Inflation Forecasting from Cross-Sectional Stocks

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Abstract

This paper examines the inflation forecastability of cross-sectional stocks. To differentiate the cross-sectional inflation exposures, we make the important observation that cross-sectional stock returns exhibit persistent sensitivity to headline inflation shocks during the calendar month of CPI, and to core inflation news on CPI announcement days. Examining the relative pricing between stocks with high- and low-inflation exposures, captured either by the headline- or core-focused inflation beta, we find active price discovery on inflation and its core component in cross-sectional stocks. The core-focused forecasting portfolio emerges as a unique and unparalleled predictor for core inflation, especially during the inflation surge of 2021 and 1973, when its predictive power and economic significance increase dramatically. Moreover, our stock-based predictors can uniquely forecast the foresting errors made by economists, especially during 2021-22, and its predictability is especially strong under Fed's QE and when the Fed is behind-the-curve in fighting inflation.

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1 Introduction

The rapid surge of global inflation since 2021 underscores the importance of inflation forecasts. In hindsight, the policy makers in the U.S. should have acted swiftly in early 2021 to avert the punishing inflation that is plaguing the world economy right now. Instead, throughout 2021 and well into March 2022, the Fed had kept its interest-rate policy and continued its $120 billion a month bond purchases. Pivoting since March 2022 and tightening aggressively since June 2022, the Fed has been fighting inflation behind the curve, and yet, inflation remains stubbornly high. The most recent core CPI (September) measure came in at 6.6% year-over-year, a level not seen in 40 years.

The severity of the 2021 inflation surge was missed not only by policy makers, but also by the economists contributing to the survey-based inflation forecasts. During the most consequential months in 2021, the median estimate of the Bloomberg surveys of economists missed the rapid ascend of the core CPI, month-over-month, by 0.1% in March, 0.6% in April, 0.2% in May, and 0.5% in June. The case for April 2021 is the most egregious, when the highest projection of the Bloomberg surveys was only 0.5%, missing the actual announcement of 0.9% by a wide margin. As both policy makers and economists form their forecasts by incorporating the information available to them at the time, their collective failure in 2021 reflects the limitation of the existing inflation forecasts and calls for alternative forecasting methods to add the much needed diversity to the traditional approach.

Motivated by the 2021 experience, our paper studies the effectiveness of financial markets, particularly the cross-sectional stocks, in forecasting inflation. Our hypothesis is that, as the impact of inflation risk varies across firms, the relative pricing between stocks with high- and low-inflation exposures can be an effective aggregator of investors' expectations of future inflation. Relative to the Treasury bond market, whose yield curves have been used widely to forecast inflation, the information contained in the cross-sectional stocks can add value, especially when the pricing of U.S. Treasury bonds is influenced by factors unrelated to inflation risk. For example, amid heightened inflation, the Treasury yield might decrease, not because of reduced inflation risk, but due to fight-to-safety or Fed's pivot from tightening. Illiquidity of the market for TIPS can also add noise to the breakeven inflation forecasts. More importantly, government interventions in the Treasury market (e.g., QE) distort bond pricing, masking the inflation expectations. By contrast, our focus on the relative pricing between stocks with high- and low-inflation exposures allows us to shift away from the overall equity-market trends and zero in on the inflation expectations.

Cross-Sectional Inflation Exposures – To estimate the extent to which inflation expectations affect the pricing of a stock, we use the pre-ranking inflation beta, estimated by regressing stock returns on inflation innovations over a 5-year rolling window. Following the standard approach of Chen et al. (1986) and Boons et al. (2020), we estimate the full-month inflation beta, β^{Full}, by regressing monthly stock returns on the contemporaneous inflation innovations. As price discovery with respect to inflation takes place not only during the contemporaneous month when inflation is realized, but also on CPI announcement days when inflation news is released, we further introduce an information-based inflation beta that has not been studied in the literature before. Specifically, our announcement-day inflation beta, β^{Ann}, measures the sensitivity of the announcement-day stock returns on the inflation innovations. For the purpose of identifying inflation-sensitive stocks, the risk-based measure β^{Full} gauges their contemporaneous inflation exposure during the entire month, while the information-based measure β^{Ann} focuses on their price reactions on the announcement day.

Both measures are found to be effective in differentiating the cross-sectional inflation exposures, but their information content varies. The full-month inflation beta β^{Full} can capture the relative exposures to headline CPI, particularly the energy component, while the announcement-day beta β^{Ann} works for core CPI, particularly goods and services.[1] Estimating β^{Full} and β^{Ann} for both Treasury bonds and the commodity index (GSCI), we find the same pattern – inflation-sensitive securities comove with headline CPI during the contemporaneous month and respond to core CPI on announcement days. This pairing of β^{Full} for headline and β^{Ann} for core makes intuitive sense as components of the headline CPI such as energy can be observed continuously and contemporaneously by the market participants throughout the CPI month, while components of the core CPI (e.g., goods and services) are not easily observed during the CPI month and constitute a bigger surprise on the CPI announcement days. For this reason, we apply the full-month approach to headline CPI and the announcement-day approach to core CPI and refer to them as β^{FullHead} and β^{AnnCore}.

Inflation Forecasting with TMB Portfolios – Sorting stocks by their pre-ranking beta into quintile portfolios, we form two monthly re-balanced top-minus-bottom (TMB) portfolios – the core-focused TMB portfolio is constructed using the information-based and core-focused β^{AnnCore}, while the headline-focused TMB portfolio is constructed by the risk-based and headline-focused β^{FullHead}. The aggregate stock market in general has a negative inflation beta, suffering in performance amid positive inflation shocks. Relative to the aggregate market, stocks in the bottom-ranked portfolio, whose inflation betas are ranked the lowest, suffer even more severely when inflation increases. By focusing on the TMB portfolios, our hypothesis is that, when informed by higher inflation expectations, investors would underprice stocks in the bottom portfolio more severely than those in the top portfolio,

[1]Consistent with Fang, Liu, and Roussanov (2021), we find that the post-ranking β^{Full}, estimated from 1972 to 2022, is more negative and significant for core CPI than headline CPI. Unlike their focus on the aggregate stock market, however, our objective is to differentiate stocks by their relative inflation exposures. For this, our results show that β^{Full} works for headline CPI and is ineffective for core CPI.

resulting in positive TMB returns. A higher than usual TMB return is therefore a reflection of heightened inflation expectations and can help predict the inflation yet to be realized.

Testing this hypothesis on headline inflation, we use the 6-week TMB returns observed by the end of month t to predict the CPI innovations realized in month $t+1$. Both the core- and headline-focused TMB portfolios have strong predictability for headline CPI, confirming our hypothesis that a non-trivial amount of the future inflation has been incorporated into the cross-sectional stocks well before the start of the actual CPI month. When used jointly to predict headline inflation, both TMB portfolios remain significant, reflecting their different focuses on the inflation innovations. Collectively, the information from the TMB portfolios has a predictive R-squared of 13.8% for headline CPI. Out-of-sample, the TMB portfolios enhance the forecasting accuracy of the month $t+1$ inflation growth by 12%, benchmarked relative to the time-series model of ARMA (1,1).

The equity-based TMB forecasts are further tested against two market-based forecasts known to contain inflation expectations – the Goldman Sachs Commodity Index (GSCI) and the TIPS-UST portfolio, which buys the inflation-neutral TIPS and sells the inflation-negative nominal U.S. Treasury (UST) bonds. Among these four market-based forecasts, the commodity-based GSCI is the most informative. Monthly returns to GSCI can predict headline CPI with an R-squared of 25.5%, nearly doubles the predictive power of our TMB portfolios. Using our TMB portfolios jointly with GSCI, however, their predictability, particularly the core-focused TMB, remains significant. Interestingly, the bond-based TIPS-UST portfolio cannot compete with the equity- and commodity-based predictors. Overall, our results show that price discovery with respect to inflation risk does take place in the pricing of cross-sectional stocks, and, given the sheer variety of firms with varying exposures to the different components of inflation, the inflation expectations embedded in the cross-sectional stocks can be a fresh source of information.

Forecasting Core Inflation – While financial markets in general and the commodity index in particular can predict the innovations in headline inflation well, their forecastability on core inflation is very much limited. Yet, given its outsize influence on Fed's monetary policy, forecasting core inflation is of enormous importance, and this is where the inflation expectations captured by our TMB portfolio can help the most. Constructed using the information-based and core-focused β^{AnnCore}, our core-focused TMB emerges as the most informative predictor for core CPI among the market-based forecasts.

The 6-week core-focused TMB returns observed by the end of month t can predict the core CPI innovations realized in month $t+1$ with an R-squared of 2.5%. A one standard increase in the TMB return predicts an increase of 2.46 bps (t-stat=3.31) in core CPI. Given that the month-over-month core CPI innovation has a standard deviation of 16 bps, this economic significance is moderate but non-trivial. Compared with the other market-based predictors, including GSCI and TIPS-UST, this core-focused TMB portfolio constructed from cross-sectional stocks offers the largest predictive R-squared and highest economic significance. More importantly, when used jointly to predict core CPI, our core-focused TMB portfolio remains significant statistically and non-trivial economically, while the other market-based predictors are insignificant.

The 2021 Experience – Focusing on 2021, we are most interested in uncovering the inflation expectations from the capital markets at the time. For the 18 months from January 2021 through June 2022, the predictability of our core-focused TMB portfolio increases tremendously. The 6-week TMB return observed at the end of month t can predict the month-$t+1$ core CPI innovations with an R-squared of 31.5%, an enormous increase from the full-sample R-squared of 2.5%. Taking place amid the heated debate on the transitory vs permanent nature of the surging inflation, this increased predictive power for core CPI suggests active price discovery in the cross-sectional stocks with respect to the much needed inflation information. For the first time since 1982, the core CPI climbed over just one month by 0.9% in April 2021. Prior to the beginning of that month, our core-focused TMB predictor was sending a 3.79-sigma signal, the second highest during our sample period (1972-2022).

Using the market-based predictors jointly to predict core CPI during the 2021 episode, the core-focused TMB emerges as the only significant predictor and its economic significance dominates the other predictors by a wide margin. During 2021, both the commodity-based GSCI and the bond-based TIPS-UST offer rather disappointing performance in predictability. The respective R-squared of the predictive regression is 0.8% and 0.0% and the regression coefficients are surprisingly negative, though statistically insignificant. By contrast, the economic significance of our TMB predictor is such that a one standard deviation increase in the core-focused TMB return predicts an increase of 10.47 bps (t-stat=2.77) in core CPI, more than four times the full-sample economic significance of 2.46 bps (t-stat=3.31).

As a parallel to 2021, the 1973 experience has frequently been brought back from history to shed light on the recent runaway inflation. Focusing on May 1973, when the year-over-year core CPI growth first crossed above 3%, we form the 1973 sample period by including the 12 months before and 24 months after May 1973. Similar to the 2021 experience, our core-focused TMB portfolio can predict core CPI innovation with a much improved R-squared of 29% and economic significance of 18.97 bps (t-stat=4.37). Moreover, similar to the case of 2021-22, this improved predictability is picked up only by our core-focused TMB portfolio. Repeating the same exercise for headline CPI, we find that, in both episodes, the significant improvement is unique only for core CPI. The predictability for headline CPI improves only mildly from its full-sample results and the limited improvement is contributed mostly by our core-focused TMB portfolio.[2]

Inflation Forecasting by Economists – Leading up to each pre-scheduled CPI announcement, economists routinely make their inflation forecasts and the Bloomberg survey of economists is one such widely followed inflation forecast. Between the time when our TMB forecast is observed (end of month t) and the announcement of the month-$t+1$ CPI (the second or third week of month $t+2$), over one month has elapsed. It is therefore interesting to study whether or not economists update their inflation expectations using the market-based information, particularly those embedded in the cross-sectional stocks. Or alternatively, we can study the extent to which market-base forecasts can predict the announcement-day error made by the economists.

We find that our core-focused TMB portfolio can predict the announcement-day errors made by economists above and beyond the other market-based predictors. A one standard deviation increase in the return of our core-focused TMB portfolio can predict an increase of 4.37 bps (t-stat=4.73) and 2.75 bps (t-stat=3.65), respectively, in the headline and core CPI not expected by the economists. As the respective CPI forecasting error has a standard deviation of 13 bps and 11 bps, the information from the cross-sectional stocks can help improve the economists' forecast. And yet, this information, available over one month in advance, does not find its way into the economists' forecasts. To further study the extent to which the economists incorporate the market-based information, we use the market-based forecasts jointly to predict the change of the economists forecast and find that the economists actively update their inflation forecasts using information from the commodity market, but not core-focused TMB portfolio. In other words, the uniquely important inflation expectations are not in the information set of the economists.

The 2021 episode further re-enforces this observation. The economists' forecasting errors for core CPI can be predicted by our TMB portfolio with an R-squared of 22.3%, a significant increase from the full-sample R-squared of 6.5%. The economic significance also increases from the full-sample result of 2.75 bps (t-stat=3.65) to 8.17 bps (t-stat=2.09). The room for improvement is significantly larger during 2021-22.

Time-Varying Inflation Risk and Expectations – Inflation is difficult to predict because of its time-varying nature. Dormant for extended periods of time, inflation has the tendency to surge rapidly and the 2021 experience is one perfect example. Against all forms of inflation forecasts, market prices offer the most timely information, but the effectiveness of their

[2]During the 1973 episode, the predictability of GSCI for headline CPI stays similar to that of the full sample, while during the 2021 episode, its predictability is in fact much weakened relative to the full-sample result. The performance of the bond-based TIPS-UST is even worse during the 2021 episode, with the predictive regression carrying the wrong sign, and unavailable for the 1973 episode as active trading of TIPS begins only after 1998.

forecastability also varies over time, as active price discovery with respect to inflation risk takes place only when inflation emerges as an important risk factor in the capital markets. The 2021 and 1973 experiences are two such examples. Exploring this idea further, we sort CPI month by the absolute value of CPI innovations and find the predictability of our TMB portfolios to be significantly stronger when inflation risk is more volatile. Using the magnitude of economists' disagreement as another proxy for time-varying inflation volatility, we observe a similar pattern.

Studying the time-varying predictability, we further focus on the unique role played by monetary policies in fighting inflation, particularly the core component. Measuring the extent to which the Fed is behind-the-curve by the distance between the Fed Fund Rate and the rate recommended by the Taylor rule, we find that, when the Fed is behind the curve, the predictive power and economic significance of our core-focused TMB are significantly larger. Separating the CPI month by whether or not it is under QE, we find a similar pattern. The predictability of our core-focused TMB is significantly stronger under QE. These results indicate that a higher than usual signal from the cross-sectional stocks does not automatically lead to sustained increases in core inflation such as in 2021 and 1973. To the extent that the Fed is ahead of the curve, inflation can be effectively contained, resulting in a much muted predictability.

Likewise, when followed immediately by a severe recession, early warnings of surging inflation might also fail to materialized. The 2008 episode offers one such example. Accompanying the rapid oil price shock that peaked in July 2008, both our TMB portfolios provided unusually high signals prior to July 2008, with the headline-focused TMB beginning its ascend in early 2007 and leading the core-focused by about six months. By June 2008, our signal for the CPI month of July was 3.80-sigma for the core-focused TMB, the largest ever reading, and was 3.97-sigma for the headline-focused TMB, the second largest reading.[3] One month later, our TMB portfolios crashed to -2.97-sigma and -2.78-sigma, respectively. Given how our TMB portfolios are constructed, their stock compositions do not change dramatically from month to month, and this sharp reversal in our TMB signals reflects a sharp reset in inflation expectation informed by the incoming financial crisis.[4]

Related Literature: Our paper belongs to the literature on inflation forecasting. Comparing the forecastability of traditional methods, Ang, Bekaert, and Wei (2007) and Faust and

[3]With 4.06-sigma, the CPI month of August 1981 is the largest ever for the headline-focused TMB. We normalize the returns by their sample standard deviation and express the signal in the unit of standard deviation (i.e., sigma).

[4]Meanwhile, the commodity- and bond-based predictors also sent out reversing signals, though with milder magnitudes. The GSCI return moved from 1.41-sigma to -2.16-sigma, while the TIPS-UST return moved from 0.56-sigma to -0.85-sigma.

Wright (2013) find the survey forecasts to perform the best, outperforming the information from the Treasury yield curve, the macro variables, and the time-series models using past inflation growths. Relative to this literature, our paper documents the unique and important role played by the cross-sectional stocks in forecasting inflation, particularly the illusive core inflation. We find the inflation forecasts from the cross-sectional stocks outperform the bond-based predictor by a wide margin and consistently forecast the forecasting errors made by economists, particularly during the 2021 inflation surge.

Conceptually, the closest paper to ours is Downing, Longstaff, and Rierson (2012), who use industry portfolios from the equity market to track the inflation growth over the subsequent month. Our focus and implementation, however, differ significantly from theirs. Instead of tracking inflation growths, our focus is on predicting the unexpected component (i.e., innovations) of inflation growth. Instead of using industry portfolios, we construct our TMB portfolios from the ground up using individual stocks. Finally, new to the literature are our predictive results for the core CPI innovations and the significantly stronger predictability of our core-focused TMB portfolio during the 1973 and 2021 episodes.

Our paper is also related to the literature that uses the cross-sectional stocks to price the inflation risk premium, including Chen, Roll, and Ross (1986) and, more recently, Boons et al. (2020). Foundational to estimating the risk premium is a stable measure of risk exposures, which is found illusive for inflation risk in the stock market. Given the weak contemporaneous correlation between stock and inflation documented by Fama and Schwert (1977), the common belief is that stock market is not a good place for inflation hedge.[5] Extrapolating this idea, it is believed that the equity market is not an active place for price discovery with respect to inflation. The strong predictability documented in our paper proves this to be wrong. Moreover, focusing on the timing and the content of price discovery, we contribute methodologically to this literature by offering two separate approaches to estimating the inflation beta, and show that the information-based beta is more suitable for core CPI, while the risk-based beta for headline CPI.

Finally, the differential pricing impact of core versus headline inflation has been examined recently in Ajello, Benzoni, and Chyruk (2020) by focusing on the Treasury yield curves, and in Fang, Liu, and Roussanov (2021) by showing that the aggregate stock market is more negatively correlated with the core component of inflation. We contribute to the disentanglement of core from headline CPI in two ways. First, we show that for the purpose of estimating cross-sectional exposures to core CPI, our proposed information-based beta is

[5]Among others, Bekaert and Wang (2010) provide international evidence on the negative and unstable relationship between equity and inflation. Using industry portfolios, Ang, Brière, and Signori (2012) and Boudoukh, Richardson, and Whitelaw (1994) further show that inflation betas vary substantially across industries and over time.

much more effective, owing to the fact that information release with respect to core CPI is concentrated on CPI announcement days. Second, we show that price discovery with respect to core CPI does take place actively in the cross-sectional stocks. Among all market-based predictors, our information-based core-focused TMB portfolio emerges as the best predictor for core CPI, particularly during the 1973 and 2021 episodes.

The rest of our paper is organized as follows. Section 2 describes our data. Section 3 documents the contemporaneous-month and announcement-day inflation exposure. Section 4 explores the predictability of market-based inflation forecasters, and Section 5 discusses their time-varying information content during important inflationary episodes, when disagreement on inflation is high, and conditional on Fed monetary policy. Finally, Section 6 discusses the channels and Section **??** concludes.

2 Data

We obtain monthly data on Consumer Price Index (CPI), including Headline CPI, Core CPI, and detailed components of CPIs (e.g., Food, Energy, Goods, and Services) from the U.S. Bureau of Labor Statistics (BLS).[6] The CPI announcement dates are also collected from BLS. Following Chen, Roll, and Ross (1986), Ang, Bekaert, and Wei (2007), Bekaert and Wang (2010), CPI growth is defined as the difference in the natural logarithm of monthly CPI:

$$\pi_t = log(P_t/P_{t-1}), \tag{1}$$

where P_t is the level of CPI for month t.

For each type of CPI series, we construct CPI innovation using the times series model of ARMA(1,1), following Fama and Gibbons (1984), Ang, Bekaert, and Wei (2007), and Boons et al. (2020). The ARMA(1,1) model is estimated by maximum likelihood in the following specification:

$$\pi_{t+1} = \mu + \phi\pi_t + \varphi\varepsilon_t + \varepsilon_{t+1}, \tag{2}$$

where $\mu + \phi\pi_t + \varphi\varepsilon_t$ is ARMA(1,1) predicted CPI growth for month $t+1$, and ε_{t+1} is the CPI innovation for month $t+1$. To avoid look-ahead bias, we estimate the CPI innovation for month $t+1$ using all the historical observations on and before month t, and require at least ten years of observations. Since data on core CPI starts after 1957, the sample on CPI innovations starts from 1967.

Appendix Table A1 reports the summary statistics for CPI innovations. Headline CPI

[6] The BLS CPI data series are as follow: Headline (CPIAUCSL), Core (CPILFESL), Food (CPIUFDSL), Energy (CPIENGSL), Goods (CUSR0000SACL1E), and Services (CUSR0000SASLE).

innovation has a mean of 0.09 bps with a standard deviation of 26.23 bps, and core CPI innovation has a mean of 0.03 bps with a standard deviation of 15.7 bps. The close-to-zero average value of CPI innovations suggest that ARMA(1,1) does a good job in capturing the overall inflation pattern. Consistent with the intuition that core CPI, with the exclusion of food and energy components, is in general more persistent than its non-core counterparts, the standard deviation of core CPI is smaller than that of headline CPI.

We obtain data on cross-sectional stock returns from the Center for Research in Security Prices (CRSP). We include all common stocks traded on NYSE, Amex, and NASDAQ. Stock returns are adjusted for delisting (Shumway (1997)). If a delisting return is missing and the delisting is performance related, we set the delisting return to -30%. We use CRSP value weighted market return (VWRETD) as aggregate stock market return. One-month T-bill return measured at the end of the previous month is the risk-free rate, downloaded from Kenneth French website. To capture asset returns in the space of commodity, we use Goldman Sachs Commodity Index Return (GSCI).[7] To capture the bond market dynamics, we us Bloomberg U.S. Treasury Inflation Notes Total Return Index (TIPS, average maturity is 7.49 years), and Bloomberg U.S. Treasury Total Return Index (UST, average maturity is 7.3 years). Since data on daily TIPS return is only available after June 1998, our sample starts from 1998 when TIPS is included as the control variable. We also download one-year and ten-year US Treasury yield, retrieved from Federal Reserve Bank of St. Louis. Finally, to capture economists' expectations about inflation growth, we use Bloomberg economists' survey forecasts of headline- and core-CPI month-over-month growth. Since data on Bloomberg economists forecasts starts from 1997, to obtain longer history of survey forecasts, we also use quarterly inflation forecasts from Survey of Professional Forecasters (SPF) database, tracing back to the third quarter of 1981.

Panel B of Appendix Table A1 reports the summary statistics of monthly assets returns, economists forecast errors, as well as their correlations with the inflation innovations. Economists forecasting errors are highly correlated with headline- and core-CPI innovations with a correlation of 0.53 and 0.78 respectively, suggesting that majority of the inflation innovations, unexplained by the time-series model of ARMA(1,1), are unexpected by the economists as well. In terms of market-based asset returns, GSCI and TIPS-UST are positively correlated with next-month inflation innovations. Their respective correlations with headline-CPI innovations are 0.51 and 0.41, and the correlations with core-CPI innovations are 0.13 and 0.18. Aggregate stock market overall exhibits a weak correlation with CPI innovation. However, TMB portfolios, which are constructed based on cross-sectional stock

[7] Goldman Sachs launched GSCI in April 1991. Information prior to the launch date is hypothetically back-tested by Goldman Sachs based on the index methodology at the launch date.

returns (described in detail in Section 3.1), have correlations of around 0.31 and 0.15 with headline- and core-CPI innovations respectively.

3 Cross-Sectional Inflation Exposures

In this section, we examine the extent to which different components of inflation expectations affect the pricing of assets, with a special focus on the cross sectional stocks. We demonstrate that asset prices, including cross-sectional stocks, as well as commodity and bonds, respond strongly to headline inflation innovations during the contemporaneous months when CPI is realized, and to core inflation innovations on the CPI announcement days.

3.1 Cross-Sectional Stocks

Price discovery with respect to inflation takes place not only during the contemporaneous month of CPI, but also on CPI announcement days when unexpected component of inflation hits the market. We thus take two approaches to examine the sensitivity of stock returns to different components of inflation innovations. The first approach is to follow the literature and estimate stocks' inflation risk exposure by the sensitivity of monthly stock excess returns to the contemporaneous-month inflation innovations (e.g., Chen, Roll, and Ross (1986), Boons et al. (2020), Fang, Liu, and Roussanov (2021)). Moreover, we introduce a second approach, where an information-based inflation beta is constructed by regressing stocks' announcement-day excess returns on announcement-day released CPI innovations. This information-based inflation beta, identified using only announcement days, is not studied by the prior literature. Since non-core components of the headline CPI (e.g., food and energy) can be observed contemporaneously by the market participants throughout the CPI month, while components of the core CPI (e.g., goods and services) are less easily observed, we allow stocks to have differential sensitivity to headline- and core-CPI innovations in the estimation of their inflation exposures.

In particular, each month after the announcement of CPI, we measure the headline- and core-inflation exposure of firm i using a rolling window of 60 months. We require a stock to have at least 24 out of the last 60 months of returns available to estimate the inflation beta. The full-month headline-CPI focused beta (β^{FullHead}) is estimated following the regression specification:

$$R_{i,t} - r_t^f = \alpha + \beta_i^{\text{Head}}\text{HeadInnov}_t + \beta_i^{\text{Mkt}}\text{Mkt}_t + \varepsilon_{i,t}, \tag{3}$$

where t denotes calendar month t, $R_{i,t}$ denotes firm i's return in month t, and r_t^f is the month-t risk free rate. As illustrated in Appendix A1, standing at announcement day A_k

(released in month M_{k+1} about the inflation of month M_k), we are using the monthly stock returns and inflation innovations from month M_{k-59} to month M_k to estimate β^{Full}.[8] Since data on CPI innovations starts from 1967, with five-year estimation periods, the individual stocks' CPI beta information then starts from 1972. Fama and Schwert (1977) and Fang, Liu, and Roussanov (2021) show that aggregate stock market exhibits a negative correlation with inflation, especially the core components. To zero in on the effect of inflation on the cross sectional stock returns, we further control for the contemporaneous market return in our main specifications. Full-month core-CPI beta (β^{FullCore}) is constructed in a similar manner by replacing HeadInnov_t with CoreInnov_t.

To construct announcement-day CPI betas, we compute firm i's announcement-day core-CPI beta (β^{AnnCore}) using the following specification:

$$R_{i,A_t} - r^f_{A_t} = \alpha + \beta_i^{\text{Core}} \text{CoreInnov}_{A_t} + \beta_i^{\text{Mkt}} \text{Mkt}_{A_t} + \varepsilon_{i,A_t}, \tag{4}$$

where R_{i,A_t} and Mkt_{A_t} denote the daily return of firm i and the aggregate market return (VWRETD) on the announcement day A_t. Similar to the full-month specification, standing at announcement day A_k, we are using the daily stock returns and inflation innovations from announcement A_{k-59} to announcement A_k to estimate β^{Ann}. Announcement-day headline-CPI beta (β^{AnnHead}) is constructed similarly. In a nutshell, the risk-based measure, β^{Full}, captures stocks' contemporaneous inflation exposure during the full month of CPI, while the information-based measure, β^{Ann}, focuses on their price reactions on the announcement day.

Having constructed individual stocks' pre-ranking inflation betas, we then form equal-weighted 2*5 size and CPI beta portfolios by sorting stocks into quintile groups based on their CPI betas within the small and large size groups. The two size groups are defined by the 50th percentile of NYSE market capitalization at the end of the previous month following Fama and French (1993). We hold the portfolio till next CPI announcement day when the next-announcement CPI innovation is ready to update the estimates of individual CPI betas. Table 1 reports the post-ranking full-month and announcement-day CPI betas for the cross sectional stocks, with the two size groups collapsed together.

Focusing first on the full-month betas in Panel A, the post-ranking headline beta increases monotonically from the lowest value of -35.7 to the highest value of 4.3 for the quintile portfolios sorted based on stocks' full-month headline beta. Column "Quintile 5-1" suggests that one standard deviation increase in headline innovation hurts the monthly return of bottom quintile β^{FullHead} stocks by an additional 40 bps, benchmarking to that of the top quintile β^{FullHead} stocks. Controlling for the contemporaneous market return, as reported in

[8]See Appendix A1 for detailed illustration of the time line.

row "CAPM", the dispersion in post-ranking beta becomes even stronger. Turning to full-month core-CPI betas, however, there is no such a monotonic pattern and the beta difference between "Quintile 5" and "Quintile 1" is insignificant. The evidence suggests that stocks' monthly returns exhibit persistent sensitivity to headline-inflation innovations but not to core-inflation innovations.

The importance of core-inflation, however, emerges in the estimation of announcement-day CPI beta in Panel B. First, we find that cross-sectional stocks' core CPI betas are significantly more negative than their headline-CPI betas, which echoes the findings in Fang, Liu, and Roussanov (2021). Moreover, innovations in core CPI have a much bigger impact on the cross-sectional stock returns on the announcement day than during the contemporaneous CPI month. One standard deviation increase in core-CPI innovation adversely affects the return of bottom quintile β^{AnnCore} stocks by -14.1 bps (t-stat=3.18) on the CPI announcement day, which is equivalent to -2.81% when converted to a monthly basis. The magnitude is much bigger than the contemporaneous-month effect of -0.7% (t-stat=2.61). It suggests that firms that exhibit strong sensitivity to core-innovations in the past announcement days continuously respond to core-innovations in the future announcements. This pattern is not driven by stocks' differential risk loadings on the market return, as the persistence in post-ranking CPI betas remains strong when controlling for the aggregate market return (Row "CAPM").

Taken together, Table 1 suggests that both the standard full-month risk-based measure and the announcement-day information-based measure are effective in differentiating the inflation exposures of cross-sectional stocks, but their information content varies. The full-month inflation beta, β^{Full}, can capture stocks' relative exposures to headline CPI, while the announcement-day beta β^{Ann} is more informative about their core-CPI exposure.

3.2 Other Market-Based Forecasters

Next, we turn to other financial and commodity assets to see if the contrast in full-month and announcement-day beta, observed for the cross-section of stocks, is just an isolated incident. We estimate inflation exposure for a wide range of assets, including the VWRETD and TMB portfolio return from the stock market, change in 10-year US Treasury yield, Bloomberg TIPS index return, and Bloomberg US Treasury index return from the bond market, and GSCI return from the commodity market. Panel A of Table 2 reports the full-month betas estimated by regressing the monthly asset returns on the contemporaneous-month inflation innovations. For easiness of comparison across asset classes, all the variables (both the dependent and independent variables) are standardized with means of zero and standard deviations of one.

Consistent with the pattern observed for the cross-section of stocks, we find that inflation-sensitive securities, i.e. commodity and nominal bonds, also comove with headline CPI during the contemporaneous month of CPI and respond to core CPI on the CPI announcement days. One standard deviation increase in headline-CPI innovation leads to around 20% of standard deviation change in US Treasury and commodity returns. As a reflection of real asset, TIPS exhibits no significant sensitivity to either headline- or core-CPI during the month when CPI is realized. Taking the difference between real and nominal bond return (i.e., TIPS-UST), the return associated with break-even inflation significantly and positively reacts to contemporaneous-month headline-CPI innovation.

Turning to assets' announcement-day betas, we observe a different pattern. Nominal bonds and commodities respond strongly to the core component of inflation on the CPI announcement days. One standard deviation increase in core-CPI innovation is associated with 15% and 8% of standard deviation increase in announcement-day US Treasury and GSCI returns, whereas Headline-CPI innovations have no such an impact. Since headline-CPI includes both the core and non-core components, the insignificant coefficient estimates of β^{AnnHead}, together with the positively significant estimate of β^{AnnCore}, point to the importance of core innovations in driving the announcement-day asset returns. It suggests that inflation expectations on the non-core components, i.e. food and energy, are well incorporated into asset prices during the month when CPI is realized, while the core components, i.e. goods and services, are not easily observed and could constitute a bigger surprise on the CPI announcement days.

4 Forecasting Inflation

As the impact of inflation risk varies across firms, the relative pricing between stocks with high- and low-inflation exposures can be an effective aggregator of investors' expectations of future inflation. In this section, we explore whether the return difference between high- and low-CPI-beta stocks can timely reflect inflation expectations and can help predict the inflation yet to be realized. Though aggregate stock market is weakly and negatively correlated with inflation shocks (Fama and Schwert (1977)), by eliminating the noisy aggregate component, the cross section of stock returns might offer a more stable and accurate forecast of inflation. Comparing with TIPS, cross-sectional stock returns are much more liquid, less under the impact of government intervention, and could offer a longer tracking record going back to the 1970s. Finally, as investor compositions vary across asset classes, inflation forecasters constructed using different asset classes could help reflect the views of different market participants. We thus also compare and contrast the forecasting power of cross-sectional stocks with forecasters from bond and commodity markets.

4.1 Forecasting Inflation using TMB Portfolios

To examine cross-sectional stocks' inflation forecasting ability, we construct two monthly re-balanced top-minus-bottom (TMB) quintile portfolios sorted by their pre-ranking beta, following the methodology in Section 3.1. The core-focused TMB portfolio, TMB (AnnCore), is constructed using the information-based and core-focused β^{AnnCore}, while the headline-focused TMB portfolio, TMB (FullHead), is constructed by the risk-based and headline-focused β^{FullHead}. As shown in Section 3.1, stocks in the bottom-ranked portfolio, whose inflation betas are ranked the lowest, suffer most severely when inflation increases. Therefore, in expectations of heightened inflation, investors would underprice stocks in the bottom portfolio more severely than those in the top portfolio, resulting in a positive value of TMB. In the other word, a higher-than-usual TMB return could be an early alarm sent from the equity market about upcoming inflation surge.

4.1.1 Event Window around Extreme CPI Events

To explore whether TMB portfolios carry information about inflation expectations, we start by tracking the performance of TMB portfolios around extreme CPI events. Since Lo and MacKinlay (1990) show that large stocks often lead small stocks in incorporating market-wide information, we focus on TMB portfolios constructed using large stocks to forecast inflation.[9]. We sort all the CPI events into quintile groups based on headline- and core-CPI innovations. We then plot the cumulative performance of TMB portfolios from t=-50 trading days before the start of CPI month to t=50 days afterwards in Figure 1, with t=0 the start of the CPI month.

Focusing first on the upper graph, in the contemporaneous month of CPI, we do not observe any significant performance difference for TMB portfolios conditional on high and low headline-CPI innovations. Instead, we find that the TMB portfolio starts to drift up more than 20 trading days before the start of higher-than-expected headline-CPI innovations. The red line lies above the yellow line, suggesting that information discovery of heightened inflation is faster for information-based and core-focused TMB portfolio (TMB (AnnCore)). Risk-based and headline-focused TMB portfolio, on the other hand, can better identify unexpected decrease in headline-inflation, as evident from its stronger downward drift before the bottom-quintile CPI innovations. Turning to the lower graph estimated conditional on core-CPI innovations, we find qualitatively similar evidence, i.e., increase in TMB (AnnCore)

[9] We find consistent evidence for small stocks, as reported in Appendix Table A2.

leads higher-than-expected core-CPI innovations, and decrease in TMB (FullHead) leads lower-than-expected core-CPI innovations.

To examine the exact timing from which the equity market starts to incorporate next-month inflation expectations, Table 3 reports the predictability of weekly TMB portfolio returns on CPI innovations, starting from 8 weeks before the CPI month to the last day before the announcement of CPI. In particular, we regress the month-$t+1$ CPI innovations (in bps, realized during Week+0 to Week+3) on week i's TMB portfolio return. For easiness of interpretation, the independent variables are standardized with means of zero and standard deviations of one.

For both headline innovations in Panel A and core innovations in Panel B, we find strong predictive power of TMB portfolios starting from six weeks (Week-6) before the CPI month. Taking Week-4 as an example, one standard deviation increase in the weekly return of TMB (AnnCore), realized four weeks before the CPI month, predicts an increase of 6.94 bps (t-stat=4.98) and 2.04 bps (t-stat=2.71), respectively, in the upcoming headline- and core-CPI innovations. Due to the noise in weekly returns, the coefficient estimates are sometimes marginally significant or insignificant. However, the signs of the coefficient estimates are all positive with meaningful economic magnitudes. Turning to weeks after the start of the CPI month, consistent with the evidence in Fama and Schwert (1977) and Bekaert and Wang (2010), we find that the contemporaneous-month inflation-return relationship is very weak except the first week (Week+0) of the month. Our finding therefore echoes Downing, Longstaff, and Rierson (2012) by showing that the equity price contains forward-looking information about future inflation expectations, at least six weeks before the start of the actual CPI month.

We further extend the analysis and explore whether a similar price discovery process also takes place in the bond and commodity market. By regressing monthly inflation innovations on the weekly returns of TIPS-UST and GSCI, we find that bond and commodity also readily incorporate investors' expectations of future inflation, though with a somewhat slower pace. Weekly GSCI and TIPS-UST returns can significantly and positively predict headline innovation starting from the fifth and fourth week prior to the CPI month. Benchmarking to equity, the price discovery of TIPS-UST starts late by two weeks of time, but the positive relation also extends to two extra weeks into the month of CPI (Week+2), resulting in a more positive contemporaneous inflation-return relationship for TIPS than equity.

4.1.2 Predicting Headline- and Core-Inflation Innovation

Motivated by the weekly analysis in Section 4.1.1, we proceed to examine the performance of TMB portfolios, in the six weeks before the start of CPI month, in forecasting the upcoming inflation innovations. We pay special attention to the incremental forecasting power of TMB, by comparing them against the two market-based signals from bond and commodity markets. In particular, as illustrated in Appendix A1, standing at the end of month t (M_t), we use the 6-week TMB returns observed by the end of month t to predict the CPI innovations realized in month $t+1$ (M_{t+1}) and announced in day A_{t+1}, i.e., we estimate the following regression specification:

$$\mathrm{CoreInnov}_{t+1} = \alpha + \beta_1 \mathrm{TMB(AnnCore)}_t + \beta_2 \mathrm{TMB(HeadFull)}_t + \beta_3 X_t + \varepsilon_{i,t}, \tag{5}$$

where $\mathrm{CoreInnov}_{t+1}$ denote month-t+1 core-CPI innovations, and X_t includes month-t TIPS-UST and GSCI return.[10] In the case of predicting headline-CPI innovations, we replace the dependent variable by $\mathrm{HeadInnov}_{t+1}$. For easiness of interpretation, the independent variables are standardized with means of zero and standard deviations of one.

Focusing first on predicting headline-CPI innovations, Panel A of Table 4 shows that both core- and headline-focused TMB portfolios exhibit strong forecasting power. One standard deviation increase in the 6-week return of core-focused TMB portfolio (TMB (AnnCore)), observed at the end of month t, predicts an increase of 8.29 bps (t-stat=6.62) in month-$t+1$ headline-CPI innovation, with an R-squared of 10.2%. The same one standard deviation increase in TMB (FullHead) predicts an increase of 7.62 bps (t-stat=5.54) with an R^2 of 8.6%. When combined together, both TMB portfolios remain significant, indicating that the inflation expectations embedded in these two portfolios are not redundant. In particular, the implied change in headline-innovation from one standard deviation change in TMB portfolios increases to 11.7 bps and the predictive R^2 enhances to 13.8%. Given that the headline innovation has a sample standard deviation of 26 bps, the economic significance of our TMB predictability is sizable. These evidence confirms our finding in Section 4.1.1 that a non-trivial amount of the future inflation expectation has been incorporated into the cross-sectional stocks well before the start of the actual CPI month.[11]

Turning to other market-based indicators, returns to commodity prices are expected to perform the best, as it directly enters into the headline inflation as an input variable (Gorton and Rouwenhorst (2006) and Downing, Longstaff, and Rierson (2012)).[12] Consistently, Gold-

[10]For TIPS-UST and GSCI, we use month-t return in the regression because Table 3 shows that the price discovery of TIPS-UST and GSCI starts from four to five weeks before the start of CPI month. If using the same 6-week return as for TMB portfolios, the predictabilities of TIPS-UST and GSCI are slightly weaker and the predictability of our TMB portfolios is slightly stronger.

[11]Appendix Table A2 further reports the predictability of TMB (AnnCore) and TMB (FullHead) when estimated using monthly returns, Fama and French five-factor alpha, and when TMB portfolios are formed based on inflation β constructed using alternative specifications.

[12]Based on the index composition in year 2022, energy and food sectors respectively account for 50% and

man Sachs Commodity Index (GSCI) can predict headline CPI with an R-squared of 25.5%, doubling the predictive power of our TMB portfolios. Interestingly, using our TMB portfolios jointly with GSCI, the predictability of our TMB portfolios remains significant statistically, although their respective economic significance decreases to 3.74 bps (t-stat=3.07) and 2.98 bps (t-stat=2.41). Also interesting is the fact that the bond-based TIPS-UST portfolio, which buys the inflation neutral TIPS and sells the inflation-negative nominal U.S. Treasury (UST) bonds, cannot compete with the equity- and commodity-based predictors. Using the market-based predictors jointly, our TMB portfolios, particularly the core-focused, remain significant, while TIPS-UST becomes insignificant. These results indicate that, although price discovery with respect to the commodity component of headline CPI takes place more actively in the commodity market, the information embedded in the cross-sectional stocks can still add value.

Though financial markets in general and the commodity index in particular can predict the innovations in headline CPI, Panel B of Table 4 shows that their forcastability on core CPI is very much limited. Instead, our core-focused TMB portfolio stands out as a leading indicator of core CPI. Specifically, one standard deviation increase in the 6-week core-focused TMB returns, observed by the end of month t, can predict 2.46 bps (t-stat=3.31) increase in month-$t+1$ innovations in core CPI, with an R-squared of 2.5%. Given that the core innovation has a sample standard deviation of 16 bps, this economic significance is non-trivial. Other market-based predictors, including the commodity- and bond-based, have rather limited capabilities in predicting core CPI. For example, one standard deviation increase in month-t GSCI and TIPS-UST return can respectively predict 2 bps (t-stat=2.61) and 1.87 bps (t-stat=2.10) increase in month-$t+1$ core-CPI innovations, a magnitude lower than that of TMB (AnnCore). Moreover, when used jointly to forecast core innovations, the predictability of our core-focused TMB portfolio remains significant statistically and non-trivial economically, while the statistical significance of the alternative predictors goes away. Given the outsized importance of core CPI in influencing Fed's monetary policy decision, this unique predictability captured from cross-sectional stocks, though moderate in size, is of tremendous importance.

As a graphical illustration, Figure 2 plots the rolling 12-month average of core-focused TMB signal observed at the end of month-t against the rolling 12-month average of core-CPI and headline-CPI innovations ending in month $t+1$. Core- and headline-CPI innovations are represented by blue and yellow bars plotted on the left axis. The red solid line is for TMB (AnnCore), normalized in the whole sample and plotted on the right axis. We see a strong comovment between the leading indicator of our core-focused TMB signal and CPI

28% of GSCI index, with the other 18% from metals.

innovations. Importantly, our core-focused TMB portfolio successfully captures the ups and downs during important inflationary episodes that occurred in 1973–82, 1998-1991, 2008, and 2021-2022 (Rouse, Zhang, and Ernie (2021)). For example, as the inflation surprises the market with the highest level in 30 years in January 2022, our TMB (AnnCore) return starts to be significantly positive since August 2021, sending an early inflation alarm to the market. The 1973 experience is most analogous to 2021. It is evident from Figure 2 that TMB (AnnCore) also successfully predicts the heightening of inflation in the period from 1973 to 1974. Besides, TMB signal can successfully predict decrease in inflation as well. Accompanied with the tenure of Paul Volcker as the chairman of the Federal Reserve in the early 1980s, we see the performance of TMB (AnnCore) decreases dramatically, serving as an early indicator for the success of Volcker disinflation.

In the lower graph of Figure 2, we conduct the same exercise for bond- and commodity-based inflation indicators. We see an overall consistent pattern, indicating that the variations in TMB (AnnCore) is not due to pure noise. Moreover, comparing with TIPS-UST and GSCI, our core-focused TMB portfolio is less affected by the recession in year 2007-2009, and it also provides a stronger signal of inflation surge in the 2021-2022 period. We discuss in more details on the unique role played by our TMB signal during those important episodes in Section 5.

4.1.3 Out-of-Sample Predictability

Section 4.1.2 provides in-sample evidence that TMB portfolios, especially the core-focused TMB, have strong predictive power on the inflation yet to be realized. To better reflect the information available to the forecaster in "real time", we next follow the methodology in Ang, Bekaert, and Wei (2007) and Faust and Wright (2013) and examine the out-of-sample forecasting power of TMB portfolios, together with other leading inflation indicators.

At the end of each month t, we estimate the forecasting model, $CPIG_{k+1} = a + \sum b * X_k + \epsilon_{k+1}$, using only public information on and before month t. X_k stands for the forecasting signal observed at the end of month k and CPIG_{k+1} stands for month-$k+1$ inflation growth. We then use the estimated coefficients to forecast month-$t+1$ inflation growth. Forecasting error for month $t+1$ is calculated as the actual inflation growth minus the forecasting growth. Out-of-sample accuracy is measured by relative RMSE, calculated as the ratio of the root-mean-square forecast error (RMSE) for a particular model, relative to that of the benchmark model. We use time-series model of ARMA(1,1) as our benchmark model. We then add other forecasting signals, such as six-week TMB return, commodity-based GSCI return, and TIPS-UST return, to evaluate their incremental forecasting power. A relative RMSE below 1 means that the indicator adds value to the benchmark model of ARMA

(1,1). Since we need enough historical observations to train the forecasting model, the out-of-sample period starts from June 2003, i.e., five years after the start of TIPS data in June 1998.

Table 5 reports the relative RMSE estimated for various forecasting models. Focusing first on headline inflation, core-focused TMB and headline-focused TMB each can improve the forecasting accuracy of month-$t+1$ inflation by 8.6% and 7.7% respectively, benchmarking to the time-series model of ARMA (1,1). When used jointly, the forecasting accuracy improves by 12%. Consistent with the in-sample evidence, the forecasting power of GSCI ranks the highest among all, with an RMSE improvement of 17.1%. Interestingly, TIPS-UST which is designed to track inflation expectation, can only improve the forecasting accuracy by 6.4%.

On top of these market-based indicators, we further include economists' inflation forecast using data from Survey of Professional Forecasters (SPF) database. Ang, Bekaert, and Wei (2007) and Faust and Wright (2013) show that subjective survey forecasts perform the best, compared with forecasts from Phillips curve or term structure models. Since we are standing at the end of month-t to predict month-$t+1$ inflation growth, we use the latest survey forecast by the end of month-t to conduct the exercise.[13] Table 5 shows that economists' preliminary forecast at month-t can only enhance the time-series model by 1.1%. Motivated by the economic model of Philips curve (e.g., Stock and Watson (1999)), we further include real GDP growth as a proxy for real economic activity into the forecasting model. Consistent with Ang, Bekaert, and Wei (2007), real activity measures fail to add a positive value. Finally, we also find very limited out-of-sample evidence of aggregate stock market and nominal yields from bond market to forecast upcoming inflation growth.

Turning to the out-of-sample forecastability on core inflation, it is apparent to see the unique role played by core-focused TMB portfolio in enhancing the forecasting accuracy. Among all the forecasters, TMB (AnnCore) adds the largest improvement of 6.2% to the time-series model of ARMA(1,1), followed by GSCI and TIPS-UST with an enhancement of around 1.9%. The rest indicators either add too much of noise or a value close-to-zero to the benchmark model. In sum, comparing with other inflation indicators, we find that stock-based TMB portfolios contain fresh and non-redundant information about inflation expectation both in-the-sample and out-of-sample. Moreover, the core-focused TMB emerges as a unique and unparalleled predictor for core CPI innovations.

[13] We cannot use Bloomberg Economist Forecasts here because Bloomberg survey forecast is updated till the last minute before the announcement.

4.2 Do Economists Update Beliefs about Inflation?

Our TMB forecaster is formed at the end of month t, while the month-$t+1$ inflation is usually announced in the second or third week of month $t+2$, i.e., over one month of time has elapsed from the signal formation day to the CPI announcement day. It is therefore interesting to study whether market participants would update their inflation expectations using the market-based information, particularly those embedded in the cross-sectional stocks. Or alternatively, if market participants fail to fully update their beliefs using information contained in our TMB portfolios, to what extent can our TMB portfolio predict the announcement-day forecasting errors made by the market participants?

To capture market participants' expectation of month-$t+1$ inflation growth, we use Bloomberg Economists' survey forecasts on headline- and core-CPI month-over-month growth.[14] The survey provides the most updated consensus view of inflation estimate just before the announcement. We define change in forecasts as the economists' estimated value of month-$t+1$ inflation growth minus the value predicted under the ARMA (1,1) model. Announcement-day forecasting error is therefore defined as the actual inflation growth for month $t+1$ minus the estimated value by Bloomberg economists.

Table 6 shows that though economist overall are responsive to market-based inflation signals observed at the end of month-t, they are not sufficiently updating their beliefs on the core-focused TMB portfolio. As a result, our core-focused TMB can significantly predict announcement-day forecasting error with a non-trivial magnitude. In particular, we use the four market-based forecasters, i.e., the two TMB portfolios together with GSCI and TIPS-UST, jointly to predict the change in forecasts by economists. Columns (1) and (2) show that though economists are responsive to our core-focused portfolio, they are mostly reacting to the commodity component of it. A one standard deviation increase in the GSCI return can predict an upward adjustment of 10 bps in the economists' forecast. By contrast, once controlling for GSCI return, we do not find any statistically significant evidence that economists use the information contained in the core-focused TMB portfolio to update their inflation expectations. The evidence is even more obvious for forecasts of core innovations in columns (5) and (6). As core-focused TMB portfolio is found to be the most important predictor of core-inflation innovations in Section 4.1.2, the fact that economists' estimates load insignificantly on TMB (AnnCore) suggests that the uniquely important core-focused TMB portfolio is not in their information set.

The inability of economists to use the information from equity market suggests that our TMB portfolios might be able to predict the announcement-day forecasting error or

[14]Bloomberg Individual Economist Estimates are based on a diverse pool of forecasters including traders, portfolio managers, think-tanks and academics.

survey-based announcement surprise. Consistently, Table 6 shows that our core-focused TMB portfolio can predict the announcement-day errors for both the headline- and core-CPI, above and beyond the other market-based predictors. A one standard deviation increase in the return of core-focused TMB portfolio can predict an increase of 4.37 bps (t-stat=4.73) and 2.75 bps (t-stat=3.65), respectively, in the headline and core CPI not expected by the economists. As the headline- and core-CPI forecasting errors have a respective standard deviation of 13 bps and 11 bps, the information from the cross-sectional stocks is non-trivial and can help improve the economists' forecasting accuracy. And yet, this information, available over one month in advance, does not find its way into the economists' forecasts.

5 Time-Varying Predictability

Inflation is difficult to predict because of its time-varying nature. Accompanied with the time-varying importance of inflation as a risk factor for asset prices, the effectiveness of market-based indicators in forecasting inflation could also vary over time. Since active price discovery with respect to inflation risk is more important when inflation emerges as an important risk factor in the capital market, in this section, we explore the role of market-based signals, especially the core-focused TMB portfolio, in predicting inflation during important inflation episodes. We also explore their time-varying forecastability during periods when the market is most uncertain about upcoming inflation movements, as well as when government intervention hinders price discovery in the Treasury market.

5.1 Predicting Inflation during Important Episodes

5.1.1 The Episode of 2021

Ever since passing the 2% Fed targeted core inflation rate in April 2021, the core CPI has been continuously increasing, reaching a year-over-year growth of 6.6% in September 2022, the highest level in 40 years. Despite the rapid surge of inflation, the Fed had kept its zero interest-rate policy throughout 2021, and did not start the tightening policy until mid 2022. Motivated by this rapid surge of inflation in 2021 and the failure of policy makers to act swiftly against heightened inflation, we evaluate the usefulness of survey-based forecasts and market-based indicators in warning us about the severity of inflation during the episode of 2021.

The upper graph of Figure 3 plots the core-CPI (MoM) growth against the median forecast made by Bloomberg economists for the period from January 2021 to September 2022. Clearly, amid the heated debate of transitory versus persistent inflation shocks in early 2021, economists chose the wrong side and under-estimated the severity of inflation by a wide margin. During the most consequential months in 2021, the median estimate of the Bloomberg economists forecasts missed the rapid ascend of the core CPI, by 10 bps in March, 60 bps in April, 20 bps in May, and 50 bps in June. The case for April 2021 is the most outstanding. With a median forecast of 30 bps and a highest forecast of 50 bps, the actual core-CPI value of 90 bps clearly hits the market with a big surprise. Given that the whole-sample standard deviation of survey forecasting error is 10.9 bps, the mistake made by economists in April 2022 is a 5.5-sigma event.

The collective failure of policy makers and economists points to the neediness of market-based forecasters in judging the inflation risk at the time. Focusing on the TMB portfolio, the lower graph of Figure 3 plots our 6-week core-focused TMB signal (red line), observed by the end of month-t, in forecasting the month-$t+1$ core- and headline-CPI innovations (blue and yellow bars) for the 18 months from January 2021 to June 2022. We observe a tremendous increase in TMB (AnnCore) just before the rapid surge of core-CPI in April 2021. The magnitude of TMB (AnnCore) observed at the end of March 2021 is 3.79 times of its sample standard deviation, the second highest during our sample period from 1972 to 2022. Meanwhile, TMB (AnnCore) comoves well with the ups and downs of inflation innovations, successfully catching the local trough in July 2021 and the local peaks in April 2021 and June 2022.

In the form of a scatter plot, the upper left graph of Figure 4 further demonstrates the capability of core-focused TMB portfolio in predicting core-CPI innovations during this important episode. A 10% increase in the 6-week TMB (AnnCore) observed at the end of month-t predicts a 32 bps (t-stat=2.71) increase in core-CPI innovation for month $t+1$, with an R-squared of 31%. When surrounded with doubts questioning the persistence of inflation shock, which is possibly driven by temporary supply-chain disruptions in the aftermath of Covid-19, our TMB (AnnCore) did a surprisingly good job in capturing the month-over-month movements of core-CPI that have been largely missed by policy makers and economists.

Turning to other market-based predictors, we find them offering a rather disappointing performance in predicting this round of inflation surge. Conducting the same exercise using the signal from the bond market, the upper right graph of Figure 4 shows that TIPS-UST predicts core-CPI innovation with an R-squared of 0.0%. The coefficient estimate is surprisingly negative, though statistically insignificant. Though the value of TIPS-UST is positive for month April 2021, the magnitude is just too small judging by their sample standard deviation in the lower graph of Figure 3.

Table 7 further reports the regression estimates when using various market-based predictors jointly to predict core- and headline-innovations. The core-focused TMB emerges as the only significant predictor and its economic significance dominates the other predictors by a wide margin. For example, during the episode of 2021, GSCI and TIPS-UST each can predict core-CPI innovation with an R-squared of 0.8% and 0.0%, and predict headline-CPI innovation with an R-squared of 3.8% and 5.5%. Though the predictability on headline-CPI innovations is slightly better, the coefficient estimates are all insignificant. By contrast, the economic significance of our TMB predictor is such that a one standard deviation increase in the core-focused TMB return can predict an increase of 10.47 bps (t-stat=2.77) in core CPI and an increase of 8.10 bps (t-stat=1.95) increase in headline CPI, with an R-squared of 31.5% and 13.2% respectively.[15] The coefficient estimate of TMB (AnnCore) on core-CPI innovation is more than four times larger than the full-sample estimate of 2.46 bps (t-stat=3.31), pointing to the raising importance of our core-focused TMB portfolio in the price discovery of inflation during the episode of 2021.

Moreover, Panel B of Table 7 shows that our core-focused TMB portfolio also significantly predicts economists' forecasting errors in the period of 2021-2022. In particular, a one standard deviation increase in TMB (AnnCore) predicts an increase of 8.17 bps (t-stat=2.09) in the forecasting error of core-CPI, with an R-squared of 22.3%. A similar magnitude is observed for predicting the forecasting error of headline inflation. Compared to the whole-sample estimate of 2.75 bps (t-stat=3.65) with an R-squared of 6.5%, the coefficient estimate in the episode of 2021 is tremendously bigger both statistically and economically. The evidence reinforces the findings in Section 4.2 that economists fail to fully update their inflation expectations using the unique information contained in our core-focused TMB portfolio, and the room of improvement is especially big during heightened inflation period.

5.1.2 The Episode of 1973

As a parallel to 2021, the 1973 experience has frequently been brought back from history to shed light on the recent runaway inflation. The buildup to the Great Inflation starts in early 1970s, and by 1973, inflation was running at 8.7%, far surpassing the average inflation of 3.3% between 1946 and 1972. Fueled by the stimulative fiscal policies in the presidency of Nixon, excessive government spending for Vietnam War, and the outbreak of Arab oil shock, the inflation surge in the 1973 share many similarities to the episode of 2021. Moreover, monetary policy was highly accommodative in the inflation run-up periods of these two episodes. In the case of 1973, inflation stays around an astonishingly high level until Paul Volcker became the Chair of the Federal Reserve and initiated the well-known campaign of monetary tightening in 1979.

[15] The coefficient estimates in Figure 4 and Table 7 differ because the independent variables are in the unit of return in Figure 4 and are standardized in Table 7.

Analogous to the case of 2021, economists and policy makers severely under-estimated the rate of inflation in early 1970s (Bowsher (1973)), it is therefore worthwhile to examine the performance of our core-focused TMB portfolio during this time. We form the 1973 episode by including the 12 months before and 24 months after May 1973 to capture the run-up period of the Great inflation. May 1973 is the first time when the year-over-year core CPI growth crossed above 3% and stayed there after for a prolonged decade. Consistent with the 2021 experience, our core-focused TMB did an outstanding job in forecasting inflation during the episode of 1973.

In particular, the lower left graph of Figure 4 shows that a 10% increase in our core-focused TMB portfolio, observed at the end of month t, can predict an increase of 76 bps (t-stat=4.37) in month-$t+1$ core CPI innovation, with a much improved R-squared of 29%. Moreover, similar to the case of 2021-22, this improved predictability on core-CPI innovation is picked up only by our core-focused TMB portfolio. The lower right graph of Figure 4 shows the predictability of bond-based forecaster on next-month core-CPI innovation. Since inflation-linked TIPS security is unavailable in the 1970s, we use month-t change in 10-Year US Treasury yield as a replacement. With an estimated R-squared of 0.7% and a coefficient estimate of 0.1, both the economic significance and statistical significance of ΔUST10YR on core innovation are ignorable. Using a regression-based analysis, Table 7 further demonstrates the joint predicative power of market-based forecasters during the episode of 1973. Among all the market-based predictors, only core-focused TMB significantly predicts upcoming core-CPI innovations, with an R-squared of 29%. The rest predictors only have a predictive R-squared between 0.0% to 3%. Turning to the predictability on headline-CPI innovation, consistently, we find that one standard deviation increase in core-focused TMB can predict an increase of 15.6 bps (t-stat=3.51) in headline-CPI innovation. Apart from core-focused TMB, GSCI also significantly predicts headline-CPI innovation. However, the predictability of GSCI is to some extent expected, as the energy crisis, driven by the Arab oil embargo in October 1973, is one of the driver of the Great inflation.

5.1.3 The Episode of 2008

The episode of 2008 provides another example when our core-focused TMB portfolio successfully sent market an early warning of inflation. But unlike the episodes of 1973 and 2021, the inflation that peaked in mid-2008 quickly cooled down by the great recession.[16] In July

[16] Surging inflation could also be quickly taken under control when Fed is fighting inflation aggressively ahead of the curve. The episode of 1998-1991 is one such an example. Due to the surging crude oil price induced by the first Gulf war, CPI increased to over 5% in May 1989. But with an effective fed fund rate maintained at around the level of 9%, the inflation returned quickly to below 3% in October 1991, while the economy entered into recession in mid-1990.

2008, consumer price index rose by 0.8% – twice the expected increase of 0.4% by Bloomberg economists – taking the annual inflation rate from 5% to 5.6%, the sharpest year-on-year increase since January 1991. The main driver of the 2008 inflation is the skyrocketing oil price. As illustrated in the upper graph of Figure 5, the price for one barrel of West Texas Intermediate (WTI) crude oil increased from $67 in July 2007 to $134 in July 2008 within a one-year time, a two-sigma increase based on its whole sample standard deviation. Core inflation, which excludes volatile food and energy costs, also rose 0.3% in July 2008, slightly higher than the 0.2% increase that economists had expected, taking the annual core inflation rate to 2.5%.

Accompanying the rapid oil price shock that peaked in July 2008, our TMB portfolios provided unusually high signals prior to July 2008. As demonstrated in the lower graph of Figure 5, in the end of June 2008, our core-focused TMB signal increased to its 3.80-sigma level, the highest ever throughout our sample period. Meantime, the headline-focused TMB signal also increased to its 3.97-sigma level, the second highest value in our sample.[17] Both of our TMB portfolios successfully sent the inflation alerts prior to the decade-high inflation surge. However, the signal is short-lived. One month later in August 2008, core- and headline-focused TMB portfolios crashed to -2.97-sigma and -2.78-sigma respectively, and dived even deeper following the Lehman default in September 2008. Turning to commodity- and bond-based forecasters, we observe a similar pattern. In particular, GSCI, which is supposed to closely track the movements in the oil price, jumped to a level of 1.41-sigma in July 2008 before crashing down to the level of -2.16-sigma in August 2008.[18] TIPS-UST behaved in a similar manner though with a much smaller magnitude from 0.56-sigma to -0.85-sigma. The sharp reversal in our TMB signals, as well as in other market-based forecasters, reflects a sharp reset in inflation expectation informed by the incoming financial crisis. The evidence suggests that when followed immediately by a severe recession, early warnings of surging inflation might fail to materialize.

5.2 Conditional on Inflation Disagreement

To further explore the time-varying nature of inflation predictability, we estimate the conditional forecastability of TMB portfolios, conditional on market participants' disagreement about expected inflation. We hypothesize that our stock-based TMB portfolio shall add the most value to the existing forecasting model when the market is most uncertain about the future course of inflation. When consensus reached and market participants are paying little

[17]The largest value for headline-focused TMB took place in the CPI month of August 1981, in which both the headline- and core-CPI year-over-year growth rose above 10%.

[18]Back in year 2008, GSCI was 76% weighted towards energy.

attention to inflation news, the room of improvement from our TMB portfolios would be rather limited.

We use two proxies of inflation disagreement to capture the time-varying importance of inflation news: (a) |CPI Innovation|, the absolute value of CPI innovation in the last month; (b) CPI disagreement, the difference between the 75th percentile and 25th percentile of quarterly CPI forecasts from the Survey of Professional Forecasters (SPF) database;[19] Panel A of Table 8 reports the predictability of our TMB portfolios on inflation innovations, for subsamples defined using the median cutoffs of the two disagreement proxies.

Focusing first on |CPI Innovation|, we use the deviation of actual CPI value from the ARMA (1,1) predicted CPI value to capture the magnitude of inflation uncertainty. We find that the forecasting power for both TMB portfolios are much stronger when the last-month |CPI Innovation| is above the median cutoff. For example, during high uncertainty periods, one standard deviation increase in TMB (AnnCore) predicts an increase of 11.61 bps (t-stat=6.02) in headline-CPI innovation and an increase of 4.2 bps (t-3.58) in core-CPI innovation, with a respective R-squared of 15.6% and 6.2%. While for low uncertainty periods, the same one standard deviation increase in TMB (AnnCore) can only predict headline- and core-CPI innovations with an R-squared of 4.3% and 0.2% respectively. The difference in the coefficient estimates between the high- and low-|CPI Innovation| subsamples are significant both economically and statistically, with a magnitude of 7.2 bps (t-stat=3.12) for headline-innovations and 3.53 bps (t-stat=2.67) for core innovations.

Using the disagreement of economists survey forecasts as another measure of inflation uncertainty, we find similar evidence. Both the economic magnitude and the explanatory power of our TMB portfolios are much larger for the subsample with above-median CPI disagreement. In particular, one standard deviation increase in core-focused TMB portfolio predicts 10.74 bps (t-stat=6.20) and 2.76 bps (t-stat=2.62) increase in the upcoming headline- and core-CPI innovations, with an R-squared of 17.9% and 4.7% respectively, much bigger in magnitude than that for periods with below-median disagreements. Overall, the evidence suggests that our TMB portfolios can readily offer information about future inflation expectations when the market is most in need of it.

5.3 Conditional on Monetary Policy

Next, we further explore the impact of monetary policies in driving the time-varying informativeness of market-based inflation forecasters. Central banks today primarily use inflation targeting as a guideline or framework to keep economic growth steady and prices stable

[19] Different from the monthly Bloomberg Economists' Survey Forecasts that starts in 1997, SPF offers quarterly forecasts but with the benefit that it can be traced back to the third quarter of 1981.

(Bernanke and Mishkin (1997)). The famous Taylor rule (Taylor (1993)) serves as a useful organizing device for describing activist monetary policy. When prices in an economy deviate from the the 2-3% inflation target, the central bank can enact monetary policy to restore the price target.[20] With Fed aggressively fighting inflation ahead of the curve, inflation can be effectively contained and the predictability of market-based forecasters muted. The case of 1989-1991 inflation is just one such example. Driven by the first Gulf war and surging oil price, annual CPI rose to 5% in May 1989, but was quickly taken under control to a level below 3% in October 1991. The Effective Fed Fund Rate, at the time, was maintained at a level around 9%, i.e. Fed successfully stepped on the brake before the sky-high inflation lift off. On the other hand, with Fed sluggishly reacting to inflation behind the curve, such as the case of 2021 and 1973, inflation became out of control and the predictability of our market-based forecasters sounded.

To formally test the predictability of inflation indicators conditional on Fed monetary policy, we measure the extent to which the Fed is behind-the-curve by the distance between Fed Fund rate recommended by the Taylor rule and the actual Fed Fund Rate. The recommended Fed Fund Rate, implied by Taylor rule, is calculated as 2.5%+1.5*(Core-CPI YoY Growth-2%)+0.5*OutPut Gap, where output gap is estimated by the percentage deviation of real output from the long-run trend (Taylor (1993)). We choose a response coefficient of 1.5 for inflation deviations and 0.5 for output gap, following Piazzesi (2022).[21]

Panel B of Table 8 reports the subsample regression estimates, where “Behind”refers to the periods when the difference between the rate implied by Taylor rule and the actual Fed Fund Rate is above the 67% percentile cutoff. Focusing on the core CPI, which is the inflation series that Fed pay closely attention to, we find that a one standard deviation increase in TMB (AnnCore) can predict an increase of 5.98 bps (t-stat=3.17) in core-CPI innovation with an R-squared of 23.7%, when Fed is behind the curve. While for periods when Fed is ahead of the curve, we find the predictability of our core-focused TMB to be much muted. A consistent pattern is observed for headline-CPI innovation, though the coefficient estimate difference between “Behind” and “Normal” is insignificant.

Since the great financial crisis in 2008, with an effective zero-interest rate policy, the Fed started pursuing the unconventional monetary policy of purchasing large quantities of long-term securities, including Treasuries, Agency bonds, Mortgage Backed Securities, and more recently corporate bonds (quantitative easing, or “QE”). On the one hand, Fed injects liquidity into the market via the purchasing of long-term assets. On the other hand, the

[20]Central banks’ choice of target inflation series is typically not the headline CPI, but an index that excludes some components or focuses on the ”core” inflation.

[21]We set the target core-inflation rate to be 2%, as suggested by former Fed vice chair Richard H. Clarida (Clarida (2021)).

pricing of nominal bonds and real bonds could be directly affected due to such government interventions (e.g., Krishnamurthy and Vissing-Jorgensen (2011), Todorov (2020), Bond and Goldstein (2015)). It is therefore worthwhile to examine the forecastability of equity- and bond-based inflation indicators conditional on the implementation of QE.

Dividing the sample into "QE" and "Non-QE" periods in Panel B of Table 8, we find that our core-focused TMB portfolio performs significantly better during "QE", while the predictability of TIPS-UST on headline-CPI innovation is slightly stronger during "Non-QE" periods.[22] In particular, one standard deviation increase in our core-focused TMB can predict a next-month increase of 5.97 bps (t-stat=2.69) in core-CPI innovations and an increase of 10.2 bps (t-stat=4.38) in headline-CPI innovations. The corresponding estimates for "Non-QE" periods are only 0.71 bps (t-stat=0.86) and 5.71 bps (t-stat=2.48) respectively. Turning to the predictability of TIPS-UST, one standard deviation increase in TIPS-UST predicts a 9.16 bps (t-stat=2.22) increase in headline-CPI innovations during "Non-QE" periods, but only 6.68 bps (t-stat=3.09) during "QE" periods, though the difference is statistically insignificant. Therefore, consistent with the findings conditional on the extent of Fed behind the curve, our evidence on QE suggests that accomodative monetary policies fosters the price discovery of equities about inflation expectations. Moreover, the implementation of QE also seems to have an impact on the informativeness of bond market.

6 Source of Predictability

In this section, we conduct further analyses to understand the channels through which inflation information can get incorporated into the cross-section of equity prices. We provide evidence that the pricing and predictability of TMB portfolios are mostly driven by the energy, goods, and service components of CPI. We also show that industry affiliation alone cannot explain the predictability of our stock-based TMB portfolios.

6.1 Which component of Inflation?

To understand the source of predictability, we start by analyzing the relative importance of each components of CPI in the pricing of cross-sectional stocks. By decomposing the non-core components of CPI into energy and food, and the core-components into goods and services, Table 9 reports the post-ranking inflation betas for each CPI components, following the same methodology in Table 1. Each month, we estimate the CPI betas, including energy beta, food beta, goods beta, and service beta, for each stock using a rolling window of five

[22] QE includes the periods from November 2008 to March 2010, November 2010 to June 2011, September 2012 to October 2014, and March 2020 to March 2022.

years. We sort the cross-sectional stocks into quintile groups based on their pre-ranking CPI betas and report their post-ranking CPI betas in Table 1.

Consistent with the evidence in Section 3, the cross section of stocks exhibit persistent sensitivity to non-core components in the contemporaneous month when the CPI is realized, and to core components on the CPI announcement days. Moreover, we show that the price sensitivity to energy components drives the price discovery of headline CPI in the cross section of stocks. One standard deviation increase in energy CPI innovation leads to a monthly return difference of 0.34% (t-stat=2.12) for top and bottom quintile stocks sorted by their pre-ranking $\beta^{\text{FullEnergy}}$. The corresponding estimate is only -0.035% (t-stat=0.45) for β^{FullFood} sorted stocks, pointing to the dominant role of energy beta in the pricing of non-core components. For the pricing of core components, we find that goods and service components almost equally contribute to the price discovery of cross-sectional stocks. In particular, one standard deviation increase in goods and service innovations can lead to a respective return dispersion of 3 bps (t-stat=1.73) and 3.1 bps (t-stat=2.01) on the announcement days.

Turning to the predictability of top-minus-bottom quintile portfolios, formed based on the beta of each CPI components, we find consistent evidence that the non-core component of energy and the core-component of goods drive the forecastability of our headline- and core-focused TMB portfolios. As reported in Table 10, one standard deviation increase in the 6-week TMB portfolio, formed based on $\beta^{\text{FullEnergy}}$ and observed at the end of month t, can predict a 7.76 bps (t-stat=5.04) increase in headline innovation and a 2.30 bps (t-stat=3.59) increase in core innovation in month $t + 1$. Similarly, one standard deviation increase in the 6-week TMB portfolio formed based on β^{AnnGoods} can predict a 6.34 bps (t-stat=5.45) increase in headline innovation and a 2.16 bps (t-stat=2.94) increase in core innovation in month $t+1$. Echoing the weak pricing results documented for announcement-day headline CPI (β^{AnnHead}) and full-month core CPI (β^{FullCore}), the predictability of their TMB portfolios are substantially weaker than that formed using β^{FullHead} and β^{AnnCore}. By studying the pricing and predictability of TMB portfolios formed using each components of CPI, we uncover the unique role played by energy and goods CPI in the price discovery of equity about future inflation expectations.

6.2 Industry vs. Stock

So far, we show that stock-based TMB portfolios contain useful information about future inflation expectations. However, to what extent this cross-sectional heterogeneity in inflation exposure is driven by inter-industry variations or intra-industry variations is still unknown. Using the standard full-month approach, Boudoukh, Richardson, and Whitelaw (1994) and Ang, Brière, and Signori (2012) show that there exists large variations in inflation exposure across different industries. Consistent with prior literature, Panel A of Table 11 shows that oil, metal, and mining industries tend to be good inflation hedgers with a positive full-month headline beta, which is consistent with the general observation that oil and gas stocks tend to benefit from commodity price increases. Consistent with Boudoukh, Richardson, and Whitelaw (1994) and Boons et al. (2020), we also find that cyclical industries such as restaurants, hotels, and banking industries suffer more severely from unexpected inflation shocks.

The literature, however, is silent on the distribution of announcement-day inflation betas. Based on the ranking list of information-based and core-focused inflation beta in Table 11, it is obvious to see that β^{AnnCore} captures uniquely different information from β^{FullHead}. For example, the industry of shipping containers enters into the list of bottom 10 β^{AnnCore} with a weak negative headline-beta of -5.06 bps per month, but appears in the list of top 10 β^{AnnCore} with a core-beta of 4.2 bps per announcement day. The contradictory beta loadings on headline- and core-CPI makes intuitive sense. Raising commodity prices are costly for firms running shipping containers, as metals and petroleum are raw materials of their daily operations. On the other hand, price increase in the components of goods and services are good news, enabling them to charge a higher price for providing shipping services to the end customers. Comparing the lists of industries that suffered the most from unexpected headline- and core-CPI changes, it is also obvious to see that consumer goods and services, such as recreation and apparel, makes a higher presence on the list for core-CPI.

Given the large cross-industry variations in inflation exposure, we next examine whether the information content of our stock-based TMB portfolios is absorbed when controlling for the industry-based TMB portfolios. Panel B of Table 11 reports the forecastability of industry-constructed TMB portfolios. We construct industry CPI betas in a similar manner as individual stock CPI betas using a rolling window of five years. TMB $(\text{AnnCore})^{\text{Ind}}$ and TMB $(\text{FullHead})^{\text{Ind}}$ are the 6-week returns for the industry-constructed portfolios, with a long position in top-quintile CPI beta industries and a short position in bottom-quintile CPI beta industries. Though the industry-based TMBs can significantly predict headline inflation innovation, both the economic significance and statistical significance are much weaker, comparing to that of stock-based TMB portfolios. Moreover, when used jointly to predict CPI innovations, the information content of industry portfolios is absorbed by stock-based portfolios. The evidence suggests that stocks' inflation exposure is not a mere reflection of their industry affiliation.

7 Conclusions

Motivated by the 2021 inflation surge and the collective failure of the policy makers and economists in forecasting its severity, we explore the inflation expectations in cross-sectional stocks and examine their forecastability for inflation innovations. Key to our predictability is our focus on the relative pricing between stocks with high- and low-inflation exposures, which allows us to shift away from the overall equity-market trends and zero in on the inflation expectations. To differentiate the cross-sectional inflation exposures, we make the important observation that cross-sectional stock returns exhibit persistent sensitivity to headline inflation shocks during the calendar month of CPI, and to core inflation news on CPI announcement days. Examining the relative pricing between stocks with high- and low-inflation exposures, captured either by the headline- or core-focused inflation beta, we find that active price discovery on inflation does take place in cross-sectional stocks.

Above and beyond the existing forecasting methods, our stock-based top-minus-bottom (TMB) portfolios contain fresh and non-redundant information, and the core-focused TMB emerges as a unique and unparalleled predictor for core CPI innovations. Its predictability is especially important during the run-away inflation episodes of 2021 and 1973, when the predictive R-squared for month-over-month core CPI innovations increases to 31.5% and 29%, respectively. Given the weak contemporaneous correlation between stock and inflation documented by Fama and Schwert (1977), the common belief is that stock market is not an active place for price discovery with respect to inflation. The strong predictability documented in our paper proves this to be wrong. Moreover, relative to the Treasury bond market, whose yield curves have been used widely to forecast inflation, our results show that the information contained in the cross-sectional stocks can add value, especially when the pricing of U.S. Treasury bonds is influenced by factors unrelated to inflation risk.

Focusing on the economists' forecasting error, we find that economists do not incorporate the information contained in TMB and their room for improvement is especially large during the 2021 episode. Moreover, on policy makers, we find stronger predictability of our TMB under Fed's QE and when the Fed is behind-the-curve in fighting inflation. As both the policy makers and the economists form their forecasts by incorporating all of the information available to them, their collective failure in capturing the severity of the 2021 inflation surge reflects the limitation of the existing inflation forecasts and calls for forecasting methods from more diverse sources. By focusing on the inflation expectations embedded in the cross-sectional stocks, this is exactly what our paper can offer. Going forward, the inflation forecasting approach developed in this paper can potentially help enrich the information set of the policy makers as well as economists in their decision making.

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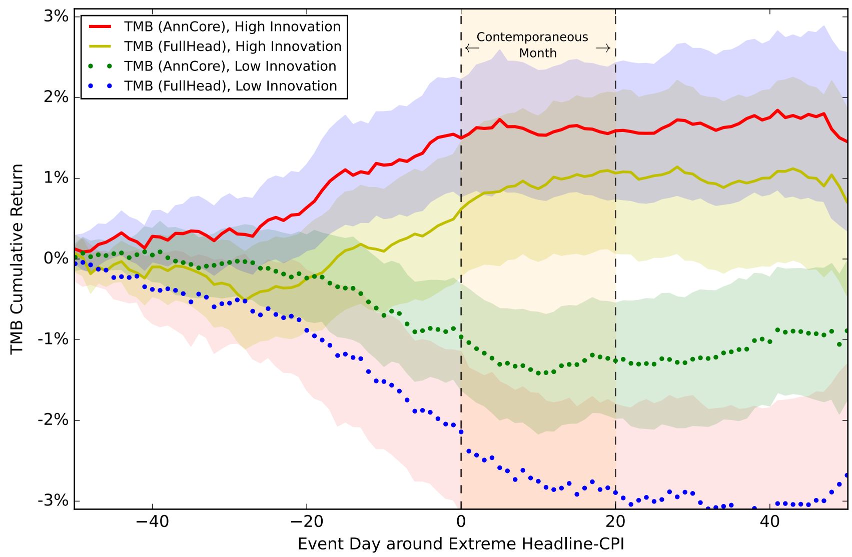
Figure 1. Performance of TMB Portfolios around Extreme CPI Months

In the upper graph, we sort all the CPI announcements into quintile groups based on headline-CPI innovation. We then plot the performance of TMB portfolios (e.g., TMB (FullHead) and TMB (AnnCore)) in the window [-50, +50] trading days around the top-quintile and bottom-quintile CPI months, with t=0 the start of the CPI months. The lower graph plots the corresponding results when extreme CPI events are defined based on core-CPI innovations.



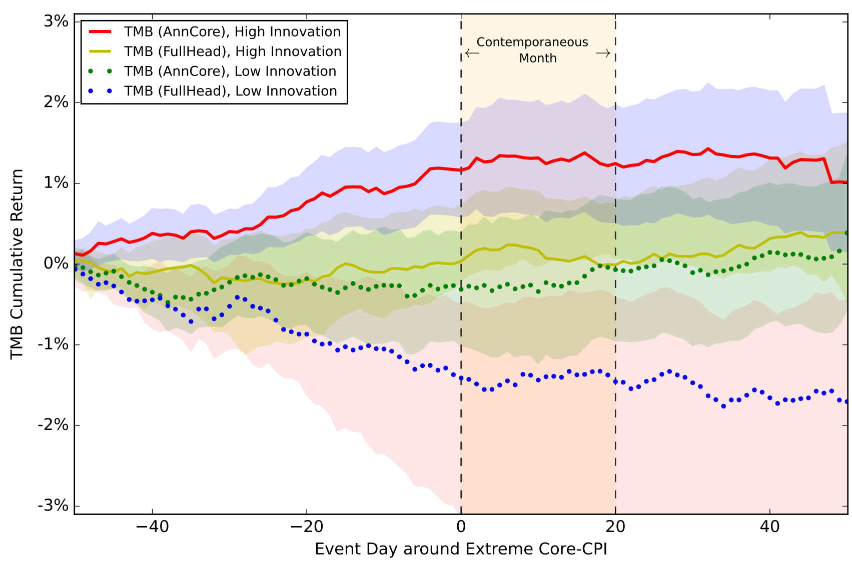


Figure 2. Predicting Inflation

The graphs show the predictability of market-based inflation forecasters on headline-CPI innovations and core-CPI innovations. The blue and yellow bars (left axis) denote the rolling 12-month core-CPI and headline-CPI innovations respectively. The inflation forecasters include the rolling 12-month average of TMB (FullHead), TMB (AnnCore), GSCI, and TIPS-UST. All the forecasting signals are standardized with means of zero and standard deviations of one. The grey areas denote the NBER recession periods.

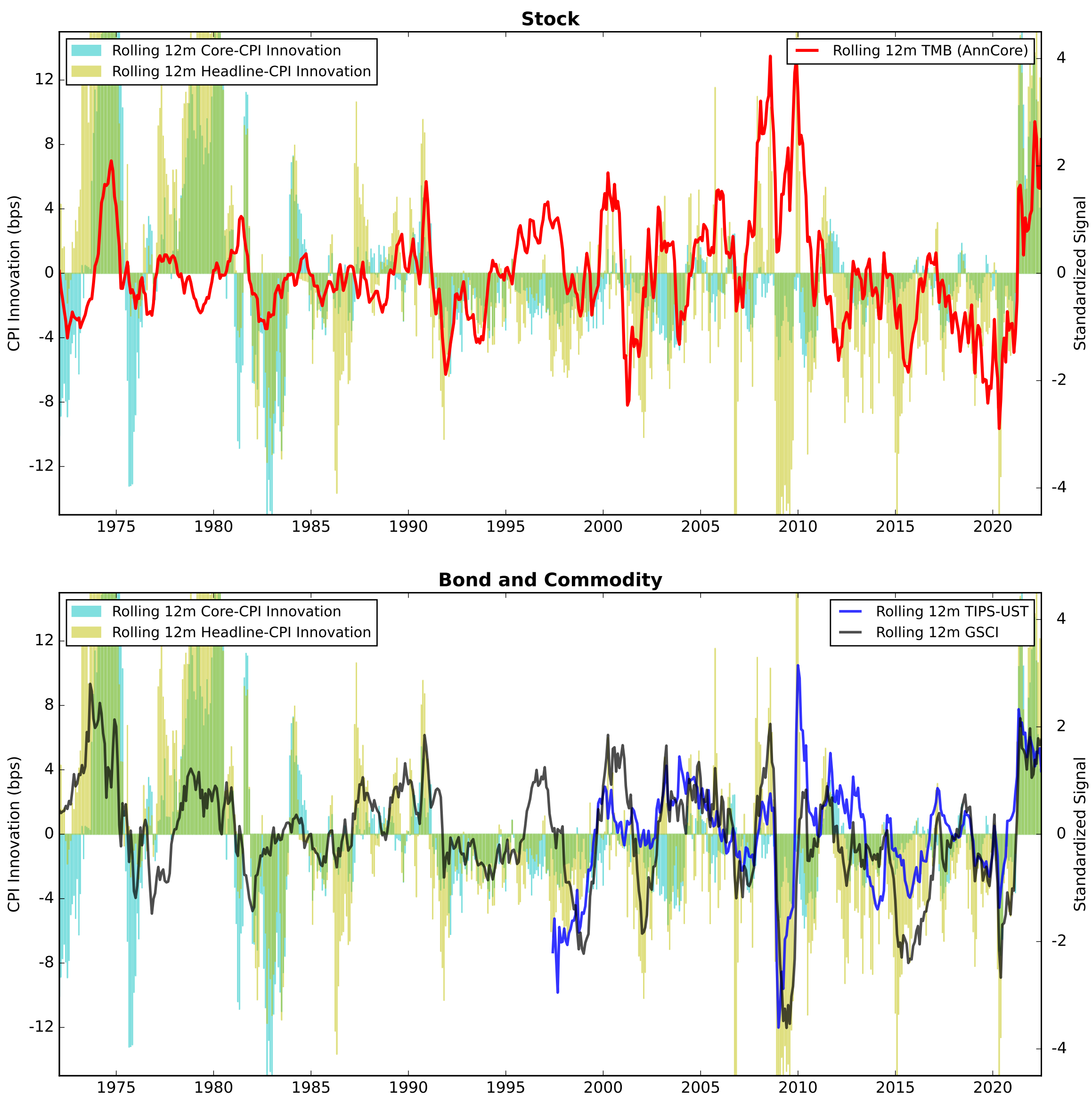


Figure 3. Survey Forecasts and Market-Based Inflation Forecasts in 2021-2022

In the upper graph, we plot the month-over-month core-CPI growth for the period from January 2021 to September 2022. The solid red line denotes the median forecast value of core-CPI (MoM) made by Bloomberg economists. The dotted lines represent the highest and lowest value of Bloomberg forecasts. The lower graph plots the monthly value of TMB (AnnCore) and TIPS-UST during 2021-2022. The blue and yellow bars denote the core- and headline-CPI innovations respectively.

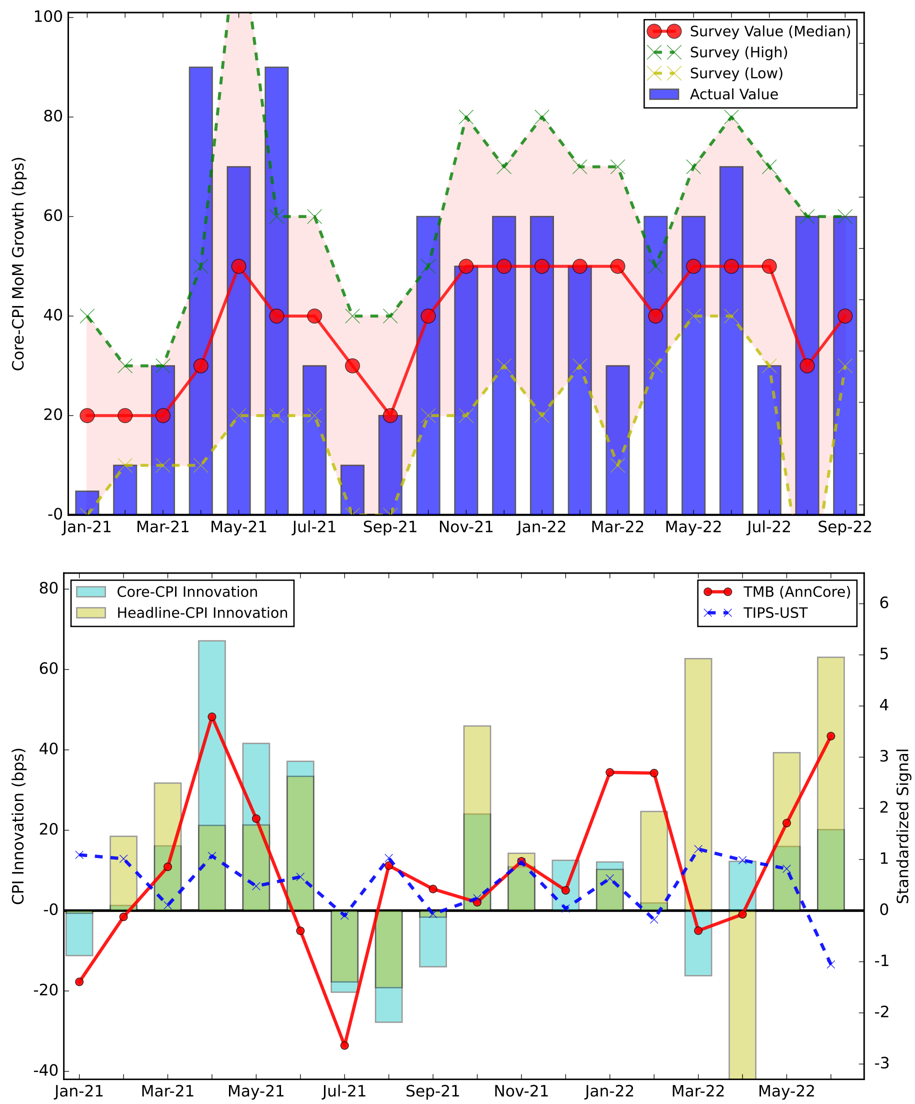


Figure 4. Predictability During Heightened Inflation Periods

The upper graphs plot the predictability of TMB (AnnCore) and TIPS-UST on core-CPI innovations during the 2021-2022 periods. The lower graphs plot the corresponding relationship for the periods from May 1972 to April 1975. Since TIPS is unavailable in the 1970s, we use change in 10-Year US Treasury yield as a replacement.

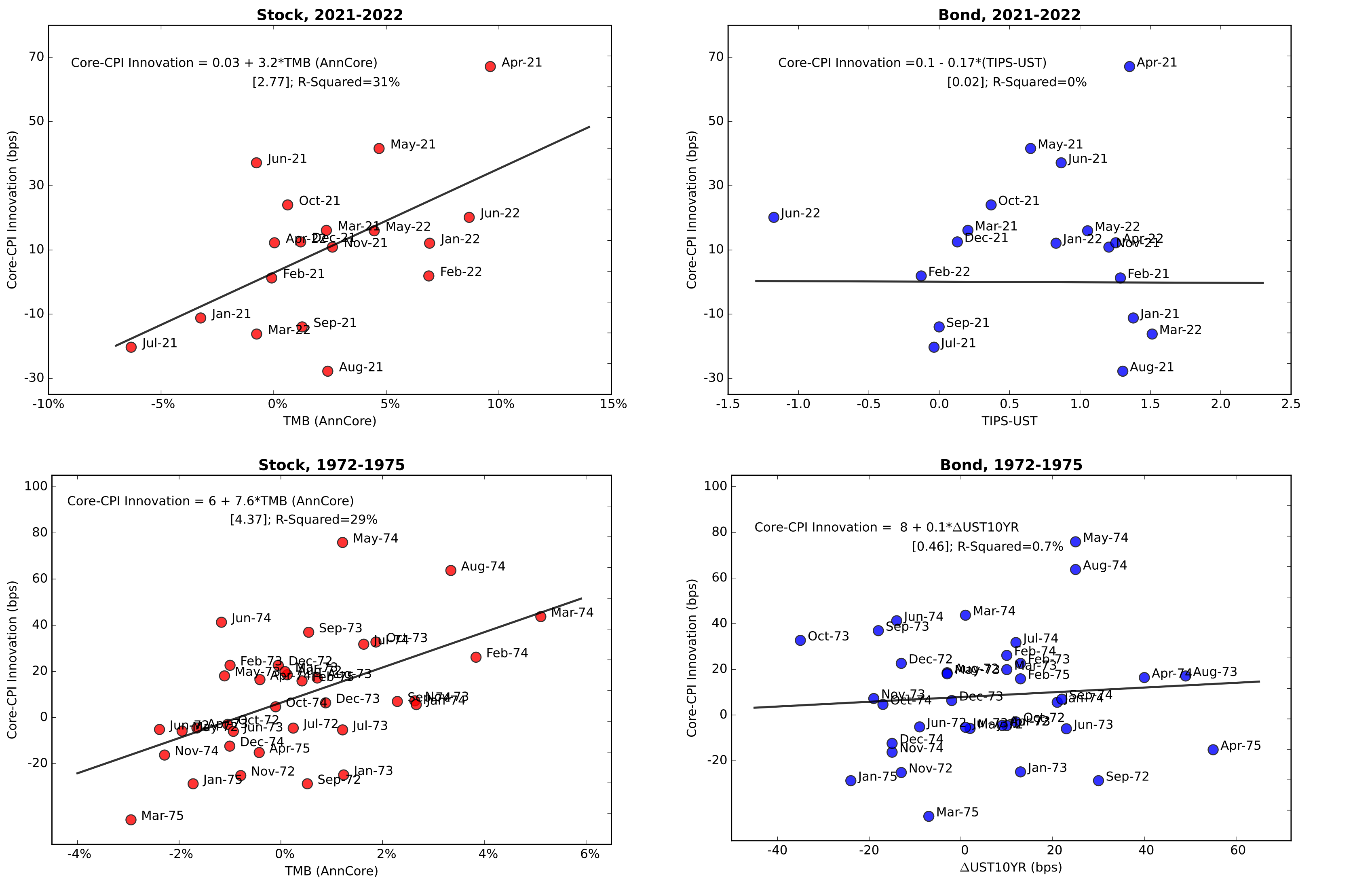


Figure 5. Predictability of TMB During the 2007-2009 Great Financial Crisis

In the upper graph, we plot the year-over-year CPI growth for the period from July 2007 to July 2009 on the left axis. On the right axis, we plot the price for global WTI Crude Oil and the rolling 12-month average of TMB (FullHead). For easiness of comparison, the right-axis variables are standardized with means of zero and standard deviations of one in their whole sample. The lower graph plots the standardized TMB (FullHead), TMB (AnnCore), and GSCI returns month-by-month in the same period. The blue and yellow bars denote the corresponding month core- and headline-inflation innovations. Shaded areas in red (starting from November 2008) refers to periods with QE.

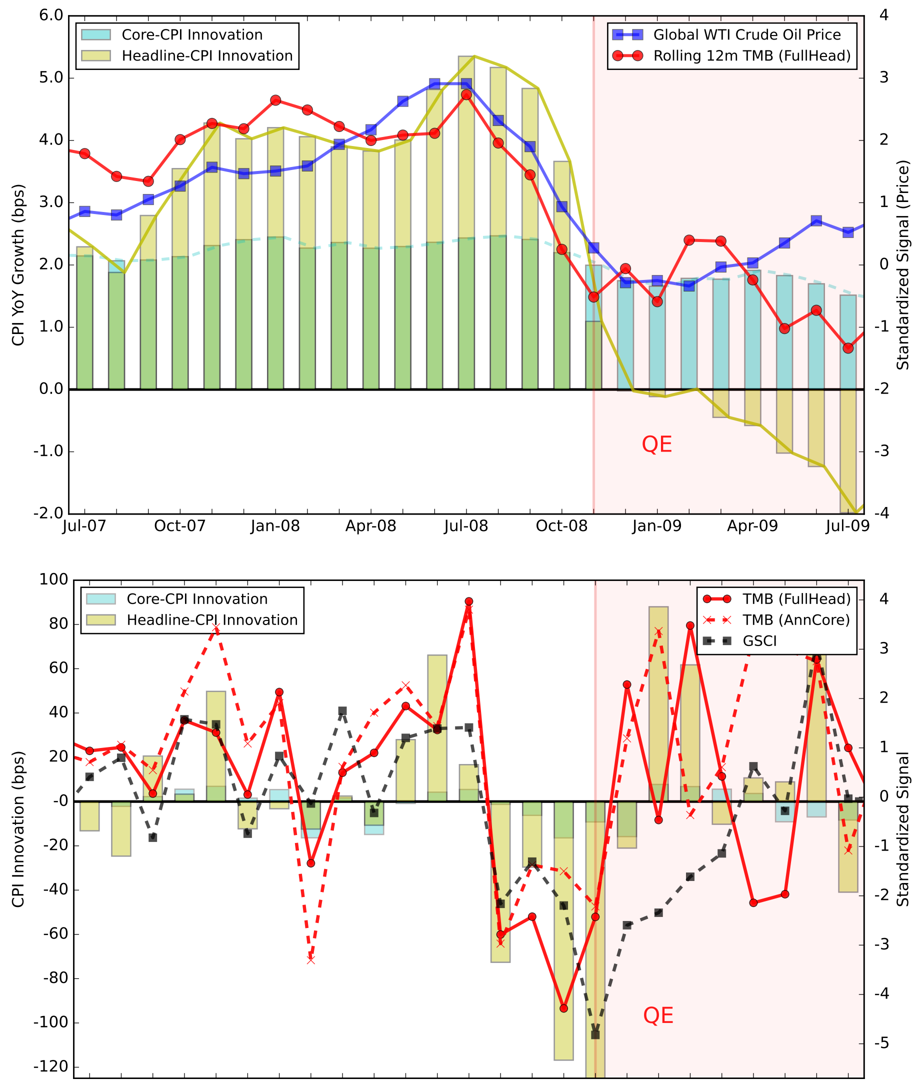


Table 1. Cross-Sectional Stock Inflation beta: Full month vs. Announcement Day

Panel A and Panel B report the post-ranking CPI betas for stock portfolios formed based on their pre-ranking betas. Each month on CPI announcement day, we construct the full-month and announcement-day CPI betas for each stock using a rolling window of 5 years. Full-month CPI beta is estimated by regressing monthly stock excess returns on contemporaneous-month inflation innovations. Announcement-day CPI beta is estimated by regressing announcement-day stock excess returns on announcement-day inflation innovations. Row "Raw" and row "CAPM" report the estimates when CPI betas are estimated without and with market return (VWRETD) as controls respectively. We then form equal-weighted 2*5 size and CPI beta sorted portfolios by ranking stocks into quintile groups based on CPI betas within the NYSE size median cutoff group, and hold the portfolio till next CPI announcement day. "Headline-CPI" refers to the CPI beta estimated using monthly headline-CPI innovations, and "Core-CPI" reports the beta estimated for core-CPI innovations. For easiness of comparison, the CPI innovations are standardized with a mean of zero and standard deviation of one. Panel A reports the post-ranking full-month CPI betas, and Panel B reports the post-ranking announcement-day CPI betas. The sample period is from January 1972 to June 2022. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

Panel A. Sorted by Full-Month CPI Beta

			Quintile1	Quintile2	Quintile3	Quintile4	Quintile5	Quintile 5-1
Headline-CPI (FullHead)	Raw	β	-35.70	-34.06	-28.14	-25.87	4.31	40.01**
		t-stat	(-0.94)	(-1.04)	(-0.95)	(-0.88)	(0.12)	(2.05)
	CAPM	β	-3.51	-7.10	-3.97	1.46	39.07***	42.58***
		t-stat	(-0.30)	(-0.83)	(-0.50)	(0.16)	(2.64)	(3.09)
Core-CPI (FullCore)	Raw	β	-71.12***	-58.56**	-61.25***	-64.09***	-66.19**	4.93
		t-stat	(-2.61)	(-2.56)	(-2.80)	(-2.80)	(-2.44)	(0.40)
	CAPM	β	-14.65	-11.01	-18.77**	-12.80	-7.58	7.06
		t-stat	(-1.10)	(-1.23)	(-2.39)	(-1.56)	(-0.66)	(0.63)

Panel B. Sorted by Announcement-Day CPI Beta

			Quintile1	Quintile2	Quintile3	Quintile4	Quintile5	Quintile 5-1
Headline-CPI (AnnHead)	Raw	β	2.87	3.09	2.83	2.46	1.38	-1.48
		t-stat	(0.35)	(0.36)	(0.31)	(0.24)	(0.12)	(-0.32)
	CAPM	β	0.16	2.64	2.00	3.26	2.54	2.38
		t-stat	(0.08)	(1.35)	(0.94)	(1.37)	(0.89)	(0.98)
Core-CPI (AnnCore)	Raw	β	-14.07***	-9.44**	-8.37**	-8.64**	-9.21*	4.86**
		t-stat	(-3.18)	(-2.30)	(-2.13)	(-2.07)	(-1.90)	(2.46)
	CAPM	β	-2.31	1.04	1.52	1.79	2.41	4.72***
		t-stat	(-1.20)	(0.58)	(0.81)	(0.89)	(1.04)	(2.76)

Table 2. Assets Inflation Beta: Full month vs. Announcement Day

This table reports the full-month and announcement-day inflation betas for different asset classes. The upper panel reports the full-month headline- and core-CPI betas, estimated by regressing monthly asset excess returns on contemporaneous-month headline- and core-CPI innovations respectively. Row "Raw" and row "CAPM" report the inflation betas estimated without and with market return (VWRETD) as controls. The lower panel reports the announcement-day headline- and core-CPI betas, estimated by regressing announcement-day asset excess returns on announcement-day inflation innovations. We estimate the inflation exposure for different assets, using CRSP value weighted market return (VWRETD), cross-sectional stock constructed TMB portfolio return, change in 10-Year US Treasury yield (ΔUST10YR), Bloomberg U.S. Treasury Inflation Notes Total Return Index (TIPS), minus value of Bloomberg U.S. Treasury Total Return Index (-UST), TIPS-UST, and Goldman Sachs Commodity Index return (GSCI). For easiness of comparison, all the variables (both the dependent and independent variables) are standardized with means of zero and standard deviations of one. The sample is from January 1972 to June 2022. The TIPS, -UST, and TIPS-UST sample is from June 1998 to June 2022. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

Panel A. Full-Month Inflation Exposure

		VWRETD	TMB	ΔUST10YR	TIPS	-UST	TIPS-UST	GSCI
Headline-CPI (FullHead)	Raw	-0.058	0.129**	0.198***	0.046	0.264***	0.339***	0.216***
		(-0.96)	(2.05)	(4.03)	(0.50)	(3.49)	(3.08)	(4.06)
	CAPM		0.176***	0.195***	0.036	0.240***	0.300***	0.228***
			(3.09)	(3.91)	(0.43)	(3.22)	(3.48)	(4.76)
Core-CPI (FullCore)	Raw	-0.103**	0.021	0.105*	0.024	0.047	0.081	0.040
		(-2.38)	(0.40)	(1.69)	(0.35)	(0.82)	(1.09)	(0.86)
	CAPM		0.035	0.099	0.022	0.042	0.074	0.060
			(0.63)	(1.59)	(0.35)	(0.69)	(1.35)	(1.30)

Panel B. Announcement-Day Inflation Exposure

		VWRETD	TMB	ΔUST10YR	TIPS	-UST	TIPS-UST	GSCI
Headline-CPI (AnnHead)	Raw	0.004	-0.034	0.067	0.093	0.115	0.249**	0.000
		(0.05)	(-0.32)	(1.15)	(0.80)	(1.33)	(2.43)	(-0.00)
	CAPM		0.067	0.068	0.093	0.115	0.249***	0.000
			(0.98)	(1.18)	(0.85)	(1.29)	(2.84)	(-0.01)
Core-CPI (AnnCore)	Raw	-0.116***	0.100**	0.114**	0.066	0.135**	0.234***	0.072**
		(-2.79)	(2.46)	(2.14)	(1.33)	(2.44)	(4.23)	(2.24)
	CAPM		0.122***	0.103*	0.080	0.146**	0.265***	0.080**
			(2.76)	(1.93)	(1.57)	(2.58)	(4.72)	(2.52)

Table 3. Predictability of Inflation Forecasting Portfolios around CPI Month

This table reports the predictive regressions of weekly forecasting portfolio returns on headline-innovations (Panel A) and core-CPI innovations (Panel B), starting from 8 weeks before the CPI month. The dependent variables are headline-CPI innovation (Panel A) and core-CPI innovation (Panel B) in bps. Week+i refers to the i^{th} week around the start of the CPI month, with i=0 being the first week in the CPI month. [Week+4, Ann) refers to periods from the fourth week after the CPI month to the last day before the CPI announcement day. We include TMB (AnnCore), TMB (FullHead), GSIC, and TIPS-UST as inflation predictors. All the weekly predictors are standardized with means of zero and standard deviations of one for easiness of interpretation. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

Panel A. Predicting Headline-CPI Innovation													
	Week-8	Week-7	Week-6	Week-5	Week-4	Week-3	Week-2	Week-1	Week+0	Week+1	Week+2	Week+3	[Week+4, Ann)
TMB (AnnCore)	1.431	-1.268	3.004**	2.788	6.943***	2.188	3.091	0.598	4.790***	1.483	0.528	-2.140	0.136
	(0.97)	(-0.72)	(2.06)	(1.55)	(4.98)	(1.44)	(1.61)	(0.24)	(3.42)	(0.96)	(0.31)	(-0.88)	(0.10)
Observations	606	606	606	606	606	606	606	606	606	606	606	606	606
R-squared	0.3%	0.2%	1.3%	1.2%	7.1%	0.7%	1.4%	0.1%	3.4%	0.3%	0.0%	0.7%	0.0%
TMB (FullHead)	1.600	0.282	0.341	3.826*	7.187***	0.528	3.346**	3.945***	5.185***	1.389	-0.036	1.565	-0.910
	(1.35)	(0.18)	(0.27)	(1.69)	(4.03)	(0.24)	(2.30)	(3.13)	(3.20)	(0.90)	(-0.03)	(1.20)	(-0.63)
Observations	606	606	606	606	606	606	606	606	606	606	606	606	606
R-squared	0.4%	0.0%	0.0%	2.2%	7.6%	0.0%	1.7%	2.3%	4.0%	0.3%	0.0%	0.4%	0.1%
GSCI	-0.197	1.300	-0.246	4.755***	6.944***	8.188***	5.664***	5.780***	7.422***	2.720	3.552**	-0.512	0.335
	(-0.15)	(1.14)	(-0.21)	(2.68)	(4.00)	(6.05)	(2.73)	(3.59)	(5.74)	(1.63)	(2.22)	(-0.31)	(0.22)
Observations	606	606	606	606	606	606	606	606	606	606	606	606	606
R-squared	0.0%	0.3%	0.0%	3.3%	7.1%	9.9%	4.8%	4.9%	8.2%	1.1%	1.9%	0.0%	0.0%
TIPS-UST	-2.389	-2.866	0.886	2.502	6.456*	6.273***	4.168	6.880***	4.252	5.659***	7.261*	2.816	1.356
	(-1.43)	(-1.53)	(0.29)	(0.95)	(1.72)	(3.01)	(1.06)	(2.94)	(1.62)	(2.76)	(1.91)	(0.86)	(1.11)
Observations	288	289	289	289	289	289	289	289	289	289	289	289	289
R-squared	0.7%	1.0%	0.1%	0.7%	4.9%	4.6%	2.0%	5.6%	2.1%	3.8%	6.2%	0.9%	0.5%

Panel B. Predicting Core-CPI Innovation

	Week-8	Week-7	Week-6	Week-5	Week-4	Week-3	Week-2	Week-1	Week+0	Week+1	Week+2	Week+3	[Week+4, Ann)
TMB (AnnCore)	0.096	-0.381	1.642**	0.795	2.035***	0.278	0.391	0.449	0.347	-0.184	0.043	-0.920	0.824
	(0.14)	(-0.71)	(2.09)	(1.19)	(2.71)	(0.39)	(0.52)	(0.71)	(0.47)	(-0.36)	(0.07)	(-1.33)	(1.34)
Observations	606	606	606	606	606	606	606	606	606	606	606	606	606
R-squared	0.0%	0.1%	1.1%	0.3%	1.7%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.3%	0.3%
TMB (FullHead)	1.353**	-0.907	0.542	0.376	2.086***	-0.524	1.735**	1.355**	1.122	0.142	-0.524	-0.054	0.914
	(2.13)	(-1.64)	(0.70)	(0.47)	(2.89)	(-0.72)	(2.55)	(2.05)	(1.50)	(0.21)	(-1.01)	(-0.08)	(1.30)
Observations	606	606	606	606	606	606	606	606	606	606	606	606	606
R-squared	0.7%	0.3%	0.1%	0.1%	1.8%	0.1%	1.2%	0.7%	0.5%	0.0%	0.1%	0.0%	0.3%
GSCI	0.263	0.872	0.675	1.377*	1.326*	1.341*	0.625	0.700	-0.194	1.349**	1.518*	-1.141*	0.954
	(0.39)	(1.36)	(0.95)	(1.84)	(1.85)	(1.94)	(0.92)	(1.08)	(-0.32)	(2.13)	(1.81)	(-1.70)	(1.62)
Observations	606	606	606	606	606	606	606	606	606	606	606	606	606
R-squared	0.0%	0.3%	0.2%	0.8%	0.7%	0.7%	0.2%	0.2%	0.0%	0.7%	0.9%	0.5%	0.4%
TIPS-UST	1.042**	-0.157	0.260	1.257**	1.766	1.912*	-0.693	0.622	-1.009	0.681	1.486*	-0.224	0.255
	(2.12)	(-0.29)	(0.40)	(2.18)	(1.57)	(1.72)	(-0.55)	(0.81)	(-1.03)	(0.78)	(1.79)	(-0.24)	(0.59)
Observations	288	289	289	289	289	289	289	289	289	289	289	289	289
R-squared	0.9%	0.0%	0.1%	1.3%	2.6%	3.0%	0.4%	0.3%	0.8%	0.4%	1.8%	0.0%	0.1%

Table 4. Predicting Inflation Innovation

This table examines the predictability of market-based inflation forecasters, observed at the end of month t, on month-$t+1$ CPI innovation. The dependent variables are headline-CPI innovations (Panel A) and core-CPI innovations (Panel B) in bps. TMB (AnnCore) is the cumulative return of the announcement-day core-beta (β^{AnnCore}) formed portfolio in the 6 weeks (Week[-6,-1]) before the end of month t. TMB (FullHead) is the six-week cumulative return of the full-month headline-beta (β^{FullHead}) formed portfolio before the end of month t. GSCI is the return of Goldman Sachs Commodity Index in month t. TIPS-UST denotes the return of Bloomberg TIPS index minus the return of Bloombegr US Treasury index in month t. All the independent variables are standardized with a mean of zero and standard deviation of one. The sample is from January 1972 to June 2022. The TIPS-UST sample is from June 1998 to June 2022. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

Panel A. Predicting Headline-CPI Innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TMB (AnnCore)	8.286***		6.372***		3.737***		7.109***	4.592**
	(6.62)		(5.45)		(3.07)		(4.35)	(2.38)
TMB (FullHead)		7.618***	5.330***		2.978**		5.358***	3.012*
		(5.54)	(4.09)		(2.41)		(3.40)	(1.87)
GSCI				13.111***	11.045***			12.730***
				(8.32)	(6.76)			(5.35)
TIPS-UST						11.724***	8.417***	3.837
						(4.04)	(3.12)	(1.41)
Constant	0.239	0.239	0.239	0.239	0.239	-1.542	-1.542	-1.542
	(0.24)	(0.24)	(0.24)	(0.26)	(0.27)	(-0.98)	(-1.05)	(-1.16)
Observations	606	606	606	606	606	289	289	289
R-squared	10.2%	8.6%	13.8%	25.5%	29.4%	16.2%	27.8%	41.1%

Panel B. Predicting Core-CPI Innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TMB (AnnCore)	2.459***		1.946**		1.684**		2.809**	2.708**
	(3.31)		(2.47)		(2.14)		(2.59)	(2.42)
TMB (FullHead)		2.127***	1.428**		1.193		0.206	0.112
		(3.09)	(1.98)		(1.64)		(0.26)	(0.14)
GSCI				1.987***	1.100			0.512
				(2.61)	(1.48)			(0.60)
TIPS-UST						1.869**	1.096	0.912
						(2.10)	(1.46)	(1.26)
Constant	0.095	0.095	0.095	0.095	0.095	-0.593	-0.593	-0.593
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(-0.92)	(-0.95)	(-0.95)
Observations	606	606	606	606	606	289	289	289
R-squared	2.5%	1.8%	3.2%	1.6%	3.6%	2.9%	9.2%	9.4%

Table 5. Out-of-Sample Forecasting Power

This table reports the out-of-sample incremental inflation forecasting power for TMB portfolios and other inflation forecasters. The forecasting period is from June 2003 to March 2022. At each month t, we estimate the forecasting model, $CPIG_{k+1} = a + \sum b * X_k + \epsilon_k$, using only public information on and before month t. We then use the estimated coefficients to forecast month-$t+1$ inflation growth. The benchmark model refers to the specification with only ARMA(1,1) included. We further add other forecasting signals, including six-week TMB (AnnCore), six-week TMB (FullHead), Goldman Sachs Commodity Index return, Bloomberg TIPS-UST return, latest SPF survey foretasted inflation growth, real GDP growth, and last-month change in one-year and ten-year UST yield. RMSE is the root-mean squared forecasting error under each forecasting model, with forecasting error calculated as the actual value minus the forecast value. "Relative RMSE"reports the ratio of the RMSE estimated using the corresponding forecast model, relative to that of the benchmark model. A relative RMSE below 1 means that the forecasting model is doing better than the benchmark model.

	Headline-CPI		**Core-CPI**	
Model	RMSE	Relative RMSE	RMSE	Relative RMSE
Benchmark: ARMA(1,1)	0.307%	100.0%	0.113%	100.0%
TMB (AnnCore)	0.280%	91.4%	0.106%	93.8%
TMB (FullHead)	0.283%	92.3%	0.113%	100.0%
TMB (AnnCore)+TMB (FullHead)	0.270%	88.0%	0.109%	95.7%
GSCI	0.254%	82.9%	0.111%	98.1%
TIP-UST	0.287%	93.6%	0.111%	98.1%
Survey	0.303%	98.9%	0.117%	103.2%
Real GDP Growth	0.325%	105.9%	0.139%	122.9%
VWRETD	0.293%	95.5%	0.116%	102.1%
ΔUST1YR	0.311%	101.4%	0.113%	99.7%
ΔUST10YR	0.309%	100.6%	0.112%	98.4%

Table 6. Do Economists Update Inflation Expectations Using Market-Based Information?

This table reports the predictability of market-based inflation forecasters on economists' estimate of inflation growth. Columns (1), (2), (5), and (6) report the results with dependent variable being the change in economists forecast in month $t+1$. Change in forecast (in bps) is calculated as Bloomberg economists' forecasting value of month-$t+1$ CPI growth minus the value predicted under ARMA(1,1) model. Columns (3), (4), (7), and (8) report the results with dependent variable being the announcement-day forecasting error. Forecasting error (in bps) is calculated as actual month-$t+1$ CPI growth minus the forecasting value by Bloomberg economists. The independent variables include the six-week TMB (AnnCore), six-week TMB (FullHead), last-month GSCI, last-month TIPS-UST return, all constructed at the end of month t. The independent variables are standardized with means of zero and standard deviations of one. The sample period is from June 1998 to June 2022. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

	Headline Inflation				**Core Inflation**			
	Change in Forecast		Forecasting Error		Change in Forecast		Forecasting Error	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TMB (AnnCore)	7.935***	2.277	4.370***	2.814**	1.066**	0.450	2.754***	2.935***
	(4.34)	(1.14)	(4.73)	(2.52)	(2.15)	(1.08)	(3.65)	(3.10)
TMB (FullHead)		2.854*		1.331		0.641*		-0.592
		(1.65)		(1.51)		(1.80)		(-0.77)
GSCI		10.111***		3.134***		0.826*		-0.180
		(4.54)		(3.49)		(1.77)		(-0.23)
TIPS-UST		3.191		-0.500		0.213		0.491
		(1.42)		(-0.52)		(0.58)		(0.72)
Constant	-1.881	-1.881	0.138	0.138	-0.252	-0.254	-0.280	-0.278
	(-1.33)	(-1.52)	(0.19)	(0.20)	(-0.84)	(-0.86)	(-0.45)	(-0.45)
Observations	289	289	289	289	288	288	288	288
R-squared	9.8%	32.3%	11.2%	17.4%	4.2%	9.3%	6.5%	6.8%

Table 7. Predictability during Heightened Inflation Periods

Panel A reports the forecasting ability of TMB portfolios and other market-based signals on headline- and core-CPI innovations, following the specifications in Table 4. "2021-2022" includes the 18 months from January 2021 through June 2022, and "1972-1975" includes the 36 months from May 1972 through April 1975. Since TIPS is unavailable in the 1970s, we use change in 10-Year US Treasury yield as a replacement. Panel B reports the predictability of market-based signals on Economists' estimate of inflation growth and their forecasting error, estimated for the episode of 2021 following the specification in Table 6. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

Panel A. Predicting Inflation Innovation

	Headline Innovation (2021 – 2022)					Core Innovation (2021 – 2022)				
TMB (AnnCore)	8.097*				6.773*	10.466**				10.863**
	(1.95)				(1.94)	(2.77)				(2.47)
TMB (FullHead)		10.204			5.846		7.348			2.452
		(0.72)			(0.56)		(0.51)			(0.20)
GSCI			6.867		7.487			-2.609		-3.149
			(1.13)		(1.18)			(-0.39)		(-0.55)
TIPS-UST				-10.935	-7.736				-0.208	5.391
				(-0.85)	(-0.76)				(-0.02)	(0.66)
Observations	18	18	18	18	18	18	18	18	18	18
R-squared	13.2%	3.0%	3.8%	5.5%	20.7%	31.5%	2.2%	0.8%	0.0%	34.3%
	Headline Innovation (1972 – 1975)					Core Innovation (1972 – 1975)				
TMB (AnnCore)	15.576***				10.471**	18.971***				20.109***
	(3.51)				(2.50)	(4.37)				(5.13)
TMB (FullHead)		6.837			-0.931		1.024			-4.092
		(1.39)			(-0.14)		(0.25)			(-1.55)
GSCI			11.459**		8.788*			2.650		1.468
			(2.31)		(1.77)			(0.85)		(0.64)
ΔUST10YR				21.684	11.367				3.491	-0.943
				(1.46)	(0.95)				(0.46)	(-0.14)
Observations	36	36	36	36	36	36	36	36	36	36
R-squared	11.3%	3.8%	25.4%	14.9%	34.4%	29.0%	0.1%	2.4%	0.7%	31.3%

Panel B. Predicting Economist Forecasts

	Headline Inflation (2021 – 2022)				Core Inflation (2021 – 2022)			
	Forecast Change		Forecast Error		Forecast Change		Forecast Error	
TMB (AnnCore)	2.253	0.605	6.134*	6.952*	2.742**	3.050***	8.174*	8.307*
	(0.45)	(0.19)	(1.80)	(2.12)	(2.38)	(3.44)	(2.09)	(1.80)
TMB (FullHead)		7.225		-4.815		1.483		-0.061
		(0.82)		(-0.53)		(0.44)		(-0.00)
GSCI		12.403*		-6.060		1.594		-5.807
		(1.97)		(-1.28)		(0.44)		(-1.07)
TIPS-UST		-9.270		3.688		4.381		0.519
		(-0.98)		(0.66)		(1.31)		(0.07)
Observations	18	18	18	18	18	18	18	18
R-squared	1.2%	19.3%	20.6%	31.0%	14.2%	24.1%	22.3%	26.7%

Table 8. Time-Varying Predictability

Panel A examines the predictability of TMB portfolios for subsamples conditional on inflation disagreement. |CPI Innovation| is the absolute value of last-month headline CPI innovation. CPI disagreement is the cross-sectional forecast dispersion, defined as the difference between the 75th percentile and the 25th percentile of current-quarter CPI forecasts from the Survey of Professional Forecasters (SPF) database. Panel B reports the subsample analysis conditional on monetary policy intervention. We estimate the recommended Fed Fund Rate implied by Taylor rule as 2.5%+1.5*(Core-CPI Yoy Growth-2%)+0.5*OutPut Gap, where output gap is estimated by the percentage deviation of real output from the long-run trend (Taylor (1993)). Subsample "Behind" refers to periods when the difference between Taylor rule implied Fed Fund rate and the actual fed fund rate is higher than the 67% percentile cutoff, i.e. Fed is severely behind the curve. We further conduct sample analysis conditional on whether the period is affected by Fed's Quantitative Easing (QE) program or not. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

Panel A. Conditional on Inflation Disagreement

	Y=Headline Innovation						Y=Core innovation					
	|CPI Innovation|			CPI Disagreement			|CPI Innovation|			CPI Disagreement		
	>Median	<=Median	Diff.	>Median	<=Median	Diff.	>Median	<=Median	Diff.	>Median	<=Median	Diff.
TMB (AnnCore)	11.607***	4.412***	7.195***	10.737***	3.806**	6.931***	4.166***	0.641	3.525***	2.763***	0.869	1.894
	(6.02)	(3.49)	(3.12)	(6.20)	(2.46)	(2.98)	(3.58)	(1.03)	(2.67)	(2.62)	(1.44)	(1.56)
Observations	303	303		225	267		303	303		225	267	
R-squared	15.6%	4.3%		17.9%	3.4%		6.2%	0.2%		4.7%	0.8%	
TMB (FullHead)	10.125***	3.957***	6.168**	10.163***	3.611***	6.552***	3.203***	0.667	2.536*	2.620***	0.591	2.029*
	(5.14)	(2.69)	(2.51)	(4.96)	(2.61)	(2.65)	(3.26)	(0.77)	(1.94)	(2.79)	(0.90)	(1.77)
Observations	303	303		225	267		303	303		225	267	
R-squared	13.1%	3.0%		14.9%	2.8%		4.1%	0.2%		3.9%	0.3%	

Panel B. Conditional on Noise from Treasury Market

	Y=Headline Innovation						Y=Core innovation					
	Distance from Taylor Rule			QE periods			Distance from Taylor Rule			QE periods		
	Behind	Normal	Diff.	QE	Non-QE	Diff.	Behind	Normal	Diff.	QE	Non-QE	Diff.
TMB (AnnCore)	9.296***	4.906**	4.390	10.199***	5.710**	4.489	5.980***	0.082	5.899***	5.973***	0.707	5.266**
	(3.71)	(2.09)	(1.28)	(4.38)	(2.48)	(1.38)	(3.17)	(0.10)	(2.86)	(2.69)	(0.86)	(2.25)
TMB (FullHead)	6.399**	6.418***	-0.019	7.713**	5.344***	2.369	0.994	1.335*	-0.341	0.667	1.217*	-0.550
	(2.46)	(2.89)	(-0.01)	(2.62)	(2.83)	(0.68)	(0.52)	(1.97)	(-0.17)	(0.26)	(1.91)	(-0.21)
TIPS-UST	11.264***	3.632	7.632*	6.681***	9.156**	-2.475	1.174	-0.146	1.321	2.023	0.021	2.002
	(3.34)	(1.34)	(1.77)	(3.09)	(2.22)	(-0.53)	(0.95)	(-0.18)	(0.89)	(1.38)	(0.03)	(1.27)
Observations	96	193		76	213		96	193		76	213	
R-squared	47.6%	17.0%		39.2%	24.5%		23.7%	3.0%		22.0%	4.4%	

Table 9. Which Components of CPI? – Pricing of Inflation Risk

This table reports the post-ranking inflation betas for stock portfolios sorted by their pre-ranking CPI betas, estimated for each CPI components following the same methodology in Table 1. We estimate the CPI betas for each stock using a rolling window of five years. Full-month CPI betas are estimated as the sensitivity of monthly stock excess returns to the contemporaneous-month CPI innovations, and announcement-day CPI betas are estimated as the sensitivity of announcement-day stock excess returns to the announcement-day released CPI innovations. We then sort the cross-sectional stocks into quintile groups based on the corresponding CPI betas within each size category and hold the portfolio till next announcement day. Columns "Head", "Energy" and "Food" report the post-ranking betas for the non-core-CPI components, and columns "Core", "Goods" and "Service" report the corresponding estimates for the core-CPI components. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

		Full Month			**Announcement Day**		
Quintile	Variable	Headline	Energy	Food	Core	Goods	Service
1	β	-3.51	-4.97	-15.92	-2.31	-2.89	-1.83
	t-stat	(-0.30)	(-0.39)	(-1.27)	(-1.20)	(-1.35)	(-1.06)
2	β	-7.10	-6.86	-16.69*	1.04	-2.39	-0.08
	t-stat	(-0.83)	(-0.66)	(-1.81)	(0.58)	(-1.35)	(-0.05)
3	β	-3.97	0.32	-18.50**	1.52	-1.53	1.52
	t-stat	(-0.50)	(0.04)	(-2.35)	(0.81)	(-0.83)	(0.86)
4	β	1.46	5.28	-21.01**	1.79	-0.29	2.31
	t-stat	(0.16)	(0.55)	(-2.47)	(0.89)	(-0.16)	(1.25)
5	β	39.07***	29.34*	-19.41*	2.41	0.11	1.24
	t-stat	(2.64)	(1.72)	(-1.73)	(1.04)	(0.05)	(0.67)
5-1	β	42.58***	34.31**	-3.49	4.72***	3.00*	3.06**
	t-stat	(3.09)	(2.12)	(-0.45)	(2.76)	(1.73)	(2.01)

		Full Month			**Announcement Day**		
Quintile	Variable	Core	Goods	Service	Headline	Energy	Food
1	β	-14.65	-15.44	-2.16	0.16	0.18	0.67
	t-stat	(-1.10)	(-1.05)	(-0.23)	(0.08)	(0.08)	(0.38)
2	β	-11.01	-9.26	-5.26	2.64	1.34	2.11
	t-stat	(-1.23)	(-0.98)	(-0.72)	(1.35)	(0.71)	(1.50)
3	β	-18.77**	-7.43	-7.57	2.00	2.82	1.45
	t-stat	(-2.39)	(-0.85)	(-1.10)	(0.94)	(1.20)	(1.01)
4	β	-12.80	-9.24	-7.52	3.26	1.60	0.79
	t-stat	(-1.56)	(-1.01)	(-1.04)	(1.37)	(0.71)	(0.53)
5	β	-7.58	-13.89	-0.39	2.54	-1.25	2.45
	t-stat	(-0.66)	(-1.16)	(-0.03)	(0.89)	(-0.61)	(1.65)
5-1	β	7.06	1.56	1.77	2.38	-1.42	1.79
	t-stat	(0.63)	(0.17)	(0.20)	(0.98)	(-0.70)	(1.64)

Table 10. Which Components of CPI? – Predicting Inflation Innovation

This table reports the predictability of TMB portfolios, constructed based on stocks' sensitivity to each detailed components of CPI in Table 9, on CPI innovations. The dependent variables are headline-CPI innovations (Panel A) and core-CPI innovations (Panel B) in bps. All the TMB portfolio returns are standardized with means of zero and standard deviations of one for easiness of interpretation. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

Panel A. Predicting Headline CPI innovation

	Sorted by β^{Ful}			Sorted by β^{Ann}		
	Headline	Energy	Food	Core	Goods	Service
TMB	7.618***	7.756***	-1.305	8.286***	6.340***	3.243***
	(5.54)	(5.04)	(-0.98)	(6.62)	(5.45)	(2.70)
Observations	606	606	606	606	606	580
R-squared	8.6%	8.9%	0.3%	10.2%	6.0%	1.6%
	Core	Goods	Service	Headline	Energy	Food
TMB	1.068	1.926*	0.403	4.037***	1.559	3.335**
	(0.97)	(1.96)	(0.33)	(2.85)	(1.15)	(2.07)
Observations	606	606	580	606	606	606
R-squared	0.2%	0.5%	0.0%	2.4%	0.4%	1.6%

Panel B. Predicting Core CPI innovation

	Sorted by β^{Full}			Sorted by β^{Ann}		
	Headline	Energy	Food	Core	Goods	Service
TMB	2.127***	2.295***	-0.674	2.459***	2.159***	-0.390
	(3.09)	(3.59)	(-0.98)	(3.31)	(2.94)	(-0.70)
Observations	606	606	606	606	606	580
R-squared	1.8%	2.1%	0.2%	2.5%	1.9%	0.1%
	Core	Goods	Service	Headline	Energy	Food
TMB	1.176	1.756**	0.834	2.035***	1.231*	0.818
	(1.55)	(2.15)	(1.11)	(2.79)	(1.95)	(1.41)
Observations	606	606	580	606	606	606
R-squared	0.6%	1.3%	0.3%	1.7%	0.6%	0.3%

Table 11. Industry vs. Stock-Level Inflation Exposure

Panel A lists the top 10 and bottom 10 industries that are most and least sensitive to full-month headline CPI innovations and announcement-day core CPI innovations respectively. Industry portfolios are defined based on Fama and French 48-Industry classification. Industry betas (reported beside the industry names) are estimated using the whole sample from 1972 to 2022. Panel B compares the predictability of industry- and stock-constructed inflation portfolios on CPI innovations. We construct industry CPI betas in a similar manner as individual stock CPI betas using a rolling window of five years. TMB $(\text{AnnCore})^{\text{Ind}}$ and TMB $(\text{FullHead})^{\text{Ind}}$ are the 6-week return for the industry-constructed TMB portfolio, with a long position in top-quintile CPI beta industries and a short position in bottom-quintile CPI beta industries. TMB (AnnCore) and TMB (FullHead) are the 6-week return for the stock-constructed TMB portfolios as in Table 4. All the TMB portfolios ae standardized for easiness of interpretation. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

Panel A. Most and Least Inflation-Sensitive Industries

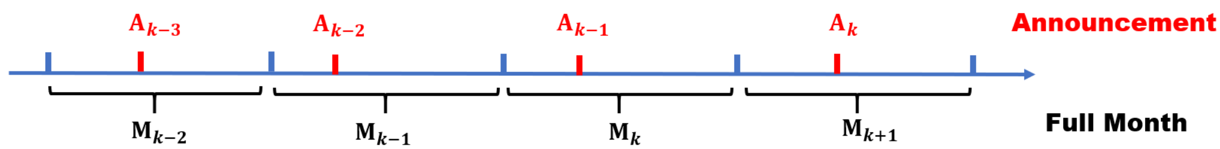
	β^{FullHead}				β^{AnnCore}			
Rank	Top 10		Bottom 10		Top 10		Bottom 10	
1	Petroleum and Natural Gas	154.41	Tobacco Products	-48.08	Ship Building	14.25	Candy & Soda	-8.33
2	Precious Metals	129.00	Restaurants & Hotels	-29.87	Petroleum and Natural Gas	12.73	Beer & Liquor	-5.66
3	Mining	126.73	Banking	-18.55	Coal	11.02	Recreation	-4.76
4	Coal	123.24	Candy & Soda	-16.74	Precious Metals	9.20	Medical Equipment	-3.75
5	Steel Works	75.10	Insurance	-15.00	Mining	5.26	Apparel	-3.51
6	Agriculture	69.62	Beer & Liquor	-13.67	Shipping Containers	4.20	Entertainment	-3.41
7	Fabricated Products	64.21	Utilities	-13.55	Defense	4.09	Agriculture	-3.18
8	Ship Building	49.71	Rubber & Plastic Products	-9.55	Rubber & Plastic Products	4.09	Tobacco Products	-3.17
9	Machinery	47.93	Apparel	-8.35	Paper Products	3.68	Consumer Goods	-2.37
10	Electrical Equipment	46.77	Shipping Containers	-5.06	Wholesale	3.61	Computers	-2.32

Panel B. Predictability of Industry vs. Stock Portfolios

	Headline Innovation			Core Innovation		
	(1)	(2)	(3)	(4)	(5)	(6)
TMB $(\text{AnnCore})^{\text{Ind}}$	4.586***		2.657**	0.648		-0.093
	(3.69)		(2.13)	(1.04)		(-0.15)
TMB $(\text{FullHead})^{\text{Ind}}$	4.479***		0.486	1.397**		0.271
	(3.69)		(0.40)	(2.37)		(0.40)
TMB (AnnCore)		6.372***	5.152***		1.946**	1.962**
		(5.45)	(4.27)		(2.47)	(2.34)
TMB (AnnCore)		5.330***	5.120***		1.428**	1.277
		(4.09)	(3.52)		(1.98)	(1.52)
Constant	0.239	0.239	0.239	0.095	0.095	0.095
	(0.24)	(0.24)	(0.24)	(0.15)	(0.15)	(0.15)
Observations	606	606	606	606	606	606
R-squared	7.6%	13.8%	14.8%	1.2%	3.2%	3.2%

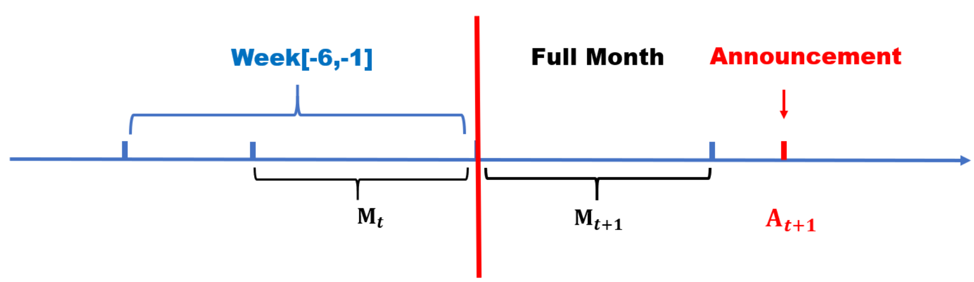
A1. Appendix A. Illustration of the Time Line

Beta Estimation– To capture the inflation exposure of individual stocks as well as for different assets, we adopt two approaches. The first approach estimates the inflation risk exposure by the sensitivity of monthly asset returns to the contemporaneous-month inflation innovations. Each month after the announcement of CPI (A_k), we measure the headline- and core-inflation exposure for firm i using a rolling window of 60 months. We dynamically update the estimation of inflation beta on the CPI announcement days, as we need to wait until announcement day A_k to get the CPI innovation for month M_k.



As illustrated in the above graph, standing at announcement day A_k, firm i 's full-month beta is estimated using monthly returns from month M_{k-59} to M_k. For example, if we are estimating inflation beta on May 12, 2022, which is the CPI announcement day for April 2022, we use the monthly returns and monthly CPI innovations from May 2017 to April 2022 (total 60 months) to estimate equation (3).

The second approach estimates an information-based inflation beta, constructed by regressing firm i's announcement-day return on announcement-day released CPI innovations. Standing at announcement day A_k, firm i 's announcement-day beta is estimated using announcement-day returns from A_{k-59} to A_k. Taking the announcement day of May 12, 2022 as an example, A_{k-59} refers to June 14, 2017, which is the announcement day for CPI month of May 2017.



Forecasting with TMB– To examine the forecastability of TMB portfolio, standing at the end of month t (M_t), we use the 6-week TMB returns observed by the end of month t (M_t) to predict the CPI innovations realized in month $t+1$ (M_{t+1}) and announced in day A_{t+1}. For example, to predict the CPI for month April 2022, i.e., M_{t+1} is April 2012, we construct our TMB signal using the 6-week cumulative return from February 18, 2022 to March 31, 2022 (total 30 trading days). The predicted CPI is then materialized in month April 2022 and announced on day May 12, 2022.

Table A1. Summary Statistics

Panel A and B report the monthly summary statistics and correlation matrix for the main variables used in the paper. TMB (AnnCore) and TMB (FullHead) are the six-week cumulative return of the β^{AnnCore} and β^{FullHead} sorted stock portfolios observed at the end of month t. TMB^{M} (AnnCore) and TMB^{M} (FullHead) denote the month-t return of the TMB portfolios. We also include other assets returns in month t, including Goldman Sachs Commodity Index return (GSCI), Bloomberg TIPS index return minus US Treasury index return (TIPS-UST), aggregate stock market return (VWRETD), and change in one-year and ten-year US Treasury yields (ΔUS1YR and ΔUS10YR). CPI innovations for month $t+1$ (HeadInnov_{t+1} and CoreInnov_{t+1}) are computed as the actual CPI monthly growth minus the value predicted by the time-series model of ARMA(1,1). CPI forecasting errors (HeadError_{t+1} and CoreError_{t+1}) are constructed as the actual CPI monthly growth minus the median forecast by Bloomberg economists. The sample period is from January 1972 to June 2022.

Panel A. Summary Statistics

Variable	N	Mean	Median	Q1	Q3	STD
TMB (AnnCore) (%)	606	0.22	0.08	-1.02	1.38	2.48
TMB (FullHead) (%)	606	-0.24	-0.14	-1.76	1.47	3.18
TMB^{M} (AnnCore)(%)	606	0.11	0.02	-0.91	1.15	2.20
TMB^{M} (FullHead) (%)	606	-0.17	-0.01	-1.44	1.32	2.73
GSCI (%)	606	0.73	0.91	-2.36	4.30	6.01
TIPS-UST (%)	289	0.10	0.18	-0.43	0.75	1.20
VWRETD (%)	606	0.92	1.27	-1.70	3.84	4.55
ΔUST1YR (%)	606	0.00	0.00	-0.14	0.15	0.49
ΔUST10YR (%)	606	0.00	0.00	-0.17	0.18	0.34
HeadError_{t+1} (bps.)	289	0.10	0.00	-10.00	10.00	13.11
CoreError_{t+1} (bps.)	288	-0.31	0.00	-10.00	10.00	10.90
HeadInnov_{t+1} (bps.)	606	0.09	-0.63	-12.21	12.58	26.23
CoreInnov_{t+1}(bps.)	606	0.03	-0.49	-7.28	5.70	15.69

Panel B. Correlation

	TMB (AnnCore)	TMB (FullHead)	TMB^{M} (AnnCore)	TMB^{M} (FullHead)	GSCI	TIPS-UST	VWRETD	ΔUST1YR	ΔUST10YR	Head $Error_{t+1}$	Core $Error_{t+1}$	Head $Innov_{t+1}$	Core $Innov_{t+1}$
TMB(AnnCore) (%)	1.00	0.36	0.87	0.38	0.31	0.25	0.15	0.06	0.08	0.33	0.25	0.31	0.15
TMB(FullHead) (%)	0.36	1.00	0.31	0.88	0.30	0.28	0.05	0.13	0.18	0.27	0.06	0.29	0.13
TMB^{M} (AnnCore)	0.87	0.31	1.00	0.42	0.34	0.21	0.16	0.05	0.10	0.27	0.20	0.28	0.11
TMB^{M} (FullHead)	0.38	0.88	0.42	1.00	0.33	0.34	0.12	0.08	0.16	0.26	0.06	0.31	0.13
GSCI	0.31	0.30	0.34	0.33	1.00	0.47	0.19	0.09	0.14	0.34	0.09	0.51	0.13
TIPS-UST	0.25	0.28	0.21	0.34	0.47	1.00	0.43	0.19	0.18	0.16	0.10	0.41	0.18
VWRETD	0.15	0.05	0.16	0.12	0.19	0.43	1.00	-0.10	-0.07	0.04	0.07	0.14	0.01
ΔUST1YR	0.06	0.13	0.05	0.08	0.09	0.19	-0.10	1.00	0.76	0.05	0.00	0.13	0.21
ΔUST10YR	0.08	0.18	0.10	0.16	0.14	0.18	-0.07	0.76	1.00	0.04	0.05	0.14	0.20
$HeadError_{t+1}$	0.33	0.27	0.27	0.26	0.34	0.16	0.04	0.05	0.04	1.00	0.57	0.53	0.52
$CoreError_{t+1}$	0.25	0.06	0.20	0.06	0.09	0.10	0.07	0.00	0.05	0.57	1.00	0.25	0.78
$HeadInnov_{t+1}$	0.31	0.29	0.28	0.31	0.51	0.41	0.14	0.13	0.14	0.53	0.25	1.00	0.41
$CoreInnov_{t+1}$	0.15	0.13	0.11	0.13	0.13	0.18	0.01	0.21	0.20	0.52	0.78	0.41	1.00

Table A2. Alternative Specifications

This table reports the predictability of TMB portfolios on inflation innovations, estimated under alternative specifications. In row (a), the six-week cumulative return of TMB portfolios are replaced by the last-month return of the TMB portfolios. In row (b), TMB portfolios' returns are replaced by Fama French 5-factor alphas. "High |Innovation|" in row (c) refers to the specification where individuals' CPI betas are estimated using all the historical observations with an above-median |Innovation| cut-off. In row (d), CPI betas are estimated using all the historical observations with a half-life of 60 months. In row (e), CPI betas are estimated using a rolling window of ten years. In row (f), TMBCPI portfolio is constructed using small stocks only. *, **, and *** denote significance at 10%, 5% and 1% levels, respectively.

	Y=Headline Innovation				Y=Core Innovation			
	TMB(AnnCore)	R-squared	TMB(FullHead)	R-squared	TMB(AnnCore)	R-squared	TMB(FullHead)	R-squared
(a) Monthly Return	7.448***	8.2%	8.268***	10.1%	1.761**	1.3%	2.044***	1.7%
	(6.52)		(6.40)		(2.48)		(3.23)	
(b) FF5F Alpha	6.941***	7.1%	7.315***	7.9%	1.968***	1.6%	2.231***	2.0%
	(6.20)		(5.65)		(3.23)		(3.26)	
(c) High |Innovation|	7.577***	8.5%	7.625***	8.6%	2.568***	2.7%	0.834	0.3%
	(6.21)		(5.90)		(3.26)		(1.15)	
(d) Past All Years, Half life of 60 months	7.159***	7.6%	7.863***	9.2%	2.658***	2.9%	1.859***	1.4%
	(6.47)		(5.77)		(3.34)		(2.67)	
(e) Past 10 Years	6.574***	6.4%	7.673***	8.7%	2.777***	3.1%	1.651**	1.1%
	(5.91)		(5.64)		(3.26)		(2.51)	
(f) Small Stocks	4.728***	3.3%	4.913***	3.6%	1.951**	1.5%	2.103***	1.8%
	(3.42)		(3.87)		(2.53)		(3.48)	