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Inflation Risk and the Labor Market: Beneath the Surface of a Flat Phillips Curve

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Abstract

While the Phillips curve appeared quiescent after the Great Financial Crisis (GFC), inflation risk, as gauged from option prices, remained sensitive to employment dynamics. Using Phillips-curve regressions centered on option-implied moments, I show that, in tight labor markets, a fall in the unemployment gap raises the risk that inflation overshoots expectations – even if realized and expected inflation remain stable. In tight labor markets, implied moments convey valuable information, as shown by their ability to anticipate future patterns in inflation breakevens and wage growth. The usefulness of inflation options in assessing risk, despite their illiquidity, is rooted in reputational incentives that dealers have to disseminate accurate quotes.

Keywords: inflation expectations, inflation risk, inflation options, labor market.

JEL classification: G12; G14; G23

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1 Introduction

The weakening empirical link between inflation and the labor market has garnered considerable attention since the Great Financial Crisis (GFC). Two main economic forces stand behind the flattening of the Phillips curve.[1] The first is firmer anchoring of inflation expectations (Ball and Mazumder, 2011, Watson, 2014, Blanchard, 2016, Barnichon and Mesters, 2021). The second is the decline in labor bargaining power, which has dampened the prices-wages amplification channel (Stansbury and Summers, 2020, Ratner and Sim, 2020, Lombardi et al., 2020).[2] Yet, there is evidence that the Phillips curve, while dormant, could resurface rapidly in an overheated job market (Hooper et al., 2020).

In this paper, I study whether perceived upside risk to inflation becomes more sensitive to employment conditions as slack tightens, even if realized inflation does not respond. I do so by characterizing the link between the unemployment gap and option-implied moments of expected U.S. inflation, conditional on labor-market tightness. The baseline proxy for tightness is changes in the labor-force participation rate, which includes information not necessarily incorporated in the unemployment rate (Erceg and Levin, 2014 and Yellen, 2014). For instance, the participation rate reflects the flow of discouraged workers in and out of the employment pool.

The main results show that upside risk rises as the unemployment gap falls – but only if the labor market is tight. Importantly, these dynamics hold even as realized inflation remains flat. That is, option-implied inflation moments indicate that, while the Phillips curve may be quiescent, there are important shifts in perceived inflation risk under the surface. These shifts anticipate a number of subsequent developments, as discussed next.

I use a two-pronged approach to asses whether the dynamics of option-implied moments convey relevant information. First, I evaluate whether they signal that inflation expectations

[1] The increased responsiveness of monetary policy to job-market dynamics can also flatten the slope of the reduced-form Phillips curve, even if the structural relation is negatively sloped (Eser et al., 2020, Hooper et al., 2020, McLeay and Tenreyro, 2020). Additional factors include issues with measuring inflation expectations (Coibion and Gorodnichenko, 2015, Coibion et al., 2018) and the labor slack (Ball and Mazumder, 2019).

[2] These elements are closely related to demographic changes that also affect low-frequency inflation dynamics, such as fluctuations in the working-age population (Juselius and Takáts, 2021) and the higher participation rate of older workers (Mojon and Ragot, 2019).

are becoming unsettled.[3] To do so, I consider the comovement between risk-neutral moments and future realized moments of daily breakeven rates, which are market-based inflation expectations built from nominal and real government-bond yields. Second, I explore the link between option-implied moments and the future dispersion of wage growth across industries. The rationale is that upside risk to inflation is likely to result in faster wage growth in industries where employees have better bargaining power. Overall, the results indicate that option-implied moments provide useful insights.

The methodology used to extract inflation moments builds on the popular non-parametric approach of Kitsul and Wright (2013) and Aït-Sahalia and Duarte (2003). It is rooted in the work of Breeden and Litzenberger (1978), who derive the return distribution for the asset underlying a set of options from the prices of calls. Importantly, option-implied moments are risk neutral, meaning that they incorporate risk premia. The presence of risk premia, however, is not a hindrance to the analysis. Rather, it means that moments are particularly informative about developments that matter the most to investors and that affect their behavior, chiefly high-inflation states that command larger risk premia (Hilscher et al., 2022a). Elaborating on the arguments set forth by Feldman et al. (2015), Nagel (2016, p.214) illustrates the usefulness of risk-neutral variables by writing that a "*social-welfare maximizing policy should take into account [...] the price that the public is willing to pay to insure against [...] states of the world. Risk-neutral probabilities capture [...] these aspects.*"

When studying option-implied inflation distributions, data quality is an important consideration. Available information suggests that these options were relatively liquid between the end of the GFC and the mid-2010s, when trading slowed down considerably and potentially dried up. Subsequently, prices have mostly reflected dealer quotes. Besides theoretical considerations that prices can be informative even in the absence of trading (Milgrom and Stokey, 1982 and Gizatulina and Hellman, 2019), conversations with market participants suggest that quotes are useful because they are disseminated, in part, to facilitate the risk management of legacy option holdings by large intermediaries (see Section 2.2 for a detailed discussion). The question of price informativeness is also an empirical one. As discussed

[3] Note that comparing moments with long-run realized inflation is impractical, since the sample starts just after the GFC.

above, option-implied moments anticipate future realized moments of breakeven rates and cross-industry dispersion in wage increases.

Option-implied moments and probabilities have been used extensively to characterize the behavior of inflation expectations and associated risk premia. The risk of long-lived deflation has been of particular interest to researchers, as in Fleckenstein et al. (2017) and Hilscher et al. (2022a), who develop a method to gauge the risk of very high or very low inflation. Relatedly, Reis (2020) finds that disagreement among market participants, rather than risk premia, is the main determinant of discrepancies between survey-based and market-implied inflation expectations. The drivers of deflation probabilities are explored by Galati et al. (2018), who find evidence of slight unanchoring in the euro area. Eser et al. (2020) highlight that more limited economic slack played an important role in the rightward shift of the of euro-area inflation distribution before the Covid-19 pandemic. A separate strand of literature uses information extracted from options to characterize the interplay of inflation and macroeconomic aggregates. For instance, Mertens and Williams (2021) study how the distribution of inflation was affected by the the zero lower bound, while Hilscher et al. (2022b) assess the likelihood that inflation can lower real U.S. public debt.

The analysis in this paper is related to research on predicted inflation distributions built using quantile regressions, which are often specified as Phillips curves (Manzan and Zerom, 2015). Applications generally focus on the drivers of inflation tails (Busetti et al., 2015) and on inflation-at-risk, which quantifies the likelihood that inflation experiences large negative realizations (Banerjee et al., 2020 and López-Salido and Loria, 2020). In this literature, Phillips-curve regressions are used to build expected distributions from the historical comovement of inflation with lagged macroeconomic factors. In contrast, inflation options span the full forward-looking distribution on each date, and I use Phillips-curve regressions to understand the drivers of the risk-neutral distributions of expected inflation. Additionally, the wide set of options' strike prices allows to measure the perceived risk of events – typically rare disasters – that, while not observed in the data, are concerning enough to investor to affect asset prices and trading activity (see, among others, Krasker, 1980 and Santa-Clara and Yan, 2010 for a general discussion).

In the remainder of the article, Section 2 discusses the methodology to extract risk-neutral inflation distributions. Section 3 computes Phillips curves with realized and risk-neutral expected inflation, while Section 4 studies option-implied moments using Phillips-curve regressions, focusing on the impact of labor-market developments on inflation risk. Section 5 evaluates the information content of implied inflation moments and Section 6 concludes.

2 Implied inflation distributions

The first step of the analysis consists of extracting risk-neutral distributions from option prices. The data used to build the densities are from Bloomberg and also include inflation swaps to measure point expectations and interest rates swaps as riskless rates. All variables have a five-year horizon and are available each day. As a result, the distributions refer to average annual inflation over the five years following the day in which they are computed.

The methodology used to extract densities is standard in the literature and originates from Breeden and Litzenberger (1978). They link the cumulative probability distribution for the values of the underlying asset (in this case, inflation) to the first derivative of call prices as a function of strike prices.[4] Option prices are normally interpolated to obtain a dense set of strikes. Doing so typically introduces inflection points that can result in negative probabilities, a sign that the interpolated prices imply arbitrage opportunities. To address this issue, I follow the approach of Aït-Sahalia and Duarte (2003). They first transform traded prices to satisfy selected slope and convexity restrictions, limiting the incidence of arbitrage. They then use kernel smoothing to obtain a dense set of prices that inherit the favorable properties of the transformed traded prices.

As in Kitsul and Wright (2013), call prices for a given strike can be obtained using the

[4] The set of options includes puts (known as floors) with strikes equal to -1%, -0.5%, 0%, and 0.5%, and calls (known as caps) with strikes equal to 1%, 1.5%, 2%, 2.5%, 3%, 3.5%, 4%, 4.5%, 5%, and 6%. I convert caps prices into floors prices using the put-call parity (see Mercurio and Zhang, 2017).

parameters $\{\hat{\beta}_0(k), \hat{\beta}_1(k)\}$ that minimize the following loss function:

$$L = \sum_{i=1}^{N} \left[m_i - \beta_0(k) - \beta_1(k)(k_i - k)\right]^2 \frac{1}{\hat{h}} K\left(\frac{k_i - k}{\hat{h}}\right), \tag{1}$$

where $\{m_i\}_{i=0}^{N}$ are the transformed prices, N is the number of strikes with a traded price, $K(u) = exp(-u^2/2)/\sqrt{2\pi}$ is the Gaussian kernel, and $\hat{h}$ is the estimated optimal bandwidth, computed according to equation (3.23) in Aït-Sahalia and Duarte (2003).

After optimizing equation (1) for each daily cross-section of traded prices, I compute cumulative probabilities corresponding to a grid of 10,000 equally spaced strikes between the minimum and maximum traded strikes (-1% and 6%). From this grid, I obtain percentiles that allow me to calculate higher moments robust to outliers (Bowley, 1920 and Moors, 1988; see Andrade et al., 2015 for an application to inflation sknewness from survey data). Specifically, option-implied volatility, skewness, and kurtosis are defined as follows:

$$vol_t^{opt} = \frac{\pi_t^{75,opt} - \pi_t^{25,opt}}{\pi_t^{50,opt}}, \tag{2}$$

$$skew_t^{opt} = \frac{\pi_t^{75,opt} + \pi_t^{25,opt} - 2 \cdot \pi_t^{50,opt}}{\pi_t^{75,opt} - \pi_t^{25,opt}}, \tag{3}$$

$$kurt_t^{opt} = \frac{\left(\pi_t^{87.5,opt} - \pi_t^{62.5,opt}\right) + \left(\pi_t^{37.5,opt} - \pi_t^{12.5,opt}\right)}{\pi_t^{75,opt} - \pi_t^{25,opt}}, \tag{4}$$

where $\pi_t^{n,opt}$ is the n^{th} percentile of the risk-neutral distribution of expected inflation on day t. These measures are the variables of interest in the analysis discussed in the remainder of the paper.

2.1 Empirical properties of risk-neutral inflation moments

The three moments follow distinct time-series patterns, but they all tend to fluctuate more sharply in the first part of the sample, until U.S. monetary-policy normalization started in 2015 (Figure 1). From then onward, volatility tended to increase in periods of lower inflation expectations, with a particularly pronounced rise in early 2020 at the beginning of the Covid-19 pandemic. Kurtosis tracked inflation expectations quite closely, peaking at the end of the sample in early 2021. In contrast, the behavior of skewness was more nuanced. At first, it turned negative as risk-neutral expected inflation rose in 2018 – implying a shift in the probability mass towards moderately higher inflation together with a higher tail risk of markedly lower inflation. However, higher risk-neutral expected inflation in early 2021 was accompanied by a rapid increase in skewness, signalling a higher chance of somewhat lower-than-expected price rises but a more pronounced tail risk of high inflation.

The three moments can be mapped into the probability of various future inflation scenarios. To gauge upside risk, I consider the link between moments and the likelihood of an inflation "overshoot" (average annual inflation up to 0.5% above median option-implied inflation) and of an inflation "surge" (more than 2% above the median). Due to the non-parametric nature of the distributions extracted from equation (1), I establish the link using regressions robust to outliers (Li, 1985) rather than formulas. The dependent variable is the logit transformation of the probability of either scenario, while the dependent variables are standardized moments (see Table 1; volatility is replaced by its natural logarithm).

The coefficients shown in Panel A indicate that higher volatility reduces the probability of an overshoot but increases that of a surge. Higher skewness – which indicates a leftward shift in probability mass but a thicker right tail – lowers the chance of an overshoot but heightens the risk of a surge. Kurtosis has a similar effect. The high adjusted R^2s indicate that the link between moments and probabilities is tight. When the moments are at their sample average, the probability of an overshoot is 21.7% and that of a surge is 3.4% (Panel B). One-standard deviation increases in individual moments alter the two probabilities meaningfully. Changes in skewness affect the chance of an overshoot the most (-2.0 percentage points), while kurtosis has a larger effect on the likelihood of an inflation surge (+1.5 percentage points).

2.2 How informative are the prices of inflation options?

As discussed in Kitsul and Wright (2013), the market for U.S. inflation options developed after the GFC. In 2011, trading amounted to $22 billion in notional value, which represented a three-fold increase relative to 2010 but was still much less than the total for inflation-indexed bonds. Kitsul and Wright (2013) argue that large volumes are not crucial to price formation, pointing to the work Wolfers and Zitzewitz (2004) on markets characterized by small transactions. From a theoretical standpoint, the no-trade theorem illustrates how quoted prices can be informative even when trading does not occur at all (Milgrom and Stokey, 1982 and Gizatulina and Hellman, 2019).

While details on recent trading activity for inflation options are difficult to obtain, conversations with data providers and market participants paint the picture of instruments with very limited volume but with meaningful legacy open positions. Although the number of transactions fell rapidly around 2015, large financial institutions, reportedly including banks and insurance companies, hold inflation options that will not expire until at least the mid-2020s. The reason is that these instruments have always had long maturities, mostly expiring after five or 10 years.

Depending on the accounting and regulatory treatment of such positions, inflation options need to be marked-to-market regularly, possibly every day. Marking-to-market of illiquid instruments is a common industry practice that often relies on dealer quotes. A key reason why dealers provide frequent quotes for instruments that rarely trade is precisely to ensure that clients can value their positions daily. Quotes are often based on the prices of more liquid contracts that load on similar risks – such as interest rate derivatives in the case of inflation options – and on expert judgment.

Dealers that provide quotes for illiquid instruments have two main incentives to give unbiased estimates. The first is that these quotes are actionable, meaning that clients can ask to trade on them. While there is no obligation for a dealer to transact, a large discrepancy between the quote and the proposed trade price would be detrimental to the dealer's reputation. The second incentive relates to the use of these quotes. To the extent that they are inputs to the calculation of regulatory capital – as they reportedly can be – they would be validated in a number of ways to ensure that they are of appropriately good quality. This process can include, among other steps, a comparison with available transaction prices and with consensus pricing data that aggregates estimates from a large set of market participants.

Providing quotes that do not clear these hurdles would tarnish the reputation of a dealer and affect its business.

3 Phillips curves with realized and implied inflation

Before exploring the link between risk-neutral inflation moments and the labor market, I estimate standard Phillips curves with realized inflation to provide an initial reference point. The specification is similar to the one in Hooper, Mishkin, and Sufi (2020), who measure inflation with the changes in the core Personal Consumption Expenditures (PCE) index. The only difference is that I use changes in the Consumer Price Index (CPI), since the payoff of U.S. inflation options is tied to CPI. The baseline specification, using data at the quarterly frequency, is:

$$\pi_t = \alpha + \beta \cdot ugap_t + \sum_{j=1}^{3} \eta_j \pi_{t-j} + \theta \cdot \pi_{t-1}^{e,frb} + \lambda \cdot \Delta RelImport_{t-1} + \epsilon_t \tag{5}$$

where π is the period-on-period relative change in CPI, $ugap$ is the difference between the unemployment rate and the natural rate of unemployment, $\pi^{e,frb}$ is the inflation expectation series used in the Federal Reserve's FRB/US model, and $\Delta RelImport$ is the change in the relative price of import goods relative to domestic goods. Standard errors are based on Newey and West (1987) with four lags. The variable $\pi^{e,frb}$ is available from the Federal Reserve Board, while all others are from the FRED database of the Federal Reserve Bank of St. Louis.

The results in the first column of Table 2 can be compared with those in Table 2.5 of Hooper, Mishkin, and Sufi (2020), since the sample is nearly identical. The conclusions are quite similar, in that the slope of the Phillips curve relative to the unemployment gap is negative but not statistically significant, implying that the measured Phillips curve is flat. Early studies, such as Tobin (1972), recognized that this relation could be asymmetric and depend on the state of the labor market. As a result, the second column of the table shows coefficients from a specification where the effect of the unemployment gap is conditioned on the labor market. The conditioning variable is the twelve-month trailing change in the labor-force participation rate ($\Delta part$), which, as discussed in Section 1, is a broad measure of labor slack that reflects the flow of discouraged workers in and out of the labor pool. The regression is:

$$\pi_t = \alpha + \beta \cdot ugap_t + \gamma \cdot \Delta part_{t-1} + \delta \cdot ugap_t \cdot \Delta part_{t-1} + \sum_{j=1}^{3} \eta_j \pi_{t-j} + \theta \cdot \pi^{e,frb}_{t-1} + \lambda \cdot \Delta RelImport_{t-1} + \epsilon_t. \tag{6}$$

The coefficients are quite similar to those in the unconditional specification. In addition, the interaction term is not statistically significant, meaning that the marginal effect of the unemployment gap on inflation is statistically zero in both slack and tight labor markets (bottom panel of the table). In the two middle columns of Table 2, the sample focuses on the post-GFC period, for which inflation-option data are available. Once again, the Phillips curve is flat. In addition, the interaction term with the unemployment gap is not statistically significant, meaning that the slope of the Phillips curve does not depend on labor slack.

The positive coefficient on $\Delta part$ is consistent with the participation rate reflecting inflationary increases in labor demand rather than deflationary improvements in labor supply. Recent studies indicate that labor demand can raise the participation rate, especially for under-represented workers (Hobijn and Şahin, 2021), even if labor supply shapes participation in subsets of the population (Mojon and Ragot, 2019). Yellen (2014, p.5) highlighted the role of labor demand as a driving factor, writing that then-recent dynamics in "*labor force participation [...] could partly reflect discouraged workers rejoining the labor force in response to the significant improvements [...] in labor market conditions.*"

The closest specification to a Phillips curve that uses information from inflation derivatives is a regression of risk-neutral expected inflation on the unemployment gap and standard controls. The last two columns of Table 2 show coefficients from equations (5) and (6), respectively, where the left-hand variable is $\pi^{e,opt}$ instead of realized inflation. This variable is the median of the risk-neutral distribution of expected inflation extracted from option prices. Since inflation swaps are used to convert the prices of floors into those of caps, $\pi^{e,opt}$ closely tracks the inflation swap rate. The regressions include lagged $\pi^{e,opt}$ as a market-based counterpart to $\pi^{e,frb}$. The results indicate that the Phillips curve is *positively* sloped (Panel A), a finding that I discuss in detail in the next section. The slope is considerably larger in tight labor markets (Panel B).

As shown in Table 3, this pattern also holds with monthly rather than quarterly data. In addition, coefficients on lagged realized and risk-neutral expected inflation indicate short-term persistence in both variables. The monthly specification, reported below, does not include $\Delta RelImport_{t-1}$ as a regressor due to the higher data frequency:

$$\pi_t = \alpha + \beta \cdot ugap_t + \gamma \cdot \Delta part_{t-1} + \delta \cdot ugap_t \cdot \Delta part_{t-1} + \sum_{j=1}^{3} \eta_j \pi_{t-j} + \zeta \cdot \pi_{t-1}^{e,opt} + \epsilon_t. \quad (7)$$

3.1 The role of monetary policy expectations

The observation that option-implied expected inflation rises when the unemployment gap widens appears counter-intuitive, but it is rooted in the role of monetary policy expectations in shaping risk-neutral expected inflation. This connection emerges from an event study that focuses on days when the unemployment rate is announced as part of scheduled Employment Situation releases. Using the specification below, I condition the link between implied inflation and unemployment surprises on both expected monetary policy and the labor market:

$$\begin{aligned} \Delta\pi_t^{e,opt} &= \Delta vix_t + surp_t + \Delta part_{t-1} + \Delta ffr_t \\ &+ surp_t \cdot \Delta part_{t-1} + surp_t \cdot \Delta ffr_t + \Delta part_{t-1} \cdot \Delta ffr_t \\ &+ surp_t \cdot \Delta part_{t-1} \cdot \Delta ffr_t + \epsilon_t, \end{aligned} \quad (8)$$

where Δffr is the change in the expected federal funds rate one-year ahead, and *surp* is the difference between the announced unemployment rate and survey expectations from Thompson Reuters, divided by the natural rate of unemployment (linearly interpolated as needed).

As shown in Panel A of Table 4, Δffr is an important explanatory variable for $\Delta\pi^{e,opt}$. Its interaction with $\Delta part$ is also negative and strongly statistically significant. On net, the marginal effect of a wider unemployment gap on option-implied expected inflation is positive and larger in tight labor markets (as in Tables 2 and 3, even if the test designs are completely different) – but only when investors expect looser monetary policy (Panel B). This result confirms that policy actions are key determinants of the empirical link between inflation and the unemployment rate (McLeay and Tenreyro, 2020).

4 Inflation risk and the labor market

The Phillips-curve framework can be used to explore how the whole risk-neutral distribution of expected inflation relates to labor dynamics. Using option-implied moments as dependent variables, Phillips-curve regressions can link the state of the job market to different types of inflation risk, from the dispersion of future changes to the incidence of extreme realizations. In turn, such risks can be expressed as the probabilities of relevant inflation scenarios (see Section 2.1). Ultimately, this analysis can shed light on the ebbs and flows of perceived inflationary pressures as employment opportunities change – even when realized inflation remains stable.

The analysis builds on specifications similar to the Phillips curves used to study realized inflation at the quarterly and monthly frequencies, as detailed in equations (6) and (7). Apart from the dependent variable (y_t) being one of volatility, skewness, or kurtosis, the only difference is that the set of regressors includes lagged values of y_t to account for autocorrelation in moments. At the quarterly frequency, the specification features the inflation-expectations series used in the Federal Reserve's FRB/US model ($\pi^{e,frb}$) and the change in the relative price of import goods relative to domestic goods ($\Delta RelImport$):

$$\begin{aligned} y_t = \alpha + \beta \cdot ugap_t + \gamma \cdot \Delta part_{t-1} + \delta \cdot ugap_t \cdot \Delta part_{t-1} \\ + \zeta y_{t-1} + \sum_{j=1}^{3} \eta_j \pi_{t-j} + \theta \cdot \pi^{e,frb}_{t-1} + \lambda \cdot \Delta RelImport_{t-1} + \epsilon_t. \end{aligned} \tag{9}$$

At the monthly frequency, constraints on data availability mean that inflation expectations are measured with the median of the option-implied distribution ($\pi^{e,opt}$) and that

$\Delta RelImport$ is not included:

$$y_t = \alpha + \beta \cdot ugap_t + \gamma \cdot \Delta part_{t-1} + \delta \cdot ugap_t \cdot \Delta part_{t-1} \\ + \zeta y_{t-1} + \sum_{j=1}^{3} \eta_j \pi_{t-j} + \zeta \cdot \pi_{t-1}^{e,opt} + \epsilon_t. \tag{10}$$

The results shown in Table 5 clearly indicate that the higher moments respond to the unemployment gap. For skewness, the coefficient on *ugap* is positive, as is the one on the interaction between *ugap* and $\Delta part$. As a result, a smaller unemployment gap is accompanied by a shift in probability mass towards higher inflation and by a thicker left tail – but only if the labor market is tight. For kurtosis, both the main and interaction coefficients are positive, meaning that only when the job market is already tight does a compression in the unemployment gap increases tail thickness.

Changes in implied moments can be translated into probabilities. As discussed in Section 2.1, there is a tight empirical relation between implied moments and the probability of inflation overshooting (at most 0.5% above the median) or surging (at least 2.0% above the median). The coefficients in Table 5, which quantify how moments change with the labor market, can be combined with the results in Panel A of Table 1, which connect moments and inflation probabilities, to link labor dynamics and the likelihood of inflation scenarios. Using the coefficients in Table 5 from the monthly sample, a one standard deviation decline in *ugap* raises the overshoot probability by about a tenth from 21.7% to 23.6% (to 25.0% if using quarterly estimates), while the surge probability declines from 3.4% to 2.9% (to 2.8% with quarterly data). The risk of a surge dips because, as *ugap* compresses, the decline in volatility more than compensates for the increase in kurtosis.

The importance of job-market conditions in determining the connection between option-implied inflation moments and the unemployment gap is not driven by the specific choice of how to measure labor tightness. In addition to changes in the participation rate, I consider two alternative proxies: the unemployment gap itself, which implies adding the squared *ugap* to the baseline regressions, and the under-employment rate, defined as the ratio of the under-employment level to the civilian labor force minus one. In both cases, and in contrast to

$\Delta part$, lower values correspond to better employment opportunities.

Table 6 shows the coefficients on *ugap* conditional on each of the two measures of labor-market tightness, using monthly data. These results should be juxtaposed to the monthly marginal effects in Table 5. Comparability is ensured because all variables are standardized. There is a remarkable correspondence between the baseline and alternative specifications. Crucially, the coefficients are always larger in tight labor markets. In addition, the only difference in terms of statistical significance pertains to skewness in slack markets, when the proxy is the unemployment gap. In this case, the t-statistic is close to -3, while it is about nil in the baseline. Finally, the magnitude of the coefficients is quite similar to the main results when conditioning on the unemployment gap, while it is noticeable larger if using the under-employment rate.

5 The informative content of inflation moments

The responsiveness of inflation moments to the labor market indicates that options quickly incorporate information, consistent with the discussion in Section 2.2 on why illiquidity does not prevent price formation. Since option-implied distributions are forward looking, moments should anticipate future inflation dynamics, especially – in light of the results so far – when the labor market is tight. In this section, I investigate whether such is indeed the case, using regressions of selected variables on lagged inflation moments.

The relatively short sample, which is limited to the post-GFC period, implies that considering the moments of realized inflation as dependent variables is impractical. As a result, I use a two-pronged approach that focuses, first, on the realized moments of daily market-based inflation expectations, and, second, on cross-industry differences in monthly wage growth.

5.1 The moments of future breakeven rates

I compute the realized log-volatility, skewness, and kurtosis of daily five-year breakeven rates (mom_t^{brk}) within a given quarter, half-year, or year. Each of these moments is then regressed on its lagged value and the corresponding lagged average option-implied moment (mom_t^{opt}):

$$mom_t^{brk} = \alpha + \beta \cdot mom_{t-1}^{opt} + \gamma \cdot mom_{t-1}^{brk} + \epsilon_t. \tag{11}$$

In the main specification, the coefficients are computed with OLS and the standard errors are based on Newey and West (1987) with two lags. In an alternative specification, I consider the possibility that persistence in the regressors could yield biased coefficients, and use the procedure of Amihud et al. (2008) to correct for this potential bias.

The results are reported in Table 7. Starting with the quarterly horizon, the first three columns of Panel A indicate that risk-neutral inflation volatility provides useful signals about future realized breakeven volatility, which increases by 0.4 standard deviation for one standard-deviation increase in option-implied volatility. However, there is no effect in the case of skewness or kurtosis. As shown in Panel B, the reduced-bias methodology of Amihud et al. (2008) yields similar coefficients to those based on OLS,

At the half-yearly horizon, the magnitude and statistical significance of the coefficient on volatility start to fade, while risk-neutral skewness is clearly linked to future breakeven skewness. Once more, there is little difference between the computations based on OLS and Amihud et al. (2008). The connection between breakeven and lagged option-implied moments disappears when considering a one-year horizon.

To take the state of the labor market into account, the marginal effect of inflation moments is computed from the coefficients β and λ in the following regression:

$$mom_t^{brk} = \alpha + \beta \cdot mom_{t-1}^{opt} + \gamma \cdot mom_{t-1}^{brk} + \delta \cdot \Delta part_{t-1} + \lambda \cdot mom_{t-1}^{opt} \cdot \Delta part_{t-1} + \epsilon_t, \tag{12}$$

where standard errors are based on Newey and West (1987) with two lags. The results are presented in Table 8, which shows marginal effects when the labor market is tight or slack, defined on the basis of $\Delta part_{t-1}$ being one standard deviation above or below average.

At the quarterly horizon, volatility remains the only option-implied moment to co-move with its equivalent computed from breakeven rates. The picture becomes richer starting with the six-month frequency: labor tightness means that all option-implied moments anticipate their realized counterparts. A similar pattern holds at the one-year horizon, although magnitudes and statistical significance decline for skewness and kurtosis. Interestingly, coefficient signs indicate that inflation risk is persistent in tight labor markets, while it tends to revert in slack ones.

5.2 The dispersion of future cross-industry wage growth

I now turn to whether risk-neutral moments anticipate the dispersion of wage growth across industries. The rationale is that inflationary pressures generally raise labor compensation (Blanchard, 1986), but industry differences in bargaining power are bound to generate discrepancies in wage growth (Stansbury and Summers, 2020). Building on this observation, I test two implications: first, dispersion should be driven by the gap between industries where workers have better/worse outside opportunities, which increase bargaining power (Pissarides, 1994); second, dispersion should be sensitive to option-implied moments, especially in tight labor markets.

Dispersion is the log-difference of the highest and lowest wage-growth rates across industries[5] in a given time period, divided by average growth:

$$disp_t = ln\frac{max(w_j) - min(w_j)}{n^{-1} \cdot \Sigma_{j=1}^{n} w_j}, \tag{13}$$

where w_j is the relative change in wages between months t and $t+h$, where $h = 3$ or $h = 6$, depending on the horizon.

In testing the first implication, I proxy for industry-specific outside opportunities with the fall in sectoral employment between 2001 and 2009 (see the discussion on outside opportunities and the unemployment rate in Summers, 1988 and Machin and Wadhwani, 1991). As Pierce and Schott (2016) highlight, employment changes over this period were heavily

[5] I consider the following industries based on availability (data codes for the St. Louis Fed's FRED dataset are shown in parentheses): construction (CES2000000008), education (CES6500000008), financials (CES5500000008), information (CES5000000008), leisure and hospitality (CES7000000008), manufacturing of durable goods (CEU3100000008), manufacturing of non-durable goods (CES3200000008), mining and logging (CES1000000008), professional and business services (CES6000000008), retail trade (CES4200000008), transportation and warehousing (CES4300000008), utilities (CES4422000008), and wholesale trade (CES4142000008).

influenced by a 2000 change in U.S. trade policy that eliminated the risk of higher tariffs on imports from China. Industries most exposed to import competition saw sharp declines in employment. A broad literature finds that import competition normally has adverse effects on wage stability (Bertrand, 2004) and distribution (Borjas and Ramey, 1995), in line with a negative effect on bargaining power.[6] As shown in Figure 2, industries with higher wage growth between 2010 and 2019 did experience a more contained fall in employment from 2001 to 2009, consistent with wage-growth dispersion reflecting differences in labor negotiating strength.

In testing the second implication, I gauge the link between risk-neutral inflation moments and future wage-growth dispersion with the following monthly regressions:

$$disp_t = \alpha + \beta \cdot mom_{t-1} + \gamma \cdot disp_{t-1} + \delta \cdot \Delta part_{t-1} + \lambda \cdot mom_{t-1} \cdot \Delta part_{t-1} + \epsilon_t, \qquad (14)$$

where mom_{t-1} is either log-volatility, skewness or kurtosis, and standard errors are based on Newey and West (1987) with lags equal to the lead horizon in months plus 12 (the length of the moving window over whcih $\Delta part$ is calculated).

Without conditioning on the labor market, higher volatility and skewness anticipate a wider wage-growth range over the next three months (Table 9). In contrast, kurtosis signals a narrower dispersion. This finding is consistent with the result in Tables 7 and 8 that higher risk-neutral kurtosis, when the coefficient is statistically significant, often prefigures lower realized kurtosis. At the six-month horizon, only the coefficient on skewness remains statistically significant, with a roughly unchanged magnitude. Taking the state of the job market into account (Table 10), the results indicate, once more, that option-implied moments are more informative in periods of labor tightness, especially in the case of skewness.

[6] Competition from international trade has also weakened the link between inflation and domestic economic slack (Auer et al., 2017 and Zhang, 2017), especially in more exposed industries (Gilchrist and Zakrajšek, 2020).

6 Conclusions

While the measured Phillips curve has flattened over time, option-implied inflation distributions indicate that perceived inflation risk has remained sensitive to labor-market dynamics. In particular, upside risk increases when the unemployment gap shrinks, especially in an already tight labor market. Among the various inflation moments, implied skewness is particularly reactive to the unemployment gap. Importantly, implied moments convey useful information, in that they anticipate future patterns in market-based inflation expectations and in wage growth. Overall, the results presented in this paper point to complex dynamics for (risk-neutral) inflation risk in the background of an apparent detachment of headline inflation from the labor market.

The use of options to compute inflation moments has two important implications. The first is that the moments incorporate risk premia, which generally create a wedge relative to estimates based on surveys or econometric methods. These premia, however, incorporate useful information on outcomes that matter the most to investors and that affect their decision making. The second consequence is that the reliability of the implied moments depends on the quality of option prices. While these instruments were illiquid in the second half of the sample and prices largely reflected dealer quotes, dealers have strong incentives to provide quotes close to fair value. The main reason is that their clients reportedly use the data to mark-to-market legacy positions in inflation options.

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Figure 1: Implied inflation moments over time

The three panels depict the time series of quarterly averages for risk-neutral (option-implied) inflation volatility, skewness, and kurtosis. Each panel also shows the median of the option-implied distribution in the background for reference. Data are quarterly and cover 2010 to 2021 Q2.

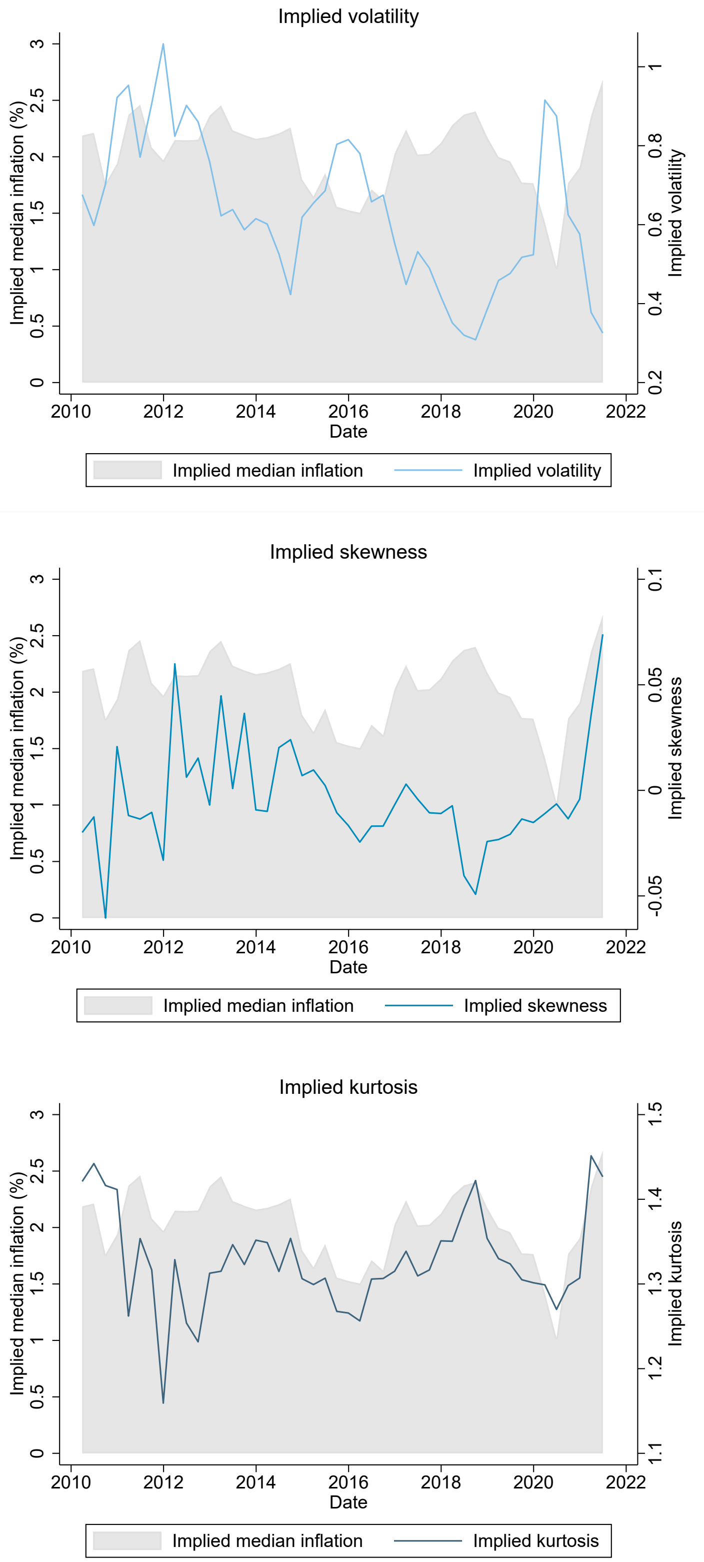

Figure 2: Wage inflation dispersion and labor outside options

In a given month, industries are sorted into two groups based on wage growth over the following three months. The bar chart shows the average decline in industry employment between 2001 and 2009, after China was granted Permanent Normal Trade Relations by the U.S. Congress in October 2000. See Pierce and Schott (2016). The decline employment is used as a proxy for industry-specific labor outside options during the 2010s. Data on wage growth cover 2010 to 2019.

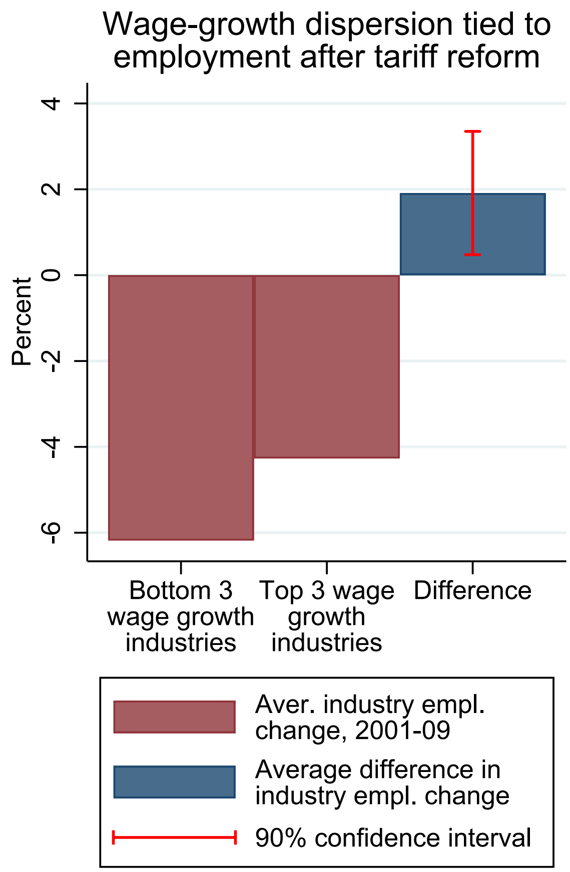

Table 1: Risk-neutral moments and upside risk to inflation

The table links risk-neutral moments to the likelihood that inflation exceeds expectations by a moderate or substantial amount. In Panel A, the variable of interest is the logit transformation ($y = ln\left(\frac{p}{1-p}\right)$) of the probability that annual average realized inflation in the next five years is up to 0.5% above median expected inflation ("Prob. Overshoot") or 2% or more above the median ("Prob. Surge"). The dependent variables are linked to standardized inflation moments using regressions robust to outliers (Li, 1985). In Panel B, the probabilities in the first line are computed with the inverse logit transformation applied to the coefficients α in Panel A: $(1 + exp\,(-\alpha))^{-1}$. Probability changes ($\Delta$Prob) when moments are one standard deviation above the mean are computed as: ΔProb= $(1 + exp\,(-(\alpha + mom^{opt})))^{-1} - (1 + exp\,(-\alpha))^{-1}$, where mom^{opt} is one of the three option-implied moments. The sample covers 2010-2019.

Panel A

	Dependent variable	
	Prob. Overshoot	Prob. Surge
vol^{opt}	-0.314***	0.896***
	(-20.22)	(19.32)
$skew^{opt}$	-0.121***	0.136***
	(-9.00)	(3.37)
$kurt^{opt}$	-0.051***	0.386***
	(-2.78)	(7.05)
α	-1.286***	-3.339***
	(-99.67)	(-86.56)
Obs.	119	119
Adj.R^2	0.829	0.791

Panel B

	Probability values	
	Prob. Overshoot	Prob. Surge
Prob. if all moments at mean	21.7%	3.4%
ΔProb. if vol^{opt} is 1σ above mean	-4.9%	4.6%
ΔProb. if $skew^{opt}$ is 1σ above mean	-2.0%	0.5%
ΔProb. if $kurt^{opt}$ is 1σ above mean	-0.9%	1.5%

Table 2: Phillips curve with realized and implied inflation (quarterly)

The table shows coefficients from Phillips curves similar to those in Hooper, Mishkin, and Sufi (2020), using quarterly data. When the dependent variable is realized inflation (π_t), the specification is: $\pi_t = \alpha + \beta \cdot ugap_t + \gamma \cdot \Delta part_{t-1} + \delta \cdot ugap_t \cdot \Delta part_{t-1} + \Sigma_{j=1}^{3} \eta_j \pi_{t-j} + \theta \cdot \pi_{t-1}^{e,frb} + \lambda \cdot \Delta RelImport_{t-1} + \epsilon_t$. When the dependent variable is option-implied expected inflation ($\pi_t^{e,opt}$), the specification is: $\pi_t^{e,opt} = \alpha + \beta \cdot ugap_t + \gamma \cdot \Delta part_{t-1} + \delta \cdot ugap_t \cdot \Delta part_{t-1} + \Sigma_{j=1}^{3} \eta_j \pi_{t-j} + \theta \cdot \pi_{t-1}^{e,frb} + \zeta \cdot \pi_{t-1}^{e,opt} + \lambda \cdot \Delta RelImport_{t-1} + \epsilon_t$. The variables included in the regressions are the relative period-on-period change in the consumer price index (π), median expected inflation as implied from option prices ($\pi^{e,opt}$), the difference between the unemployment rate and the natural rate of unenplyoment ($ugap$), the four-quarter change in the labor force participation rate ($\Delta part$), the inflation expectation series used in the Federal Reserve's FRB/US model ($\pi^{e,frb}$) and the change in the relative price of import goods relative to domestic goods ($\Delta RelImport$). All variables are standardized and constants are unreported. Standard errors are based on Newey and West (1987) with four lags.

Period (quarterly):	1989-2019		2010-2019		2010-2019	
Dep. Var.:	π_t		π_t		$\pi_t^{e,opt}$	
$ugap_t$	-0.180	-0.279	-0.144	0.409	0.281*	0.590***
	(-1.54)	(-1.22)	(-0.61)	(1.50)	(1.91)	(2.80)
$\Delta part_{t-1}$		-0.070		0.585***		0.409***
		(-0.54)		(4.00)		(3.12)
$ugap_t \cdot \Delta part_{t-1}$		-0.066		-0.085		0.108
		(-0.70)		(-0.74)		(1.37)
π_{t-1}	-0.120	-0.128	0.113	0.086	0.473***	0.403**
	(-0.88)	(-0.92)	(0.55)	(0.47)	(2.93)	(2.48)
π_{t-2}	-0.220	-0.211	-0.041	-0.034	0.618**	0.497*
	(-0.91)	(-0.92)	(-0.20)	(-0.17)	(2.22)	(1.90)
π_{t-3}	0.019	0.007	-0.340	-0.271	-0.028	-0.029
	(0.22)	(0.08)	(-1.66)	(-1.55)	(-0.11)	(-0.11)
$\pi_{t-1}^{e,frb}$	0.411***	0.446**	0.312	0.195	-0.277	-0.314
	(2.68)	(2.36)	(1.64)	(1.25)	(-1.24)	(-1.47)
$\pi_{t-1}^{e,opt}$					0.618***	0.759***
					(5.18)	(6.14)
$\Delta RelImport_{t-1}$	0.167	0.155	0.176	0.112	-0.310	-0.350
	(0.92)	(0.88)	(0.88)	(0.50)	(-1.30)	(-1.33)
Obs.	123	123	40	40	39	39
R^2	0.117	0.124	0.132	0.266	0.621	0.667

Labor market	Marginal effect of $ugap_t$		
Slack ($\Delta part_{t-1} = -1\sigma$)	-0.213	0.494	0.482**
	(-1.26)	(1.57)	(2.12)
Tight ($\Delta part_{t-1} = +1\sigma$)	-0.345	0.323	0.699***
	(-1.13)	(1.17)	(3.14)

Table 3: Phillips curve with realized and implied inflation (monthly)

The table shows coefficients on Phillips curves similar to those in Hooper, Mishkin, and Sufi (2020), using monthly data. The dependent variable y is either π or $\pi^{e,opt}$. The specification is: $y_t = \alpha + \beta \cdot ugap_t + \gamma \cdot \Delta part_{t-1} + \delta \cdot ugap_t \cdot \Delta part_{t-1} + \Sigma_{j=1}^{3} \eta_j \pi_{t-j} + \zeta \cdot \pi_{t-1}^{e,opt} + \epsilon_t$. The variables included in the specifications are defined in Table 2. Monthly natural rates are linearly interpolated from quarterly data. Constants are not reported. All variables are standardized. Standard errors are based on Newey and West (1987) with twelve lags.

Period (monthly):	2010-2019		2010-2019	
Dep. Var.:	π_t		$\pi_t^{e,opt}$	
$ugap_t$	0.025	0.101	0.036	0.156**
	(0.41)	(1.10)	(0.98)	(2.47)
$\Delta part_{t-1}$		0.105		0.150**
		(1.18)		(2.38)
$ugap_t \cdot \Delta part_{t-1}$		-0.039		0.059
		(-0.64)		(1.43)
π_{t-1}	0.429***	0.421***	0.182***	0.184***
	(4.88)	(4.80)	(3.31)	(3.23)
π_{t-2}	-0.131*	-0.129*	-0.048	-0.038
	(-1.74)	(-1.75)	(-1.11)	(-0.83)
π_{t-3}	-0.060	-0.065	-0.033	-0.034
	(-0.66)	(-0.73)	(-0.53)	(-0.54)
$\pi_{t-1}^{e,opt}$	-0.008	0.007	0.885***	0.902***
	(-0.16)	(0.15)	(20.16)	(24.20)
Obs.	119	119	119	119
R^2	0.168	0.180	0.836	0.845

Labor market	Marginal effect of $ugap_t$	
Slack	0.140	0.097
($\Delta part_{t-1} = -1\sigma$)	(1.10)	1.41
Tight	0.061	0.215***
($\Delta part_{t-1} = +1\sigma$)	(0.67)	(2.64)

Table 4: Expected policy rates and the implied-inflation/unemployment-gap link

The table shows the result of an event study based on scheduled releases of the Employment Situation. The variables Δvix_t and Δffr_t are changes in log-VIX and in the 1-year ahead federal funds rate (implied from futures) between day $t-1$ and day t, where t is the date of the monthly release of the employment situation. The variable $surp_t$ is the difference between the actual an expected unemployment rate (based on Thompson Reuters surveys) divided by the natural rate of unemployment measured in the previous month. Monthly natural rates are linearly interpolated from quarterly data. Other variables are defined in Table 2. Constants are not reported. All variables are standardized. Standard errors are based on Newey and West (1987) with twelve lags.

Panel A		
Dep. Var.:	$\Delta\pi_t^{e,opt}$	
Δvix_t		-0.142
		(-1.37)
$surp_t$	0.075	0.083
	(0.79)	(0.96)
$\Delta part_{t-1}$	0.122	0.111
	(1.57)	(1.44)
Δffr_t	0.348***	0.323***
	(3.95)	(3.66)
$surp_t \cdot \Delta part_{t-1}$	0.066	0.048
	(1.17)	(0.80)
$surp_t \cdot \Delta ffr_t$	-0.086*	-0.097*
	(-1.67)	(-1.79)
$\Delta part_{t-1} \cdot \Delta ffr_t$	-0.248***	-0.252***
	(-2.91)	(-2.93)
$surp_t \cdot \Delta part_{t-1} \cdot \Delta ffr_t$	-0.009	-0.030
	(-0.12)	(-0.39)
Obs.	116	116
R^2	0.215	0.234

Panel B

Effect of *ugap* surprise on change in implied inflation, by labor tightness and change in expected mon. pol.

		Expected monetary policy: Expand ($\Delta ffr_t = -1\sigma$)	Expected monetary policy: Contract ($\Delta ffr_t = +1\sigma$)
Labor market	Slack ($\Delta part_{t-1} = -1\sigma$)	0.103	-0.032
		(1.65)	(-0.14)
	Tight ($\Delta part_{t-1} = +1\sigma$)	0.258**	0.004
		(2.51)	(0.04)

Table 5: Phillips-curve regressions with option-implied inflation moments

The table shows coefficients from regressions similar to Phillips curves, where the dependent variables are option-implied moments (log-volatility, skewness and kurtosis) for expected average inflation five-years ahead. The variables included in the specifications are defined in Tables 2 and 3. Monthly natural rates are linearly interpolated from quarterly data. Constants are not reported. All variables are standardized. Standard errors are based on Newey and West (1987) with twelve lags. The sample covers 2010-2019.

Period:	2010-2019 (quarterly)				2010-2019 (monthly)		
Dep. Var. (y_t):	vol_t^{opt}	$skew_t^{opt}$	$kurt_t^{opt}$		vol_t^{opt}	$skew_t^{opt}$	$kurt_t^{opt}$
$ugap_t$	0.177	0.696***	-0.391*		0.184***	0.342***	-0.231
	(0.79)	(2.90)	(-1.84)		(2.77)	(2.72)	(-1.63)
$\Delta part_{t-1}$	0.036	0.463***	-0.242		-0.021	0.277**	-0.198**
	(0.28)	(3.23)	(-1.57)		(-0.55)	(2.36)	(-2.57)
$ugap_t \cdot \Delta part_{t-1}$	0.103	0.684***	-0.439***		0.024	0.330***	-0.262***
	(1.36)	(4.54)	(-3.34)		(0.64)	(3.06)	(-3.68)
y_{t-1}	0.652***	0.030	0.145		0.774***	0.298***	0.377***
	(4.82)	(0.18)	(0.54)		(11.84)	(2.86)	(3.90)
π_{t-1}	-0.091	-0.376**	-0.005		-0.036	0.050	0.030
	(-0.73)	(-2.09)	(-0.03)		(-0.85)	(0.44)	(0.46)
π_{t-2}	-0.412**	0.516	-0.093		0.092**	-0.031	-0.168*
	(-2.62)	(1.28)	(-0.31)		(2.18)	(-0.22)	(-1.88)
π_{t-3}	-0.138	-0.141	0.018		0.039**	-0.037	-0.169**
	(-1.19)	(-0.74)	(0.10)		(2.00)	(-0.53)	(-2.48)
$\pi_{t-1}^{e,frb}$	0.256**	-0.066	-2.467	$\pi_{t-1}^{e,opt}$	-0.140***	0.090	0.251***
	(2.25)	(-0.29)	(-1.66)		(-2.99)	(1.12)	(3.33)
$\Delta RelImport_{t-1}$	0.066	-0.335	0.272				
	(0.39)	(-0.99)	(1.00)				
Obs.	39	39	39	Obs.	119	119	119
R^2	0.834	0.511	0.471	R^2	0.907	0.253	0.385

Labor market	Marginal effect of $ugap_t$					
Slack ($\Delta part_{t-1} = -1\sigma$)	0.073	0.012	0.048	0.160**	0.012	0.031
	(0.37)	(0.04)	(0.33)	(2.14)	(0.11)	(0.19)
Tight ($\Delta part_{t-1} = +1\sigma$)	0.280	1.380***	-0.831**	0.208***	0.672***	-0.493***
	(1.03)	(4.83)	(-2.58)	(2.71)	(3.29)	(-3.16)

Table 6: Phillips-curve regressions: alternative measures of labor-market slack

The table reports marginal coefficients on $ugap_t$ from monthly Phillips-curve regressions similar to those in Table 5. The specifications use two alternative measures of labor market slack: the unemployment gap (meaning that the regressions include a linear and squared term for $ugap_t$) and the underemployment rate ($underempl_t$), defined as the underemployment level divided by the civilian labor force, minus one. All variables are standardized. Standard errors are based on Newey and West (1987) with twelve lags. The sample covers 2010-2019.

	Unenemployment gap		
Labor market	vol^{opt}	$skew^{opt}$	$kurt^{opt}$
Slack	0.180**	-0.223***	0.139
($ugap_t = +1\sigma$)	(2.59)	(-2.82)	(0.66)
Tight	0.229**	0.503***	-0.301**
($ugap_t = -1\sigma$)	(2.56)	(3.86)	(-2.18)
	Underemployment rate		
Labor market	vol^{opt}	$skew^{opt}$	$kurt^{opt}$
Slack	0.247	0.521	-0.521
($underempl_t = +1\sigma$)	(1.18)	(1.50)	(-1.56)
Tight	0.339	1.667***	-1.302***
($underempl_t = -1\sigma$)	(0.96)	(2.97)	(-2.72)

Table 7: Option-implied moments and future break-even moments

The coefficients reported in the table are from the following regressions using monthly data: $mom_t^{brk} = \alpha + \beta \cdot mom_{t-1}^{opt} + \gamma \cdot mom_{t-1}^{brk} + \epsilon_t$, where mom^{opt} is either option-implied log-volatility, skewness, or kurtosis. The variable mom_t^{brk} is either realized log-volatility, skewness, or kurtosis of daily five-year breakeven inflation rates over the horizon indicated in the table starting from t. Similarly, the variable mom_{t-1}^{brk} is calculated over the horizon indicated in the table up to and including $t-1$. In Panel A, the coefficients and t-statistics are based on Newey and West (1987) with lags equal to double the horizon. In Panel B, the results are based on the methodology of Amihud, Hurvich, and Wang (2008) for persistent regressors. All variables are standardized. The sample covers 2010 to 2019.

Panel A									
Method:	Newey-West								
Horizon:	3 months			6 months			12 months		
Realized moment:	vol_t^{brk}	$skew_t^{brk}$	$kurt_t^{brk}$	vol_t^{brk}	$skew_t^{brk}$	$kurt_t^{brk}$	vol_t^{brk}	$skew_t^{brk}$	$kurt_t^{brk}$
$moment_{t-1}^{opt}$	0.368***	0.083	-0.004	0.260	0.292**	-0.023	0.040	0.159	-0.058
	(2.89)	(0.95)	(-0.05)	(1.58)	(2.38)	(-0.23)	(0.22)	(1.62)	(-0.87)
$moment_{t-1}^{brk}$	0.043	0.091	-0.001	0.221	-0.103	-0.005	0.330	-0.210	-0.158
	(0.32)	(1.21)	(-0.02)	(1.56)	(-1.26)	(-0.05)	(1.30)	(-1.59)	(-1.47)
Obs.	103	103	103	100	100	100	94	94	94
R^2	0.147	0.015	0.000	0.155	0.094	0.001	0.115	0.075	0.030

Panel B									
Method:	Reduced bias								
Horizon:	3 months			6 months			12 months		
Realized moment:	vol_t^{brk}	$skew_t^{brk}$	$kurt_t^{brk}$	vol_t^{brk}	$skew_t^{brk}$	$kurt_t^{brk}$	vol_t^{brk}	$skew_t^{brk}$	$kurt_t^{brk}$
$moment_{t-1}^{opt}$	0.391***	0.080	-0.008	0.273*	0.296***	-0.025	0.049	0.161	-0.058
	(2.91)	(0.85)	(-0.08)	(1.71)	(2.84)	(-0.26)	(0.26)	(1.38)	(-0.86)
$moment_{t-1}^{brk}$	0.021	0.095	-0.010	0.210*	-0.12	-0.002	0.319	-0.217*	-0.158
	(0.16)	(1.30)	(-0.10)	(1.75)	(-1.55)	(-0.02)	(1.15)	(-1.85)	(-1.61)

Table 8: Option-implied moments and future break-even moments, by labor slack

The coefficients reported in the table are from the following regressions using monthly data: $mom_t^{brk} = \alpha + \beta \cdot mom_{t-1}^{opt} + \gamma \cdot mom_{t-1}^{brk} + \delta \cdot \Delta part_{t-1} + \lambda \cdot mom_{t-1}^{opt} \cdot \Delta part_{t-1} + \epsilon_t$, where mom^{opt} is either option-implied log-volatility, skewness, or kurtosis, and $\Delta part_t$ is the change in the labor force participation rate over the previous twelve months. Tight/slack labor market is defined as $\Delta part_{t-1}$ being one standard deviation above/below the mean. The the coefficients and t-statistics are based on Newey and West (1987) with lags equal to double the horizon. All variables are standardized. The sample covers 2010 to 2019.

Horizon:	3 months		6 months		12 months	
Labor market:	Tight	Slack	Tight	Slack	Tight	Slack
	Dep. var.: vol_{t-1}^{brk}					
vol_{t-1}^{opt}	0.352*	0.387	0.400**	0.109	0.595***	-0.399**
	(1.81)	(1.35)	(2.00)	(0.38)	(3.78)	(-2.54)
	Dep. var.: $skew_{t-1}^{brk}$					
$skew_{t-1}^{opt}$	0.095	0.080	0.682**	0.221**	0.665*	0.081
	(0.51)	(0.73)	(2.29)	(2.13)	(1.81)	(1.13)
	Dep. var.: $kurt_{t-1}^{brk}$					
$kurt_{t-1}^{opt}$	0.126	-0.042	0.528*	-0.129***	0.472	-0.141***
	(0.67)	(-0.37)	(1.99)	(-2.98)	(1.09)	(-3.79)

Table 9: Inflation moments and the dispersion of industry wage growth

The dependent variable is the dispersion of wage growth across industries, defined as: $disp_t = ln\frac{max(w_j)-min(w_j)}{n^{-1}\cdot\Sigma_{j=1}^{n}w_j}$, where w_j is the relative change in wages between months t and $t+3$ or $t+6$, depending on the horizon indicated in the panels below. The variable $disp_{t-1}$ is defined in a similar way, but with the relative change in wages being computed between months $t-3$ or $t-6$ and t, depending on the horizon. All variables are standardized and t-statistics are computed using standard errors based on Newey and West (1987) with lags equal to twice the lead/lag horizon. The monthly sample covers 2010-2019.

Dep. Var.:	$disp_t$			$disp_t$		
Horizon:	3 months			6 months		
vol_{t-1}^{opt}	0.264**			0.060		
	(2.18)			(0.40)		
$skew_{t-1}^{opt}$		1.712*			1.707*	
		(1.75)			(1.93)	
$kurt_{t-1}^{opt}$			-0.945**			-0.198
			(-2.55)			(-0.47)
$disp_{t-1}$	0.525***	0.554***	0.559***	0.667***	0.637***	0.676***
	(7.75)	(7.88)	(8.34)	(13.24)	(11.12)	(13.17)
Obs.	118	118	118	118	118	118
R^2	0.574	0.555	0.564	0.591	0.605	0.590

Table 10: Inflation moments and wage-growth dispersion, by labor slack

The table reports the coefficients of regressions (monthly frequency) linking the future dispersion of industry wage growth to lagged option-implied inflation moments. The specification is: $disp_t = \alpha + disp_{t-1} + x_{t-1} + \delta \cdot \Delta part_{t-1} + \lambda \cdot x_{t-1} \cdot \Delta part_{t-1} + \epsilon_t$. The variable x_{t-1} represents one of the different option-implied moments, while $disp_t$ and $disp_{t-1}$ are defined as detailed in Table 9. All variables are standardized and t-statistics are computed using standard errors based on Newey and West (1987) with lags equal to the lead horizon plus 12 ($\Delta part$ is computed over 12 months). The sample covers 2010-2019.

	Marginal effect of option-implied moments			
Horizon:	3 months		6 months	
Labor market:	Tight	Slack	Tight	Slack
vol^{opt}_{t-1}	0.303*	0.089	0.061	-0.013
	(1.88)	(0.47)	(0.64)	(-0.05)
$skew^{opt}_{t-1}$	0.494***	0.062	0.228**	0.118**
	(4.98)	(1.29)	(2.21)	(2.05)
$kurt^{opt}_{t-1}$	-0.306**	-0.151**	0.067	-0.087
	(-2.20)	(-2.11)	(0.57)	(-1.17)

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