

# Inflation Forecasting from Cross-Sectional Stocks

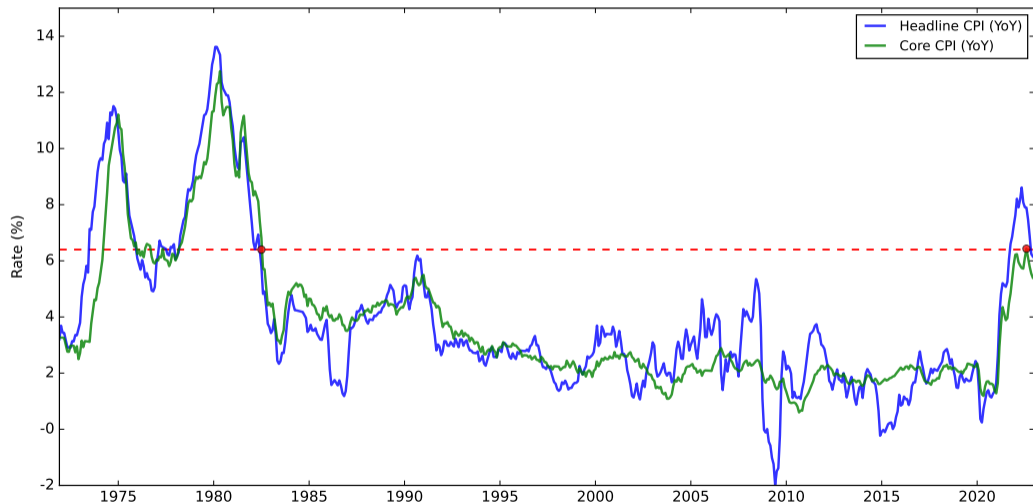
**Claire Yurong Hong**

**Shanghai Advanced Institute of Finance (SAIF)  
Shanghai Jiao Tong University**

**May 25th, 2023  
ABFER 10th Annual Conference**

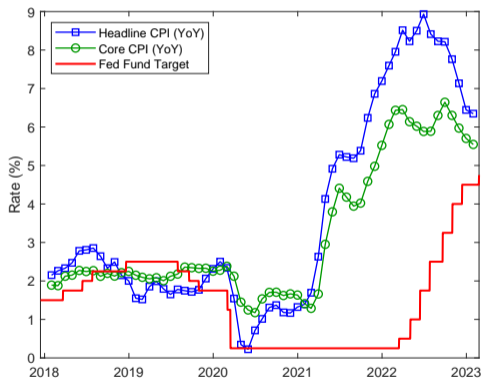
**Joint work with Jun Pan and Shiwen Tian from SAIF**

# Motivation: The Post-Covid Inflation Surge



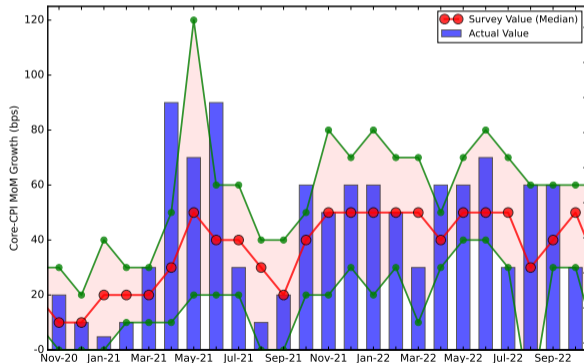
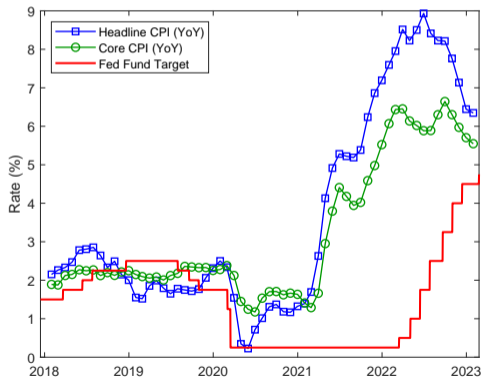
# Policy Makers and Economists Forecasts

- Policy markers underestimated the severity of inflation



# Policy Makers and Economists Forecasts

- Policy makers underestimated the severity of inflation
- Economists also missed the initial inflation surge



# Inflation Forecasting using Information from Financial Markets

- **Treasury Bonds:**

- ▶ UST: Amid heightened inflation, the Treasury yield might decrease, not due to reduced inflation risk, but fight-to-safety or Fed's pivot from tightening.
- ▶ TIPS: Illiquidity adds noise to the breakeven inflation forecasts.
- ▶ Government interventions in the Treasury market (e.g., QE) distort bond pricing, masking the inflation expectations.

- **Commodities & Inflation Swap:** Headline vs Core.

- **Aggregate Stock:** not a good hedge for inflation (Fama and Schwert (1977)).

- **Cross-Sectional Stocks:**

- ▶ Shift away from the overall equity-market effects.
- ▶ Zero in on the inflation expectations embedded in the relative pricing between stocks with high- and low-inflation exposures.

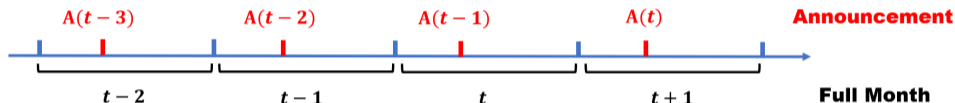
# The Informational Channel

- Roll (1984):
  - ▶ The market price of frozen concentrated orange juice is affected by the weather.
  - ▶ Financial markets (orange-juice futures) process this information and price it in.
  - ▶ A statistically significant relation between OJ futures price changes and subsequent errors in temperature forecasts for Orlando, Florida.
- Our paper:
  - ▶ Stock-level inflation exposures are persistent over time and vary across firms.
  - ▶ Active price discovery for future inflation takes place in the equity market.
  - ▶ The cross-sectional approach: harness the informational channel.

- **Inflation beta estimation**
- Inflation forecasting using TMB portfolios
- Can TMB predict economists' forecasting error?
- Time-varying predictability: The case of 2021

# Headline- and Core-Focused Inflation Betas

- Price discovery with respect to inflation takes place
  - ▶ Through the inflation experiences: during the contemporaneous CPI month.
  - ▶ Via the informational shocks: at the CPI announcements.
  - ▶ Differ for different inflation components: headline vs. core



- Two approaches to capture the sensitivity of stock returns to inflation innovations

$$R_t^i - r^f = \alpha + \beta_i \text{Innov}_t + \beta_i^M (R_t^M - r_f) + \varepsilon_t^i$$

- ▶  $\beta^{\text{Full}}$  month- $t$  returns on month- $t$  CPI innovations.
  - ▶  $\beta^{\text{Ann}}$  announcement-day returns on announcement-day CPI innovations.
  - ▶  $\text{Innov}_t$  estimated using ARMA(1,1), following Fama and Gibbons (1984).
- Apply the full-month approach to headline CPI to get  $\beta^{\text{FullHead}}$ , and the announcement-day approach to core CPI to get  $\beta^{\text{AnnCore}}$ .



# Inflation Beta Across Asset Classes

Full-Month Inflation Exposure							
	VWRETD	$\Delta$ UST10YR	TIPS	-UST	TIPS-UST	ISwap <sup>1Year</sup>	GSCI
$\beta^{\text{FullHead}}$	-0.020 (-0.31)	0.186*** (3.75)	0.043 (0.46)	0.277*** (3.39)	0.348*** (3.23)	0.611*** (5.36)	0.239*** (4.11)
$\beta^{\text{FullCore}}$	-0.095** (-2.03)	0.030 (0.47)	0.010 (0.16)	-0.041 (-0.65)	-0.030 (-0.44)	-0.013 (-0.18)	-0.056 (-1.10)
Announcement-Day Inflation Exposure							
$\beta^{\text{AnnHead}}$	0.061 (0.62)	0.026 (0.42)	0.080 (0.66)	0.081 (0.90)	0.195* (1.88)	0.155** (2.35)	-0.034 (-0.58)
$\beta^{\text{AnnCore}}$	-0.141*** (-2.95)	0.104* (1.89)	0.041 (0.78)	0.110** (2.04)	0.174*** (3.07)	0.221*** (3.81)	0.085** (2.08)

# Post-Ranking Inflation Beta for Cross-Sectional Stocks

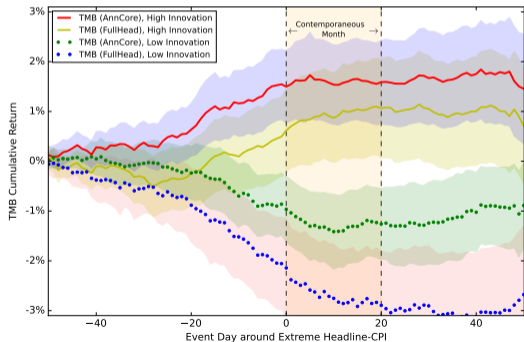
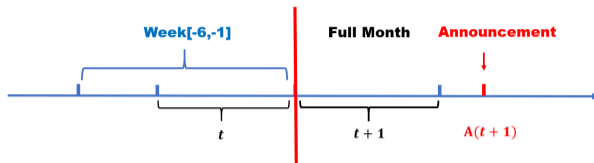
Sorted by Full-Month CPI Beta						
	Quintile1	Quintile2	Quintile3	Quintile4	Quintile5	Quintile 5-1
$\beta^{\text{FullHead}}$	-3.51 (-0.30)	-7.10 (-0.83)	-3.97 (-0.50)	1.46 (0.16)	39.07*** (2.64)	42.58*** (3.09)
$\beta^{\text{FullCore}}$	-14.65 (-1.10)	-11.01 (-1.23)	-18.77** (-2.39)	-12.80 (-1.56)	-7.58 (-0.66)	7.06 (0.63)
Sorted by Announcement-Day CPI Beta						
	Quintile1	Quintile2	Quintile3	Quintile4	Quintile5	Quintile 5-1
$\beta^{\text{AnnHead}}$	0.16 (0.08)	2.64 (1.35)	2.00 (0.94)	3.26 (1.37)	2.54 (0.89)	2.38 (0.98)
$\beta^{\text{AnnCore}}$	-2.31 (-1.20)	1.04 (0.58)	1.52 (0.81)	1.79 (0.89)	2.41 (1.04)	4.72*** (2.76)

## List of Top 10 and Bottom 10 Inflation $\beta$ Industries

- Industry\*Time fixed effects can explain 5% of variations in stocks' inflation  $\beta$
- Firm fixed effects can explain 30% of variations
- Industries that are most and least sensitive to full-month headline CPI innovations and announcement-day core CPI innovations

Rank	$\beta^{\text{FullHead}}$		$\beta^{\text{AnnCore}}$	
	Top 10	Bottom 10	Top 10	Bottom 10
1	Petroleum and Natural Gas	Tobacco Products	Ship Building	Candy & Soda
2	Precious Metals	Restaurants & Hotels	Petroleum and Natural Gas	Beer & Liquor
3	Mining	Banking	Coal	Recreation
4	Coal	Candy & Soda	Precious Metals	Medical Equipment
5	Steel Works Etc	Insurance	Mining	Apparel
6	Agriculture	Beer & Liquor	Shipping Containers	Entertainment
7	Fabricated Products	Utilities	Defense	Agriculture
8	Ship Building	Rubber & Plastic Products	Rubber & Plastic Products	Tobacco Products
9	Machinery	Apparel	Business Supplies	Consumer Goods
10	Electrical Equipment	Shipping Containers	Wholesale	Computers

# The Timeline of Inflation Forecasting



Predicting Month  $t + 1$  Headline-CPI Innovation

	Week-8	Week-7	Week-6	Week-5	Week-4	Week-3	Week-2	Week-1
Core TMB	1.431 (0.97)	-1.268 (-0.72)	3.004** (2.06)	2.788 (1.55)	6.943*** (4.98)	2.188 (1.44)	3.091 (1.61)	0.598 (0.24)
Observations	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%
Head TMB	1.600 (1.35)	0.282 (0.18)	0.341 (0.27)	3.826* (1.69)	7.187*** (4.03)	0.528 (0.24)	3.346** (2.30)	3.945*** (3.13)
Observations	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%

# Predicting the Headline-CPI Innovations

Predicting Month  $t + 1$  Headline-CPI Innovation

Core TMB <sub><i>t</i></sub>	8.286*** (6.62)		6.372*** (5.45)		3.737*** (3.07)		7.109*** (4.35)		8.783*** (4.54)	6.924*** (3.00)
Head TMB <sub><i>t</i></sub>		7.618*** (5.54)	5.330*** (4.09)		2.978** (2.41)		5.358*** (3.40)		4.270* (1.72)	2.299 (0.96)
GSCI <sub><i>t</i></sub>				13.111*** (8.32)	11.045*** (6.76)					7.821** (2.50)
TIPS <sub><i>t</i></sub> -UST <sub><i>t</i></sub>						11.724*** (4.04)	8.417*** (3.12)			0.788 (0.30)
ISwap <sub><i>t</i></sub> <sup>1Year</sup>								18.310*** (10.11)	13.956*** (6.30)	9.969*** (3.33)
Observations	606	606	606	606	606	289	289	214	214	214
R-squared	10.2%	8.6%	13.8%	25.5%	29.4%	16.2%	27.8%	34.0%	44.7%	48.2%

- Core and Head TMB: the six-week TMB return observed by the end of month  $t$ .
- GSCI: the month- $t$  return of Goldman Sachs Commodity Index.
- TIPS-UST: difference in month- $t$  returns between TIPS and UST.
- ISwap: Change in month- $t$  1-year swap rate.

# Predicting the Core-CPI Innovations

Predicting Month $t + 1$ Core-CPI Innovation										
Core TMB <sub><i>t</i></sub>	2.459*** (3.31)		1.946** (2.47)		1.684** (2.14)		2.809** (2.59)		3.577*** (2.76)	3.673*** (2.71)
Head TMB <sub><i>t</i></sub>		2.127*** (3.09)	1.428** (1.98)		1.193 (1.64)		0.206 (0.26)		-1.207 (-1.15)	-1.105 (-1.05)
GSCI <sub><i>t</i></sub>				1.987*** (2.61)	1.1 (1.48)					-0.406 (-0.40)
TIPS <sub><i>t</i></sub> -UST <sub><i>t</i></sub>						1.869** (2.10)	1.096 (1.46)			-0.036 (-0.04)
ISwap <sub><i>t</i></sub> <sup>1Year</sup>								3.678*** (2.72)	3.029** (2.49)	3.233** (2.40)
Observations	606	606	606	606	606	289	289	214	214	214
R-squared	2.5%	1.8%	3.2%	1.6%	3.6%	2.9%	9.2%	10.1%	18.2%	18.2%

- Core and Head TMB: the six-week TMB return observed by the end of month  $t$ .
- GSCI: the month- $t$  return of Goldman Sachs Commodity Index.
- TIPS-UST: difference in month- $t$  returns between TIPS and UST.
- ISwap: Change in month- $t$  1-year swap rate.

# Out-of-Sample Forecasting Power

- At each month  $t$ , we estimate the forecasting model,  $CPI_{k+1} = a + \sum b * X_k + \epsilon_k$
- Use the estimated coefficients to forecast month- $t + 1$  inflation growth
- Forecasting error = actual value - forecast value

Model	Headline-CPI		Core-CPI	
	RMSE	Relative RMSE	RMSE	Relative RMSE
Benchmark: ARMA(1,1)	0.307%	100.0%	0.113%	100.0%
Core TMB	0.280%	91.4%	0.106%	<b>93.8%</b>
Head TMB	0.283%	92.3%	0.113%	100.0%
Core TMB + Head TMB	0.270%	<b>88.0%</b>	0.109%	95.7%
GSCI	0.254%	82.9%	0.111%	98.1%
TIP-UST	0.287%	93.6%	0.111%	98.1%
ISwap (2009)	0.188%	82.7%	0.122%	96.8%
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%
$\Delta UST1YR$	0.311%	101.4%	0.113%	99.7%
$\Delta UST10YR$	0.309%	100.6%	0.112%	98.4%

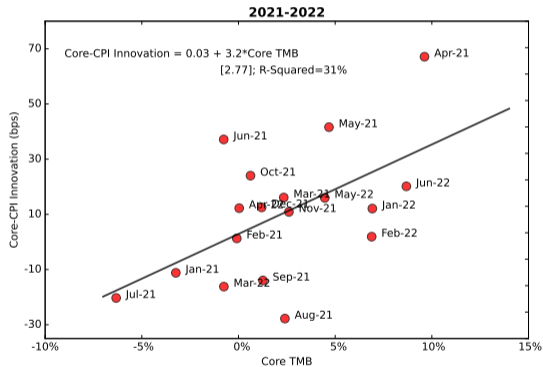
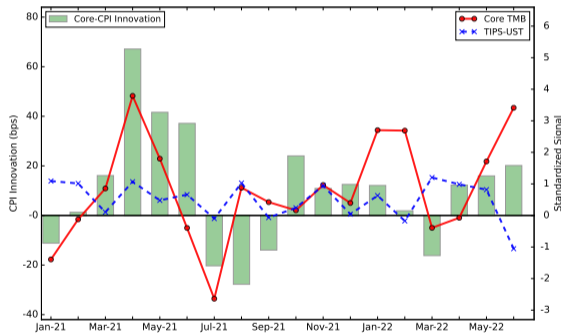
# Do Economists Update Inflation Expectations Using Equity Information?

- Change in Forecast: Bloomberg economists' forecast - ARMA(1,1) predicted value
- Forecasting Error: Actual month- $t + 1$  CPI growth - Bloomberg economists forecast

	Headline Inflation				Core Inflation			
	Change in Forecast		Forecasting Error		Change in Forecast		Forecasting Error	
Core TMB	10.145*** (4.51)	3.535 (1.38)	5.227*** (4.79)	3.922*** (2.94)	1.102* (1.71)	0.54 (1.06)	3.743*** (4.24)	4.031*** (3.61)
Head TMB		2.881 (1.13)		1.319 (1.08)		0.119 (0.25)		-1.025 (-1.05)
GSCI		6.516** (2.06)		1.018 (0.89)		0.617 (1.19)		-1.52 (-1.56)
TIPS-UST		-0.805 (-0.31)		-0.949 (-0.79)		-0.311 (-0.60)		0.462 (0.51)
ISwap <sup>1Year</sup>		9.509*** (3.51)		2.251 (1.52)		1.147* (1.85)		2.045* (1.74)
Observations	214	214	214	214	213	213	213	213
R-squared	13.7%	38.7%	15.8%	20.4%	4.4%	10.7%	11.3%	14.4%



# The 2021 Inflation Surge



# The 2021 Inflation Surge

	Core Inflation Innovation						Change in Forecast	Forecasting Error
Core TMB	10.466** (2.77)				12.518** (3.01)		2.898 (0.95)	9.643** (2.26)
Head TMB	7.348 (0.51)				-1.698 (-0.13)		1.474 (0.14)	-3.412 (-0.26)
GSCI			-2.609 (-0.39)		-4.114 (-0.77)		11.066* (1.79)	-6.586 (-1.10)
TIPS-UST			-0.208 (-0.02)		-2.853 (-0.28)		-20.694** (-2.26)	-6.136 (-0.73)
ISwap <sup>1Year</sup>					2.843 (0.40)	10.637 (1.01)	14.739 (1.31)	8.587 (0.86)
Observations	18	18	18	18	18	18	18	18
R-squared	31.5%	2.2%	0.8%	0.0%	1.0%	42.0%	31.1%	32.6%

## Out-of-Sample Relative RMSE

Core TMB	Head TMB	TIPS-UST	GSCI	ISwap	Survey	VWRETD	Real GDP	$\Delta$ UST1YR	$\Delta$ UST1YR
85.7%	101.7%	102.4%	91.1%	98.0%	102.5%	122.1%	101.6%	106.7%	98.5%

## Time-Varying Predictability – Uncertainty and Disagreement

	CPI Innovation			CPI Disagreement		
	High	Low	H-L	High	Low	H-L
Core TMB	4.166*** (3.58)	0.641 (1.03)	3.525*** (2.67)	2.763*** (2.62)	0.869 (1.44)	1.894 (1.56)
Observations	303	303		225	267	
R-squared	6.2%	0.2%		4.7%	0.8%	
Head TMB	3.203*** (3.26)	0.667 (0.77)	2.536* (1.94)	2.620*** (2.79)	0.591 (0.90)	2.029* (1.77)
Observations	303	303		225	267	
R-squared	4.1%	0.2%		3.9%	0.3%	

- |CPI Innovation|: the absolute value of CPI innovation in the last month
- CPI Disagreement: Difference between the 75th and 25th percentile of CPI forecasts
- Reported are for core-CPI innovations. Similar (and stronger) results for headline-CPI innovations.

## Time-Varying Predictability – U.S. Treasury “Distortions”

	Distance from Taylor Rule			QE Periods		
	Behind	Normal	Diff	QE	Non-QE	Diff
Core TMB	5.980*** (3.17)	0.082 (0.10)	5.899*** (2.86)	5.973*** (2.69)	0.707 (0.86)	5.266** (2.25)
Head TMB	0.994 (0.52)	1.335* (1.97)	-0.341 (-0.17)	0.667 (0.26)	1.217* (1.91)	-0.550 (-0.21)
TIPS-UST	1.174 (0.95)	-0.146 (-0.18)	1.321 (0.89)	2.023 (1.38)	0.021 (0.03)	2.002 (1.27)
Observations	96	193		76	213	
R-squared	23.7%	3.0%		22.0%	4.4%	

- Behind: when the fed fund target rate is below that implied by the Taylor rule.
- QE Periods: when the Fed perform quantitative easing.

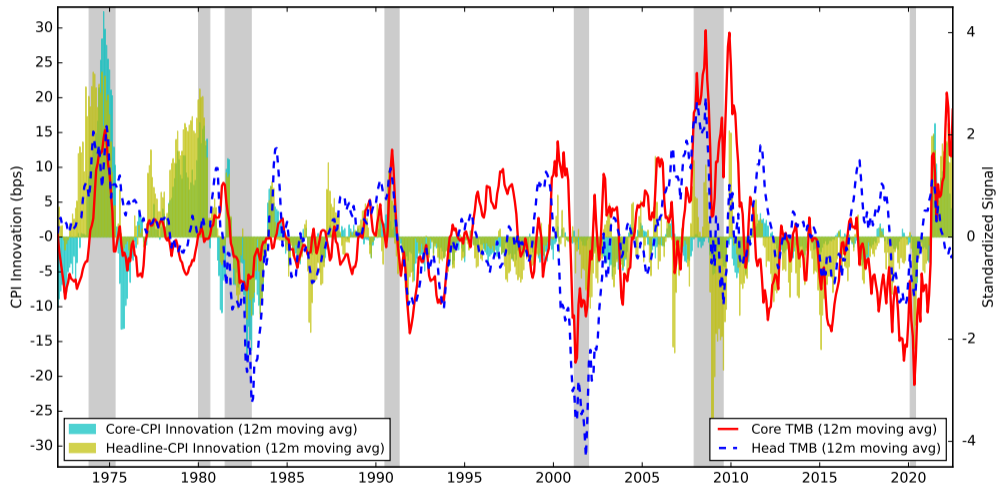
## Other Discussions

- Determinants of CPI- $\beta$ ? Who are the top and bottom CPI- $\beta$  stocks?
  - ▶ Industry\*Time FE (R2 of 5%), Firm FE (R2 of 30%)
  - ▶ Individual firm CPI- $\beta$  dominates industry CPI- $\beta$
- Is variation in Core TMB driven by time-varying risk premium?
  - ▶ Stocks with more negative  $\beta^{\text{AnnCore}}$  are not with higher return unconditionally, nor when conditional on the nominal-real covariance (Boons et al., 2020).
- Which Components of Headline and Core CPI drive the predictability?
  - ▶ Energy (Headline), Goods and Service Components (Core)
- Implications on firm future cash flows
  - ▶ Firms with more negative  $\beta^{\text{AnnCore}}$  and  $\beta^{\text{FullHead}}$  become less profitable (ROE  $\downarrow$ ) and invest less (ATG  $\downarrow$ ) during heightened inflation periods.

# Conclusions

- Compelling evidences of active price discovery on inflation in cross-sectional stocks:
  - ▶ Fresh and non-redundant information above and beyond other asset classes.
  - ▶ Not yet incorporated by the economists' forecasts.
  - ▶ Unique and unparalleled predictability for core inflation.
  - ▶ Stronger predictability
    - ★ During the 2021 and 1973 inflation surge.
    - ★ When the US Treasury is under QE and when the Fed is behind the curve.
  - ▶ Relate to literature on inflation forecasting: [Ang, Bekaert, and Wei \(2007\)](#), [Frost and Wright \(2013\)](#). [Downing, Longstaff, and Rierson \(2012\)](#).
- Methodological contribution:
  - ▶ The announcement-day approach for core-inflation exposure.
  - ▶ Relate to literature on the pricing of inflation: [Chen, Roll, and Ross \(1986\)](#), [Boons et al. \(2020\)](#), [Ajello, Benzoni, and Chyruk \(2020\)](#), [Fang, Liu, and Roussanov \(2021\)](#).

# The Core- and Headline-Focused TMB Portfolios



## Time-Varying Risk Premium?

- Following Boons et al. (2020):  $R_{t+1,t+k} = a + b * NRC_t + \epsilon_{t+1,t+k}$

		Q1	Q2	Q3	Q4	Q5	TMB
K=1	Intercept	12.476*** (4.48)	13.452*** (5.70)	13.343*** (5.79)	13.276*** (5.39)	13.746*** (4.72)	1.27 (1.14)
	NRC	-1.706 (-0.64)	-1.835 (-0.76)	-1.631 (-0.70)	-2.493 (-0.98)	-2.075 (-0.72)	-0.369 (-0.34)
K=3	Intercept	12.672*** (5.13)	13.634*** (6.52)	13.492*** (6.69)	13.416*** (6.23)	13.898*** (5.46)	1.31 (1.26)
	NRC	-1.369 (-0.55)	-1.837 (-0.82)	-1.615 (-0.76)	-2.463 (-1.07)	-1.854 (-0.71)	-0.618 (-0.63)
K=12	Intercept	13.175*** (5.58)	14.166*** (7.15)	13.978*** (7.56)	13.925*** (6.93)	14.292*** (6.28)	1.409 (1.34)
	NRC	-1.408 (-0.57)	-2.141 (-1.05)	-1.863 (-0.98)	-2.649 (-1.32)	-1.942 (-0.86)	-0.524 (-0.49)



# Components of CPI

- Energy component in headline inflation
- Goods and Service Components in Core inflation

Inflation Exposure: Post-Ranking Beta						
Quintile	Full Month			Announcement Day		
	Headline	Energy	Food	Core	Goods	Service
1	-3.51	-4.97	-15.92	-2.31	-2.89	-1.83
2	-7.10	-6.86	-16.69	1.04	-2.39	-0.08
3	-3.97	0.32	-18.50	1.52	-1.53	1.52
4	1.46	5.28	-21.01	1.79	-0.29	2.31
5	39.07	29.34	-19.41	2.41	0.11	1.24
5-1	42.58*** (3.09)	34.31** (2.12)	-3.49 (-0.45)	4.72*** (2.76)	3.00* (1.73)	3.06** (2.01)

# Components of CPI

- Energy component in headline inflation
- Goods and Service Components in Core inflation

Predicting Headline CPI innovation						
	$\beta^{\text{FullHead}}$	$\beta^{\text{FullEnergy}}$	$\beta^{\text{FullFood}}$	$\beta^{\text{AnnCore}}$	$\beta^{\text{AnnGoods}}$	$\beta^{\text{AnnService}}$
TMB	7.618*** (5.54)	7.756*** (5.04)	-1.305 (-0.98)	8.286*** (6.62)	6.340*** (5.45)	3.243*** (2.70)
Observations	606	606	606	606	606	580
R-squared	8.6%	8.9%	0.3%	10.2%	6.0%	1.6%
Predicting Core CPI innovation						
TMB	2.127*** (3.09)	2.295*** (3.59)	-0.674 (-0.98)	2.459*** (3.31)	2.159*** (2.94)	-0.39 (-0.70)
Observations	606	606	606	606	606	580
R-squared	1.8%	2.1%	0.2%	2.5%	1.9%	0.1%

# Industry vs. Stock-Level Inflation Exposure

Predictability of Industry vs. Stock Portfolios						
	Headline Innovation			Core Innovation		
Core TMB <sup>Industry</sup>	4.586*** (3.69)		2.657** (2.13)	0.648 (1.04)		-0.093 (-0.15)
Head TMB <sup>Industry</sup>	4.479*** (3.69)		0.486 (0.40)	1.397** (2.37)		0.271 (0.40)
Core TMB		6.372*** (5.45)	5.152*** (4.27)		1.946** (2.47)	1.962** (2.34)
Head TMB		5.330*** (4.09)	5.120*** (3.52)		1.428** (1.98)	1.277 (1.52)
Observations	606	606	606	606	606	606
R-squared	7.6%	13.8%	14.8%	1.2%	3.2%	3.2%