level over the previous four quarters.

> *"Unfortunately, researchers have repeatedly needed to modify the Phillips curve to fit new data. Friedman added expected inflation to the specification in Samuelson and Solow (1960). Subsequent authors have added supply shocks, time variation in the Phillips-curve slope, and time variation in the natural rate of unemployment. Each modification helped explain past data, but, as Stock and Watson (2010) observe, the history of the Phillips curve "is one of apparently stable relationships falling apart upon publication.""*

This quote explains the stakes of Beaudry, Hou and Portier's paper. As Figure 1 shows, the 2020s was another major inflation episode, in which inflation rose from around 2% to almost 7%. Beaudry et al ask whether the flat Phillips Curve can rationalize the new data. Alternatively, the flat Phillips Curve might be post hoc theorizing, which "falls apart" with new data. If so, then the Phillips Curve is of questionable value. A relationship that makes sense of past episodes, but must be modified with each successive episode, is surely of limited use.

2.3 The Flat Phillips Curve: An Illustration

I now illustrate the success of the flat Phillips Curve before 2020. In doing so I develop an empirical framework to be used throughout the comment, which parallels Beaudry, Hou and Portier's paper. I estimate the regression

$$\pi_t = \beta \pi^e_{t,t+4} - \kappa \tilde{u}_t + \gamma e_t + \varepsilon_t, \tag{2}$$

where π_t is annualized quarterly personal consumption expenditures (PCE) headline inflation, $\pi^e_{t,t+4}$ is households' median 1 year ahead inflation expectations from the Michigan Consumer Survey, $\tilde{u}_t$ is the difference between quarterly unemployment and its natural rate as measured by the Congressional Budget Office, e_t is annualized quarterly PCE energy inflation, and ε_t is a regression residual that may be interpreted as a supply shock. In the regression, κ is the parameter of interest, the "slope" of the Phillips Curve. I estimate this regression by ordinary least squares (OLS) from 1984Q1 to 2020Q2. In using OLS I ignore the important issue of omitted variable bias (e.g. McLeay and Tenreyro, 2020).[1]

Figure 2 shows that the flat Phillips Curve can rationalize inflation dynamics before 2020. In the figure, I plot annualized quarterly inflation in the thick black line, and inflation predicted by regression equation (2) in the thick light gray line, for 1995-2020. The model is successful: actual and predicted inflation align closely. In the dark dashed line, the light dashed line, and the thick dark gray line, I plot the contribution due to inflation expectations, energy and the unemployment gap. The contribution of unemployment to inflation is small, since the line associated with unemployment varies little—even though changes in unemployment were often large. As such the Phillips Curve is flat.

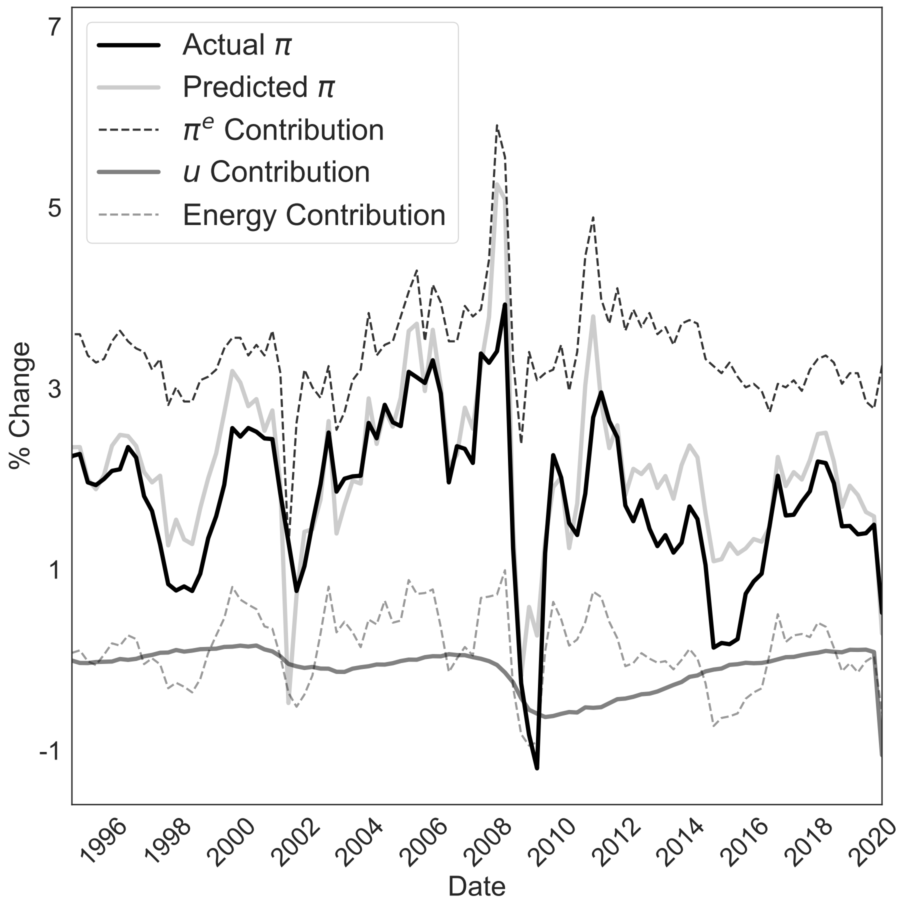
2.4 Contribution #1: The Flat Phillips Curve Fits After 2020

Beaudry et al's first contribution shows that the flat Phillips Curve fits the data well after 2020. To replicate this analysis, I extend the previous empirical exercise. I take the coefficients of the Phillips Curve estimated using data from before 2020Q2; combine them with unemployment, inflation expectations, and energy growth after 2020; and predict inflation after 2020. If the flat pre-2020 Phillips Curve fits the post 2020 data, then predicted and actual inflation will align. If the flat Phillips Curve cannot explain the post pandemic inflation, then predicted inflation will fall below actual inflation.

Figure 3 shows that the flat pre 2020 Phillips Curve characterizes the post pandemic inflation well. In the figure, the black line plots the evolution of annualized quarterly inflation before and after 2020. There is the sharp increase in inflation from 2021 onwards, with inflation peaking at around 7%. The thick light gray line shows the key finding of the paper. Predicted inflation, using the pre-2020 Phillips Curve coefficients and the subsequent path of $\pi^e_{t,t+4}$, $\tilde{u}_t$ and e_t, closely matches actual inflation.

[1] This framework was originally estimated in unpublished slides circulated by James Stock.

Figure 2: Inflation Dynamics: A Historical Decomposition



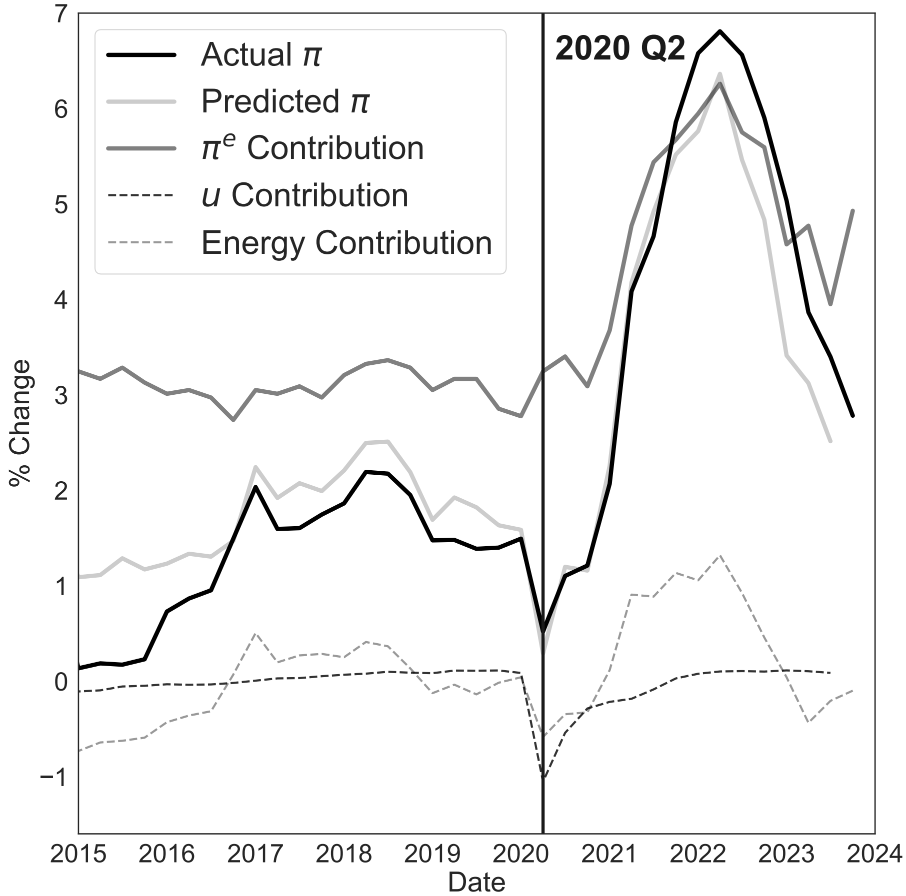
Notes: this graph estimates the Phillips Curve, equation (2), relating PCE inflation to median 1 year ahead household inflation expectations from the Michigan survey, the unemployment gap and PCE energy price growth, using 1984Q1-2020Q1 data. The figure plots actual inflation and inflation predicted by the model. The figure also plots the contribution of each individual regressor towards explaining overall inflation.

Beaudry, Hou and Portier's finding is remarkable and invites several comments. First, the model is successful out of sample. The coefficients are estimated only using data up to 2020Q2, and yet, the post 2020 fit is good. Second, the Phillips Curve can explain the data well despite its flatness. The dashed dark line shows that the contribution of unemployment to explaining inflation is small, as before 2020. Third, the proximate cause of higher inflation is higher inflation expectations. The thick dark gray line is the contribution of inflation expectations to actual inflation, which is by far the largest contributor. The reason for this large contribution is that household inflation expectations increased rapidly, as Figure 4 shows.

2.5 Contribution #2: Inflation Expectations and "Broad Based Supply Shocks"

The first contribution, then, is that the flat Phillips Curve characterizes the post pandemic inflation, and that the proximate cause was rising inflation expectations. The second contribution

Figure 3: Predicting Post-2020 Inflation using Pre-2020 Phillips Curve



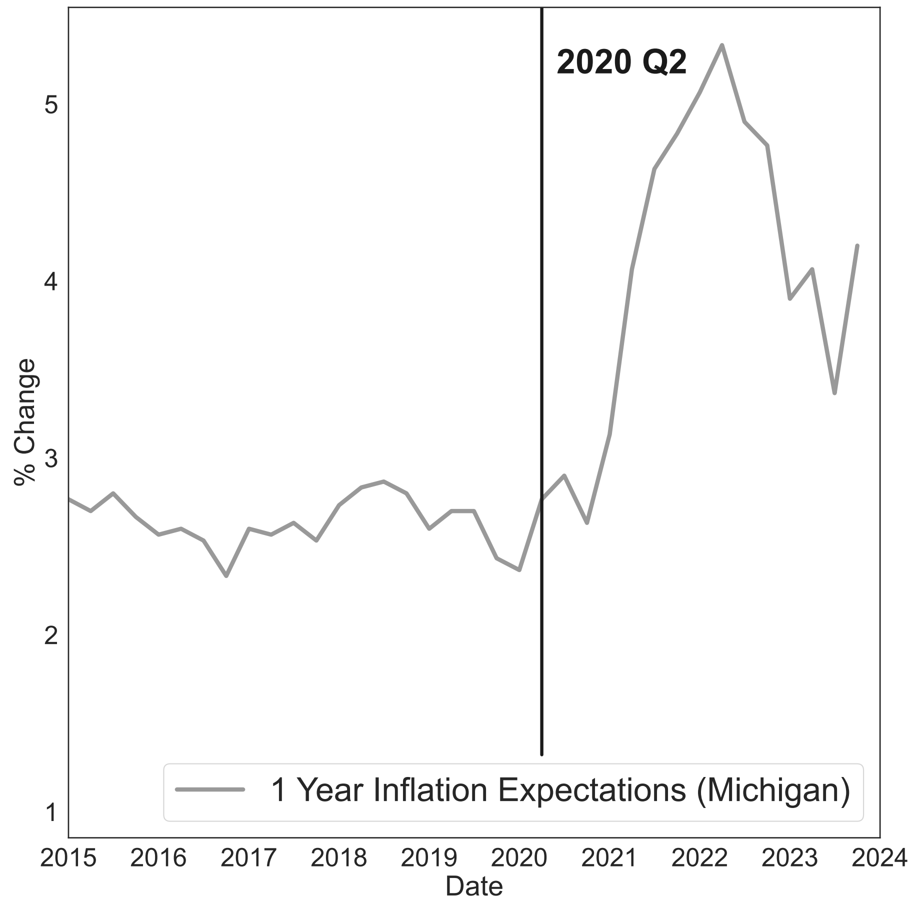
Notes: the figure uses estimated regression coefficients from estimating equation (2)—the relationship between inflation, inflation expectations, the unemployment gap and energy price growth—using data up to 2020Q2. The figure then uses the realized path of inflation expectations, the unemployment gap and energy price growth after 2020, combined with the pre 2020 regression coefficients, in order to predict inflation after 2020. The figure also plots the contribution associated with each regressor to predicting overall inflation.

is a model of why inflation expectations rose by so much.

The authors propose a theory with incomplete information and bounded rationality. In the model, inflation obeys the New Keynesian Phillips curve, as in equation (1). There is a number of sectors, which together form an aggregate Phillips Curve. The novelty is how the authors model expectation formation. Agents in the model perceive inflation as a common component $\tilde{z}_t$ as well as sectoral supply shocks $\tilde{e}_{jt}$ to inflation in sector j. Agents believe that the common component $\tilde{z}_t$ follows an AR(1) process. Agents infer the common component based on observing inflation in a subset of sectors J, following a standard signal extraction problem. There is incomplete information, in that agents do not observe inflation in all sectors in order to infer the aggregate component. There is also bounded rationality, in that agents' beliefs about the common component of inflation $\tilde{z}_t$ do not respect the Phillips Curve.

One example of the mechanism is people who extrapolate overall inflation expectations

Figure 4: Michigan Consumer Survey Inflation Expectations



Notes: this figure plots median household inflation expectations over the next year, at quarterly frequency, from the Michigan Consumer Survey. The sample period is 2015Q1 to 2023Q3.

from observing inflation in only a few goods. For instance, people might form inflation expectations based on observing rent, food and gas prices. There is a burgeoning literature documenting precisely this behavior (e.g. D'Acunto, Malmendier, Ospina, and Weber, 2021).

In the authors' model, "broad based supply shocks" increase inflation expectations. For instance, supply shocks specific to only rent, food and gas may increase the aggregate component of inflation expectations. Intuitively, agents solve a signal extraction problem to estimate the aggregate component $\tilde{z}_t$. When sufficiently many sectoral supply shocks raise inflation, agents infer that $\tilde{z}_t$ has increased. Then, inflation expectations increase.

Therefore the authors' model can rationalize the increase in inflation expectations that they have documented. Since their model obeys a Phillips Curve, higher inflation expectations also raise inflation itself. The rise in inflation expectations is "quasi-self confirming". Actual inflation does end up rising, precisely as agents believed would happen via their inference over the common component $\tilde{z}_t$. The authors then parameterize and estimate a version of the model. The model successfully accounts for inflation dynamics, both during the post pandemic inflation and earlier.

The role of supply shocks is different from the standard New Keynesian model. In the standard model, supply shocks increase inflation through a direct effect on marginal costs, i.e. the ε_t term in equation (1). In Beaudry et al's calibration, these effects are relatively small. Rather, supply shocks indirectly raise inflation, to the extent that they increase inflation expectations via the "broad based supply shock" mechanism.

3 Recap and Comments

Beaudry, Hou and Portier have produced a remarkable paper, which is essential for understanding the post pandemic inflation. Their finding that a flat pre 2020 Phillips Curve fits the post pandemic inflation will be influential.

Their finding is an out of sample explanation using a standard model. As such, the paper contrasts with a fast growing literature proposing a range of 2020s specific modifications to the Phillips Curve. For instance, Ball, Leigh, and Mishra (2022) and Benigno and Eggertsson (2023) argue that the slope of the Phillips Curve increases when the labor market is tight, as in the early 2020s. Both papers advocate different measures of labor market slack other than unemployment, which were particularly tight during the early 2020s. Blanco, Boar, Jones, and Midrigan (2024) suggest that the slope of the Phillips Curve increases after large shocks, such as the rapid increase in real activity after the pandemic. Di Giovanni, Kalemli-Özcan, Silva, and Yildirim (2022) and Bai, Fernández-Villaverde, Li, and Zanetti (2024) suggest that new kinds of supply shocks, arising from "bottlenecks", are important. Papers such as Barro and Bianchi (2023) and Bianchi, Faccini, and Melosi (2023) are motivated by the large rise in deficits in the early 2020s, and argue for the Fiscal Theory of the Price Level.

Beaudry, Hou and Portier suggest a simple explanation: the flat and linear New Keynesian Phillips Curve can explain the data. In this view, there is no need to modify the conventional wisdom about inflation dynamics from before 2020. Rather, the same process characterizes inflation both before and after 2020. Their explanation has at least three virtues. First, Beaudry et al use a model that was conceived and estimated prior to 2020. As such, they avoid post hoc theorizing—the traditional pitfall of Phillips Curve estimation. The 2020s specific alternative explanations may be more vulnerable to this critique. Second, the model is parsimonious, containing three simple and off-the-shelf explanatory variables for inflation. Nevertheless, Figure 3 shows that the model is remarkably successful at explaining inflation dynamics, despite their unusual size and speed. Third, the result suggests a tantalizing possibility. There is a unified equation that can make sense of all of the major inflation episodes after the 1960s. The flat and linear Phillips Curve seems broadly applicable.

To round off this excellent paper, Beaudry et al then explain why inflation expectations rose by so much. They advance a novel, plausible and quantitatively successful theory of rising inflation expectations. I expect future work will develop the ideas they have advanced. In the rest of this discussion, I make two comments that provide context to the paper.

3.1 The Importance of Household Inflation Expectations

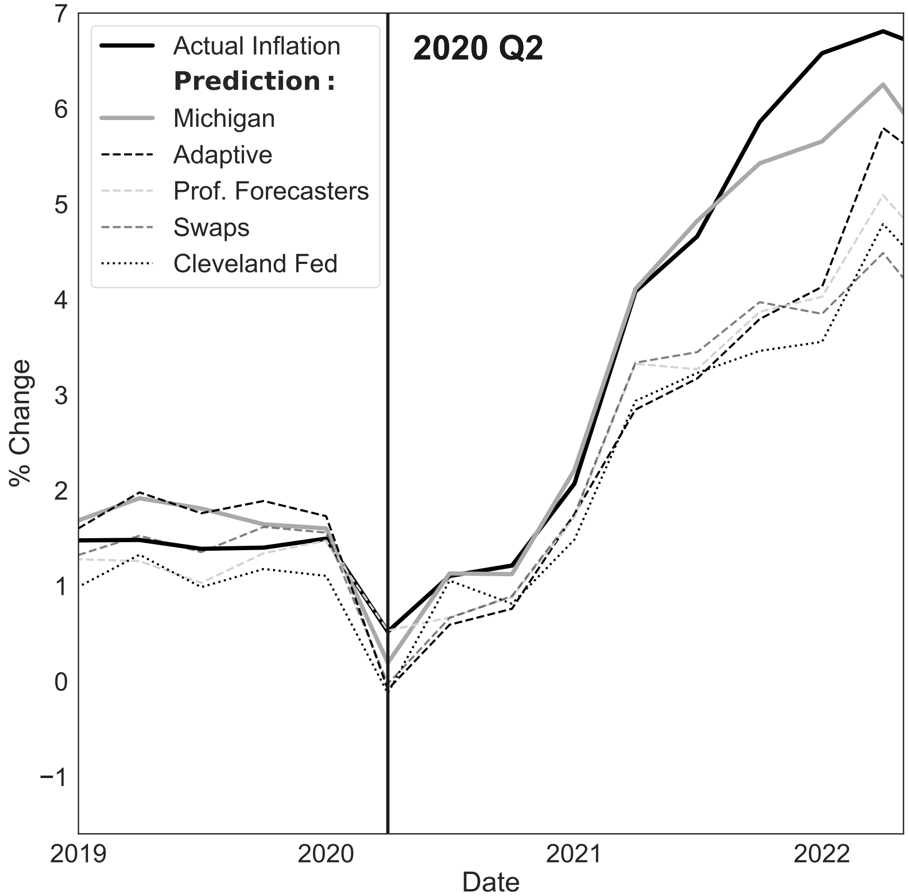
Beaudry et al's Phillips Curve uses household inflation expectations from the Michigan Consumer survey. This choice is ex ante reasonable, but turns out to be crucial for their results. To make this point, I carry out the exercise from Figure 3, but use alternative measures of inflation expectations. That is, I estimate the Phillips Curve equation (2) using data from 1978 to 2020, but with different measures of inflation expectations. I use not only household expectations from Michigan, but also adaptive expectations (the fourth lag of inflation), expectations from the Survey of Professional Forecasters, 1 year ahead inflation expectations from swaps, and the 2 year ahead inflation expectation measure provided by the Cleveland Federal Reserve. This last measure is a weighted average of expectations from profession forecasters and swaps. Then, for each inflation expectations measure, I calculate the predicted value of inflation after 2020, using the pre-2020Q2 regression coefficients and the post 2020 data.

Figure 5 reports the results, and shows that the success of the Phillips Curve depends on using household inflation expectations. In the figure, the solid black line is actual inflation. The other lines show predicted inflation using Michigan household expectations (solid gray), adaptive expectations (dashed black), professional forecasters (dashed light gray), swaps (dashed medium gray) and Cleveland Fed expectations (dotted black). Evidently, the other inflation expectations measures perform worse—there is a 2 percentage point difference between actual and predicted inflation according to the other measures, throughout 2021.

This figure clarifies a source of disagreement in the literature. Influential papers such as Benigno and Eggertsson (2023) argue that the Phillips Curve slope became steeper during the post pandemic inflation. This paper uses the Cleveland Fed and professional forecaster measures, and not household expectations as in Beaudry et al.

Michigan household expectations are ex ante a reasonable measure for at least two reasons. First, household expectations perform better for Phillips Curve estimation prior to the post pandemic inflation. For instance, Coibion and Gorodnichenko (2015) show that household expectations are critical for understanding the “Missing Disinflation” during the Great Recession. Coibion, Gorodnichenko, and Kamdar (2018) show that household expectations perform better for Phillips Curve estimation over the whole US time series. Second, from a conceptual stand-

Figure 5: Prediction of Inflation with Different Expectations Measures



Notes: the figure uses estimated regression coefficients from estimating equation (2)—the relationship between inflation, inflation expectations, the unemployment gap and energy price growth—using pre 2020Q2 data. The regression is estimated for five different measures of inflation expectations, from: Michigan households, swaps, professional professional forecasts, the Cleveland Fed, and adaptive expectations (the fourth lag of inflation). The figure then uses the realized path of inflation expectations, separately for each measure; as well as the the unemployment gap and energy price growth after 2020, combined with the pre 2020Q2 regression coefficients; in order to predict inflation after 2020.

point, what matters for the Phillips Curve is firms' inflation expectations. Arguably, household expectations are a better proxy for firms' expectations than are professionals' expectations. After all, most firms do not hire professional forecasters, and are run by households. In support of this view, Beaudry et al show that during the 2020s, household expectations closely correlate with firm expectations from the Cleveland Federal Reserve's SoFIE measure.

3.2 Fiscal Stimulus May Matter Even with a Flat Phillips Curve

To remind the reader, the narrative of this paper is that supply shocks caused higher inflation by raising inflation expectations. An alternative narrative through which inflation expectations and inflation rose is fiscal stimulus. The United States experienced enormous fiscal stimulus during the post pandemic inflation. 13% of annual 2020 GDP was disbursed in two rounds of fiscal stimulus of late 2020 and early 2021, via the Consolidated Appropriations Act and the American Rescue Plan Act. Shortly after this stimulus, inflation rose significantly. Furthermore, the US experienced a third large stimulus of 10% of annual 2020 GDP in early 2020, via the CARES Act.

The fiscal stimulus suggests a possible alternative cause of inflation. A demand shock from fiscal stimulus could have caused inflation and inflation expectations to rise. If the shock were sufficiently large and persistent, inflation could rise even with a flat albeit positively sloped Phillips Curve. Higher inflation then arises without limited information or bounded rationality.

A back of the envelope exercise suggests that this alternative narrative is plausible. To carry out this exercise, one can write the Phillips Curve equation (1) in terms of output, and then solve forward for the inflation expectations term. One arrives at an equation

$$d\pi_t = \kappa_y \mathscr{M} E_t \sum_{j=0}^{\infty} \beta^j \frac{dG_{t+j}}{\bar{Y}} \tag{3}$$

where $d\pi_t$ is the response of inflation at time t to a sequence of shocks to government spending $\{dG_{t+j}\}$ relative to steady state output $\bar{Y}$. κ_y is the slope of the Phillips Curve in terms of output, and $\mathscr{M}$ is the "cumulative multiplier" (e.g. Ramey and Zubairy, 2018), defined as $\mathscr{M} \equiv E_t \sum_{j=0}^{\infty} \beta^j dY_{t+j} / E_t \sum_{j=0}^{\infty} \beta^j dG_{t+j}$.

One can plug some rough numbers into equation (3) to gauge the approximate effect of the 2020s fiscal stimulus on inflation. An annual calibration with a flat Phillips Curve suggests $\kappa_y = 0.08$, using the numbers of Hazell, Herreno, Nakamura, and Steinsson (2022) and Beaudry, Hou and Portier.[2] There was a fiscal shock of 13% of GDP in 2021, excluding the 2020 CARES Act and including the two later stimulus bills. The cumulative multiplier $\mathscr{M}$ could potentially be as high as 2. This high multiplier is possible if monetary policy was loose and the Federal Reserve was "behind the curve". Moreover the stimulus was deficit financed, which may lead to large multipliers (e.g. Auclert, Rognlie, and Straub, 2023).

The back of the envelope number suggests that fiscal stimulus raised inflation in 2021-22 by 2.2 percentage points. This contribution is sizeable, given that PCE inflation in 2022 was 6.4%. Therefore fiscal stimulus is potentially important for inflation expectations and for inflation. The core reason is that fiscal stimulus was large. Therefore stimulus could raise inflation despite a flat Phillips Curve, as several observers noted in 2021 (e.g. Blanchard, 2021).

More detailed analysis again suggests that fiscal stimulus was important for the post pandemic inflation, even with a flat Phillips Curve. For instance, in Hazell and Hobler (2024), we

[2] To convert between a Phillips Curve in output versus employment, I assume a production function $Y = N^{\alpha}$ with $\alpha = 2/3$.

provide “high frequency narrative evidence” that the 2021 fiscal stimulus raised inflation by around 2 percentage points in 2021 and 2022. We use the release of deficit news around the 2021 Georgia Senate Election runoffs to show that markets expected inflation to rise by several percentage points due to the anticipated stimulus. We also find that a standard heterogeneous agent New Keynesian model, combined with a flat Phillips Curve, can rationalize the inflation response.

4 Conclusion

Beaudry, Hou and Portier have produced one of the most important papers to date on the post pandemic inflation. A range of papers have tackled the question of why inflation rose in the United States and around the world in the 2020s. What sets Beaudry et al apart is the parsimony of their explanation. Without 2020s specific ingredients, and only using the conventional flat Phillips Curve from before 2020, they are able to make sense of the dramatic post 2020 inflation episode. In tracing the proximate cause of the inflation to inflation expectations, they ask exciting questions about why inflation expectations rose so much. Their model offers a thought provoking answer that will be influential for future work.

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