What Can Cross-Sectional Stocks Tell Us About Core Inflation Shocks?

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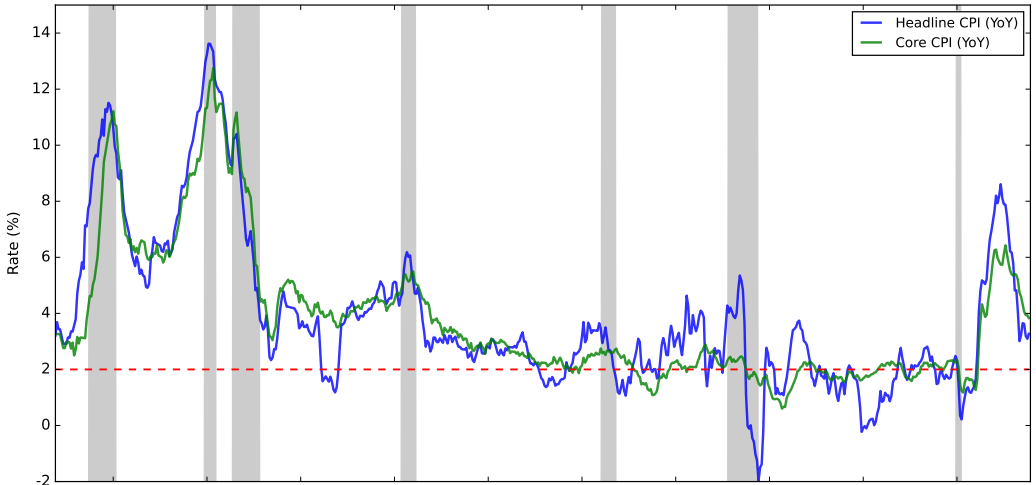
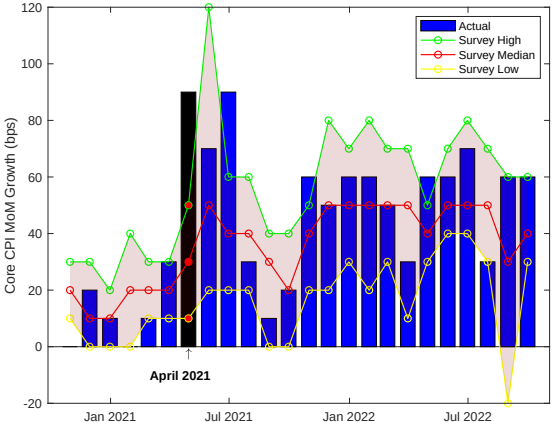
Motivation: The Post-Covid Inflation Surge

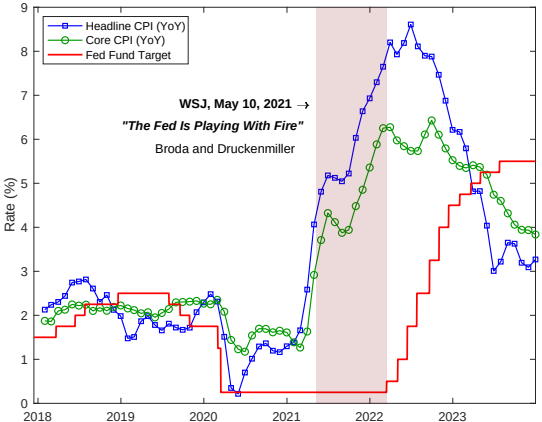


Policy Makers and Economists in 2021

Economists Forecasts



Monetary Policy



Inflation Forecasting Using Information From Financial Markets

- **Treasury Bonds:** Nominal Yield (UST) = Inflation + Real Rate (TIPS)
  - Nominal U.S. Treasury Bonds (UST):
    - ⋆ Influenced by expectations of monetary policy.
    - ⋆ Distorted by government interventions (e.g., QE).
    - ⋆ Episodes of flights-to-safety.
  - TIPS: Illiquidity adds noise to the breakeven inflation forecasts.
- **Aggregate Stock:** Also influenced by expectations of monetary policy.
- **Commodities:** Rich information on headline CPI, but not core.

Inflation Forecasting Using Information From Cross-Sectional Stocks

- **The Cross-Sectional Approach:**
  - Identify stocks with high- and low-inflation exposures.
  - Use their relative pricing to predict future inflation shocks.
  - Minimize the influence of the aggregate market.
- **The Information Channel:**
  - The same inflation shock can affect different firms' cash flows differently.
  - Estimates of the future cash flows are *priced in* today's stock prices.
  - Cross-sectional stocks can be used to predict the future inflation shock.
- **An Analogy to 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.
  - OJ futures can predict subsequent errors in temperature forecasts.

Summary of Main Results

- **Inflation exposure:** Significant and persistent cross-sectional spread in core inflation exposure.
- **The cash-flow channel:** Firms with positive inflation exposure later experience increased cash flow as inflation rises.
- **Inflation forecasting:** The relative pricing of stocks with diverging core inflation exposures significantly predicts core inflation shocks and economists' forecasting errors.

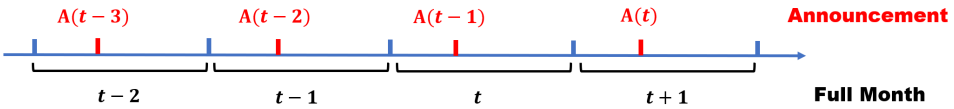
Related Literature

- Cross-Sectional Inflation Risk Premium:
  - Chen, Roll, and Ross (1986), Boons et al. (2020).
- Pricing Impact of Core vs. Headline Inflation:
  - Ajello, Benzoni, and Chyruk (2020), Fang, Liu, and Roussanov (2021).
- Inflation Forecasting:
  - Surveys are the best: Ang, Bekaert, and Wei (2007), Frost and Wright (2013);
  - Using industry portfolios: Downing, Longstaff, and Rierson (2012);
  - Using aggregate stock market: Titman and Warga (1989).
- Our Paper:
  - **Inflation Exposure:** Information-based beta for core CPI, and risk-based beta for headline CPI.
  - **Inflation Forecast:** The cross-sectional inflation portfolio (IP) significantly predicts core inflation shocks and the economists' forecasting errors.

Part I: Inflation Exposure – Estimation

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

$$R_t^i - r_f = \alpha + \beta_i \, \text{Innov}_t + \beta_i^{\text{M}} \left(R_t^M - r_f \right) + \epsilon_t^i$$



- **Risk-based beta for headline CPI:**
  - β^{Full}: month-t returns regressed on the contemporaneous CPI innovations.
  - Price discovery of headline CPI takes place through the inflation experiences.
- **Information-based beta for core CPI:**
  - β^{Ann}: announcement-day returns regressed on CPI innovations.
  - Price discovery of core CPI occurs at the CPI announcements.

Part I: Inflation Exposure – Inflation Beta Across Asset Classes

Core and Headline Inflation Beta
(standardized by asset return volatility)

	Ann-Day (β^{Ann})		Full-Month (β^{Full})		Sample Period
	Core	Headline	Core	Headline	
IP (Cross Section)	0.11** (2.49)	0.07 (0.98)	0.03 (0.50)	0.17*** (3.07)	1972-2023
Δy^{10YR}	0.12** (2.40)	0.06 (1.09)	0.10* (1.72)	0.20*** (4.08)	1972-2023
GSCI	0.06* (1.84)	-0.01 (-0.20)	0.04 (0.74)	0.22*** (4.12)	1972-2023
Aggregate Stock	-0.12*** (-2.82)	0.01 (0.06)	-0.11** (-2.43)	-0.06 (-0.94)	1972-2023
TIPS – UST	0.22*** (4.09)	0.25** (2.58)	0.05 (0.70)	0.31*** (2.87)	1998-2023

Part I: Inflation Exposure – Cross-Sectional Stocks

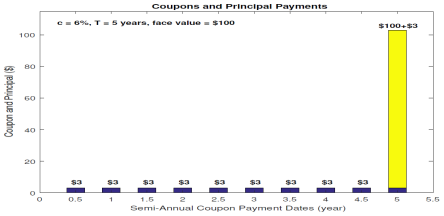
Post-Ranking Inflation Beta				
	Ann-Day (β^{Ann})		**Full-Month (β^{Full})**	
	Core	Headline	Core	Headline
Q1	-2.19	-1.10	-11.77	-1.86
	(-1.14)	(-0.52)	(-0.89)	(-0.16)
Q2	0.75	1.27	-8.47	-5.31
	(0.44)	(0.62)	(-0.95)	(-0.62)
Q3	1.75	1.20	-15.97**	-2.42
	(0.92)	(0.59)	(-2.01)	(-0.31)
Q4	2.10	2.55	-11.87	3.44
	(1.01)	(1.11)	(-1.38)	(0.39)
Q5	2.37	1.43	-6.27	39.75***
	(1.01)	(0.50)	(-0.54)	(2.68)
Q5-Q1	4.56**	2.53	5.50	41.62***
	(2.49)	(0.98)	(0.50)	(3.07)
	IP$^{\text{Core}}$			**IP$^{\text{Head}}$**

Part I: Inflation Exposure – Determinants of Inflation Beta

Dependent Variable = Core Inflation Beta						
Log(Size)	0.025*	0.027**	0.024*	0.019	0.021	0.011
	(1.95)	(2.16)	(1.90)	(1.50)	(1.58)	(0.83)
CF Beta	0.032***	0.031***	0.031***	0.031***	0.033***	0.031***
	(3.16)	(3.09)	(3.08)	(3.01)	(3.20)	(3.04)
ME/BE		-0.029**	-0.037**	-0.027**	-0.015	-0.002
		(-2.08)	(-2.55)	(-2.22)	(-1.25)	(-0.21)
Cash Flow			0.032***	0.040***	0.047***	0.032***
			(2.95)	(3.51)	(4.13)	(3.18)
Div Payout				0.019***	0.018**	0.012*
				(2.68)	(2.55)	(1.84)
CF Duration					-0.029**	-0.037***
					(-2.11)	(-2.68)
Time FE	Y	Y	Y	Y	Y	Y
Industry FE	N	N	N	N	N	Y
Adj. R^2	1.3%	1.4%	1.5%	1.9%	2.0%	3.4%

Higher inflation beta stocks have higher cashflow betas.

Higher inflation beta stocks offer more immediate cash flow.



Q5 relative to Q1:

lower mkt-to-book (value)

higher cash flow

higher dividend payout

lower duration

Part II: An Illustrative Model – Inflation Shock ϵ^{π}_{t+1} and its Predictor y_t

- For econometricians, the time-$t+1$ inflation π_{t+1} follows

$$\pi_{t+1} = \mu^{\pi}_{t} + \sigma_{\pi}\epsilon^{\pi}_{t+1}\,,$$

where μ^{π}_{t} is the econometrician's forecast and ϵ^{π}_{t+1} is the inflation shock.

- For market participants,

$$\epsilon^{\pi}_{t+1} = y_t + \epsilon_{t+1}\,,$$

where y_t represents their superior information on the inflation shock, and $y_t = \sigma_y \epsilon^{y}_{t}$.

- The riskfree rate follows

$$r_t = \mu_r + \alpha\, y_t + \sigma_r \epsilon^{r}_{t}\,,$$

where the predictor y_t can influence the short rate r_t via the constant coefficient α.

Part II: An Illustrative Model – Pricing Under the Cash Flow Channel

- The time-$t+1$ dividend for stock i is

$$D^i_{t+1} = D^i_t \exp\left(\mu_i + b_i \sigma_\pi \epsilon^\pi_{t+1} - \frac{1}{2}\sigma_i^2 + \sigma_i \epsilon^i_{t+1}\right),$$

  where b_i captures the cash flow inflation exposure for stock i.
- The time-t market price of stock i with parameter θ_i is

$$S^i_t = \mathrm{E}^Q_t\left[\sum_{\tau=1}^{\infty} \exp\left(-\sum_{u=0}^{\tau-1} r_{t+u}\right) D^i_{t+\tau}\right] = D^i_t\, f(y_t, \theta_i),$$

  with price-dividend ratio

$$f(y_t, \theta_i) = \frac{S^i_t}{D^i_t} = \frac{\exp\left(\left(b_i\sigma_\pi - \alpha\right) y_t + \mu_i - \mu_r - \sigma_r \epsilon^r_t + \frac{1}{2} b_i^2 \sigma_\pi^2\right)}{1 - e^{-\left(\mu_r - \mu_i - \frac{1}{2}(\sigma_r^2 + b_i^2\sigma_\pi^2 + (b_i\sigma_\pi - \alpha)^2 \sigma_y^2)\right)}},$$

  where b_i captures the cashflow channel and α the riskfree rate channel.

Part II: An Illustrative Model – The Long/Short Inflation Portfolio

- **Proposition Beta**
  - We estimate stock i's inflation beta β_i via

$$\ln\left(\frac{S^i_{t+1}}{S^i_t}\right) = a_i + \beta_i \,\text{Inflation Shock}_{t+1} + u^i_{t+1}\,, \text{ where } \beta_i = \frac{b_i\sigma^2_\pi + \sigma_\pi\alpha\sigma^2_y}{\sigma^2_\pi(1+\sigma^2_y)}.$$

  - For the cross-section inflation portfolio (**IP**) that longs β^i stocks and shorts β^j stocks, its inflation exposure is $\beta_i - \beta_j = \dfrac{b_i - b_j}{1+\sigma^2_y}$.
- **Proposition Gamma**

$$\text{Inflation Shock}_{t+1} = a + \gamma\,\mathbf{IP}_t + \epsilon_{t+1}\,,$$

where

$$\gamma = \frac{(b_i - b_j)\,\sigma^2_\pi}{(b_i-b_j)^2\sigma^2_\pi(1+1/\sigma^2_y) + (\sigma^2_i + \sigma^2_j - 2\rho_{ij}\sigma_i\sigma_j)/\sigma^2_y}\,.$$

Part III: Cash Flow vs Risk Premium – The Cash-Flow Channel

Conditioning on high $\text{IP}_t^{\text{Core}}$ (i.e., high y_t), firms with higher β^{Core} have higher $t+1$ cashflow.

$$D_{t+1}^i = D_t^i \exp\left(\mu_i + b_i \sigma_\pi \epsilon_{t+1}^\pi - \frac{1}{2}\sigma_i^2 + \sigma_i \epsilon_{t+1}^i\right)$$

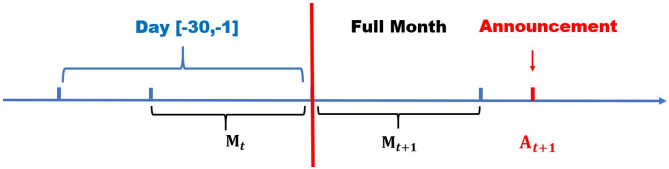
	Sales Growth$_{t+1}$		Cash Flow$_{t+1}$		IBES LTG$_{t+1}$		Return$_{t+1}$	
$\beta^{\text{Core}}_{\text{Rank}} \times \text{IP}_t^{\text{Core}}$	0.196***	0.177***	0.178***	0.142***	0.109**	0.145***	-0.133	-0.155
	(3.69)	(3.11)	(3.76)	(3.09)	(2.24)	(2.76)	(-0.97)	(-1.14)
$\beta^{\text{Core}}_{\text{Rank}}$	0.002	0.002	0.001	0.003	-0.005**	-0.003	0.001	0.001
	(0.62)	(0.71)	(0.34)	(1.48)	(-2.23)	(-1.38)	(0.31)	(0.39)
Log(Size)	-0.024**	-0.093***	0.198***	0.119***	-0.006	-0.001	-0.519***	-0.476***
	(-2.00)	(-7.11)	(13.76)	(8.46)	(-0.70)	(-0.16)	(-16.64)	(-16.63)
Lag(Y)	-0.291***	-0.337***	0.384***	0.341***	-0.079***	-0.079***	-0.006	-0.013
	(-18.05)	(-20.38)	(26.02)	(21.06)	(-6.06)	(-6.04)	(-0.50)	(-1.00)
Asset Growth		0.199***		0.027***		0.008***		0.002
		(16.55)		(5.90)		(3.33)		(0.67)
ME/BE		0.083***		0.165***		0.011**		-0.013
		(9.93)		(17.29)		(2.19)		(-1.34)
Dividend payout		0.006		-0.031***		0.019***		-0.025***
		(1.32)		(-8.48)		(4.76)		(-4.92)
Time FE	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	167,559	150,573	168,021	150,917	137,358	124,181	173,512	152,867
Adj. R^2	10.9%	14.4%	58.6%	58.4%	2.7%	3.5%	29.8%	29.8%

Part III: Cash Flow vs Risk Premium – The Inflation Risk Premium

We do no find evidence that the core inflation risk is priced.

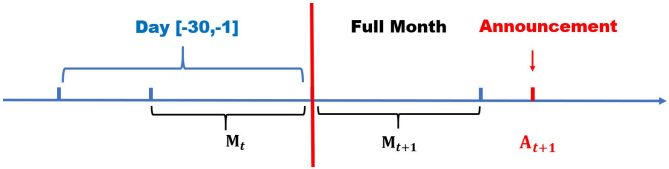
	Mean Excess Returns (annualized in %)					
	β^{Core}-Sorted Portfolios			β^{Head}-Sorted Portfolios		
	Full sample	Pre-2002	Post-2002	Full sample	Pre-2002	Post-2002
Q1	8.45	7.04	10.52	9.78	8.91	11.07
	(3.19)	(2.01)	(2.60)	(3.67)	(2.50)	(2.79)
Q2	9.48	7.81	11.94	9.63	8.06	11.96
	(4.19)	(2.63)	(3.42)	(4.17)	(2.64)	(3.41)
Q3	9.21	7.69	11.46	9.50	7.99	11.73
	(4.13)	(2.66)	(3.26)	(4.23)	(2.76)	(3.29)
Q4	8.86	7.45	10.95	9.16	7.49	11.62
	(3.70)	(2.46)	(2.81)	(3.91)	(2.50)	(3.10)
Q5	9.63	7.68	12.52	7.61	5.32	11.00
	(3.41)	(2.13)	(2.76)	(2.67)	(1.47)	(2.38)
Q5-Q1	1.19	0.63	2.00	-2.17*	-3.59**	-0.07
	(1.06)	(0.61)	(0.87)	(-1.68)	(-2.23)	(-0.03)

Part IV: Inflation Forecasting – CPI Innovations



	Core-CPI Innovation					Headline-CPI Innovation				
IP^{Core}	2.235***	1.653**	2.591***	2.394**		7.901***	4.476***	8.858***	5.556***	
	(2.98)	(2.30)	(2.79)	(2.47)		(6.54)	(3.84)	(5.45)	(2.97)	
IP^{Head}					0.703					4.994***
					(1.13)					(3.22)
GSCI		1.803**		0.715	1.351		10.615***		12.003***	12.331***
		(2.23)		(0.71)	(1.30)		(6.94)		(5.95)	(6.32)
TIPS-UST			1.352*	1.014	1.002			8.021***	2.348	2.025
			(1.75)	(1.30)	(1.32)			(2.63)	(0.74)	(0.66)
Intercept	-0.072	-0.072	-0.835	-0.835	-0.835	-0.012	-0.012	-1.942	-1.942	-1.942
	(-0.12)	(-0.12)	(-1.37)	(-1.37)	(-1.34)	(-0.01)	(-0.01)	(-1.32)	(-1.42)	(-1.42)
Observations	624	624	308	308	308	624	624	308	308	308
Adj. R^2	1.9%	2.9%	7.5%	7.5%	3.8%	9.1%	24.0%	20.3%	31.3%	30.6%

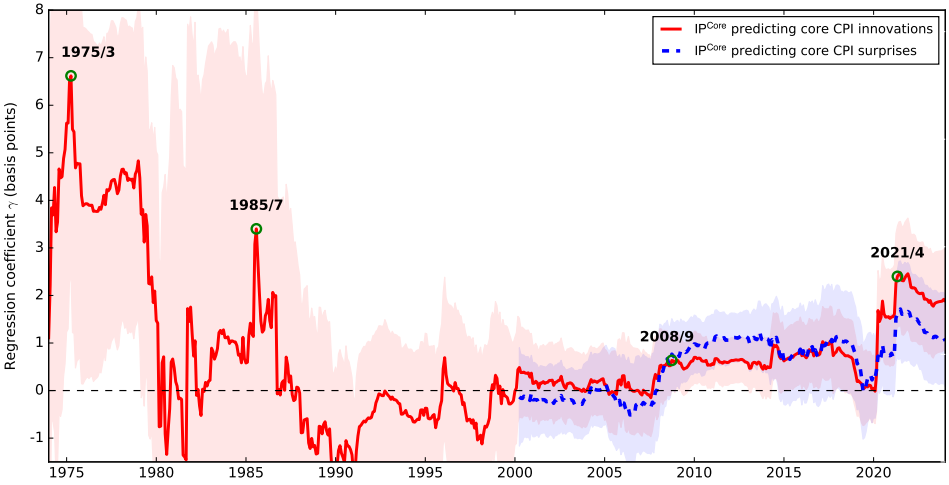
Part IV: Inflation Forecasting – Economists' Forecasting Errors



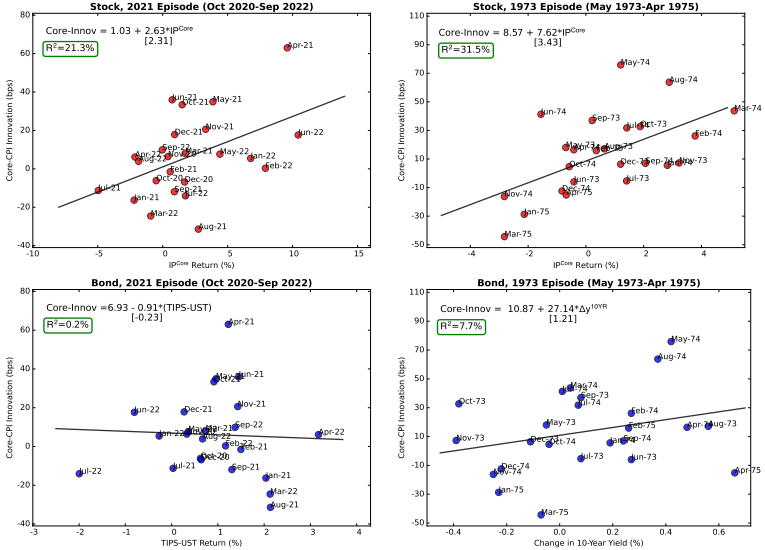
	Core-CPI Forecasting Error					Headline-CPI Forecasting Error				
IP^{Core}	2.300***	2.326***	2.137***	2.308***		3.786***	2.583**	3.594***	2.597**	
	(3.10)	(2.72)	(2.85)	(2.70)		(4.22)	(2.54)	(3.93)	(2.57)	
IP^{Head}					0.113					1.953**
					(0.17)					(2.54)
GSCI		-0.068		-0.626	0.180		3.194***		3.625***	3.908***
		(-0.09)		(-0.67)	(0.21)		(3.49)		(3.98)	(4.76)
TIPS-UST			0.757	1.055	1.092			0.893	-0.82	-0.938
			(1.31)	(1.44)	(1.60)			(0.84)	(-0.73)	(-0.86)
Intercept	-0.23	-0.229	-0.227	-0.225	-0.225	0.097	0.097	0.097	0.097	0.097
	(-0.38)	(-0.38)	(-0.37)	(-0.37)	(-0.36)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Observations	307	307	307	307	307	308	308	308	308	308
Adj. R^2	4.1%	3.8%	4.3%	4.2%	0.3%	8.2%	13.1%	8.3%	13.1%	11.6%

Part IV: Inflation Forecasting – Time-Varying Predictability

$$\text{Inflation Shock}_{t+1} = a + \gamma\, \mathbf{IP}_t^{\mathbf{Core}} + \epsilon_{t+1}$$



Part IV: Inflation Forecasting – Inflation Surges of 2021 and 1973



Part IV: Inflation Forecasting – When is Our IP Core More Informative?

- When the Fed is behind the curve

	Behind the Curve		Other Months	
	Core Innov	Core Surprise	Core Innov	Core Surprise
IP^{Core}	4.266***	2.980***	0.864	1.920*
	(3.16)	(3.48)	(1.23)	(1.86)
Adj. R^2	6.9%	5.9%	0.1%	2.8%

- When the SPF forecast is more dispersed; and when inflation uncertainty is high

	High Disagreement		Low Disagreement	
	Core Innov	Core Surprise	Core Innov	Core Surprise
IP^{Core}	2.474**	2.946***	0.939	1.005
	(2.25)	(2.89)	(1.46)	(1.26)
Adj. R^2	3.3%	6.3%	0.6%	0.3%

	High Uncertainty		Low Uncertainty	
	Core Innov	Core Surprise	Core Innov	Core Surprise
IP^{Core}	3.918***	2.900**	0.442	1.815**
	(3.34)	(2.39)	(0.70)	(2.38)
Adj. R^2	5.4%	5.1%	-0.2%	3.1%

- When IP Core is extracted from stocks that are more efficiently priced

	Y= Core-CPI Innovation								
	X = Size			X=Institutional Ownership			X=Analyst Coverage		
IP^{Core} (X>Median)	2.235***		2.025***	2.701***		2.710***	2.062***		1.790**
	(2.98)		(2.69)	(3.47)		(3.22)	(2.66)		(2.21)
IP^{Core} (X≤Median)		1.359*	0.488		1.204	-0.02		1.473**	0.5
		(1.84)	(0.69)		(1.56)	(-0.03)		(2.36)	(0.90)
Adj. R^2	1.9%	0.6%	1.8%	3.4%	0.5%	3.2%	1.8%	0.9%	1.8%

Part IV: Inflation Forecasting – Predicting Inflation-Sensitive Securities

	Dependent Variable = Change in Inflation Swap Rate (%)				
	1 Year	2 Year	5 Year	10 Year	30 Year
IP^{Core}	0.194***	0.129**	0.067**	0.038**	0.025*
	(2.93)	(2.48)	(2.22)	(2.23)	(1.78)
Observations	234	233	233	234	233
Adj. R^2	7.6%	6.1%	4.8%	3.3%	1.5%
	Dependent Variable = Change in Nominal Yield (%)				
	1 Year	2 Year	5 Year	10 Year	30 Year
IP^{Core}	0.117***	0.102***	0.077***	0.056***	0.045***
	(3.87)	(3.70)	(3.56)	(3.15)	(2.76)
Observations	624	571	624	624	563
Adj. R^2	2.4%	2.2%	1.7%	1.2%	1.0%

- Change in rate: from the end of month t to the CPI announcement day of month $t+1$.

Conclusions

- **Inflation Exposure** – Methodological contribution on estimating stock-level inflation exposure:
  - Information-based beta for core CPI using the announcement-day approach.
  - Risk-based beta for headline CPI using the full-month approach.
- **Inflation Forecast** – Active price discovery on inflation in cross-sectional stocks through the cash flow channel:
  - Unique predictability for core inflation shocks, both relative to a benchmark model and to the economists' forecasts.
  - Stronger predictability during heightened inflation episodes.
- **The Bigger Picture** – Macro shocks can have heterogeneous impact on the cross-section of stocks. Under efficient market pricing, the information contained in the cross-sectional pricing can be extracted to infer the market's expectation of the future macro shocks.

Industry Loadings β^{Ind} of Inflation Portfolios (IP)

$$\text{IP}_t = \alpha + \beta^{\text{Ind}} \left(R_t^{\text{Ind}} - r_f \right) + \beta^{\text{M}} \left(R_t^{M} - r_f \right) + \epsilon_t$$

Industry Loadings β^{Ind} of IP Core

	Manuf	Enrgy	Money	Other	Utils	Telcm	Chems	Durbl	NoDur	BusEq	Hlth	Shops
Full Sample	0.258***	0.155***	0.136***	0.093***	0.018	0.012	-0.009	-0.045***	-0.062***	-0.063***	-0.124***	-0.246***
	(11.81)	(19.53)	(6.95)	(4.94)	(1.38)	(1.23)	(-0.62)	(-4.92)	(-3.80)	(-5.57)	(-10.96)	(-18.70)
2021 Episode	0.848***	0.203***	0.775***	0.758***	0.407***	0.281***	0.733***	-0.100***	0.696***	-1.060***	-0.106	-0.351***
	(16.99)	(11.22)	(12.47)	(6.82)	(8.77)	(4.90)	(10.31)	(-5.05)	(9.00)	(-19.46)	(-1.52)	(-4.83)
1973 Episode	-0.088*	0.088***	-0.072*	0.063	0.064**	0.046**	-0.081**	-0.022	-0.072	-0.009	-0.058**	-0.122***
	(-1.76)	(3.26)	(-1.85)	(1.33)	(2.09)	(2.12)	(-2.37)	(-0.90)	(-1.54)	(-0.38)	(-2.37)	(-4.01)

Industry Loadings β^{Ind} of IP Headline

	Enrgy	Manuf	BusEq	Utils	Telcm	Other	Chems	Durbl	Hlth	Money	NoDur	Shops
Full Sample	0.190***	0.171***	0.023*	-0.001	-0.020	-0.032	-0.052***	-0.055***	-0.134***	-0.166***	-0.202***	-0.324***
	(18.26)	(8.30)	(1.77)	(-0.04)	(-1.56)	(-1.13)	(-3.67)	(-6.11)	(-11.50)	(-7.86)	(-12.79)	(-19.53)
2021 Episode	0.057***	0.405***	-0.377***	0.063*	0.026	0.429***	0.193***	0.003	-0.229***	0.304***	0.146***	-0.150***
	(3.72)	(11.50)	(-8.05)	(1.86)	(0.76)	(7.16)	(4.29)	(0.30)	(-5.79)	(11.32)	(3.52)	(-2.82)
1973 Episode	0.042	0.160***	0.047**	0.060	0.013	-0.223***	0.021	0.030	-0.041	-0.166***	-0.250***	-0.123***
	(1.55)	(2.80)	(2.04)	(1.60)	(0.51)	(-4.42)	(0.52)	(1.15)	(-1.39)	(-3.90)	(-4.70)	(-4.15)

Inflation Forecasting – Cross-Industry vs. Cross-Stock Inflation Portfolios

	Core-CPI Innovation			Headline-CPI Innovation		
IP^{Core}_{Ind}	1.009*		0.057	5.621***		2.725**
	(1.69)		(0.10)	(4.32)		(2.18)
IP^{Core}		2.235***	2.210***		7.901***	6.729***
		(2.98)	(2.81)		(6.54)	(5.59)
Intercept	-0.072	-0.072	-0.072	-0.012	-0.012	-0.012
	(-0.12)	(-0.12)	(-0.12)	(-0.01)	(-0.01)	(-0.01)
Observations	624	624	624	624	624	624
Adj. R^2	0.3%	1.9%	1.7%	4.5%	9.1%	9.9%