Getting to the Core: Inflation Risks Within and Across Asset Classes

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Introduction

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  - One of the most important topics of the time
  - The financial market highly sensitive to inflation news

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- Which assets can protect against inflation, and at what cost?
  - Conventional wisdom: currencies, commodities, and real estate are hedges, stocks are "real" assets
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- Challenging to identify macro factors that matter for investors and their compensation, especially inflation
- Which assets can protect against inflation, and at what cost?
  - Conventional wisdom: currencies, commodities, and real estate are hedges, stocks are "real" assets
  - Empirically, the price of inflation risk is ambiguous
- This paper
  - Decomposes inflation into core and noncore components - in particular, energy
  - Uses data from 8 asset classes and shows that conventional wisdom tells only part of the truth

Main Findings

- Inflation hedging
  - None of the 8 asset classes hedge against core inflation
  - Conventional “real" assets hedge against energy inflation
- Price of inflation risk
  - Core inflation carries a negative risk premium, with magnitude **consistently estimated within and across asset classes**
- New insights on driver of the changing stock-bond correlation
- Two-sector NK model that qualitatively accounts for the facts

Related Literature

- Inflation hedging
  - Fama and Schwert (1977), Fama (1981), Boudoukh and Richardson (1993), Bekaert and Wang (2010), Katz, Lustig, and Nielsen (2017)
- Inflation risk premium
  - Chen, Roll, and Ross (1986), Hollifield and Yaron (2003), Ang, Bekaert, and Wei (2008), Ajello, Benzoni, and Chyruk (2019), Boons, Duarte, de Roon, and Szymanowska (2019), Cooper, Mitrache, and Priestley (2020), Andrews, Colacito, Croce, and Gavazzoni (2021)
- Equilibrium models of inflation, macroeconomy, asset prices
  - Buraschi and Jiltsov (2005), Wachter (2006), Piazzesi and Schneider (2006), Bansal and Shaliastovich (2012), Kung (2015), Kang and Pflueger (2015), Weber (2015), Gomes, Jermann, and Schmid (2016), Eraker, Shaliastovich, and Wang (2016), Bhamra, Dorion, Jeanneret, and Weber (2020), Pflueger and Rinaldi (2021)
- Stock-bond correlation
  - Song (2016), Campbell, Sundarem, and Viceira (2017), Campbell, Pflueger, and Viceira (2019), Cieslak and Pang (2020)
- Commodity prices, inflation, and other asset classes
  - Barro and Misra (2016), Ready, Roussanov, and Ward (2017, 2018), Ready (2017, 2018), Bakshi, Gao, and Rossi (2019)

Empirics

Inflation Summary Statistics

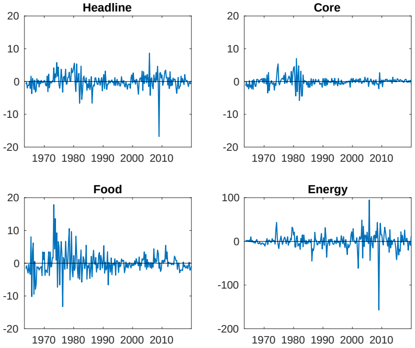
	Headline	Core	Food	Energy
		A. Summary Statistics		
Mean	3.76	3.75	3.75	4.01
Std	3.24	2.66	4.04	19.52
Persist	0.60	0.79	0.43	0.04
		B. Contribution to Headline		
	1.00	0.71	0.20	0.09
		C. Correlation		
Headline	1.00			
Core	0.80	1.00		
Food	0.60	0.44	1.00	
Energy	0.69	0.20	0.17	1.00

Sample: 1963Q3 to 2019Q4

- Similar mean, different volatility and persistence
- Core accounts for the largest portion
- Though a small share, energy inflation volatility makes it important

Inflation Shocks

- VAR, $Y_t = c + AY_{t-1} + u_t$, u_t as shocks
- Y_t includes headline inflation and its components, p/d ratio, risk-free rate, and output gap



- Alternative: using survey data to extract shocks

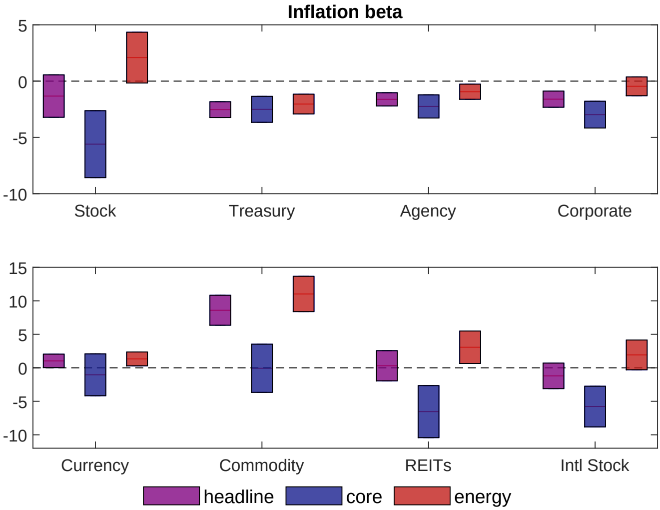
VAR details

Portfolios

Wide and standard asset classes

- 8 asset classes: stock, Treasury, agency bond, corporate bond, currency, commodity future, REITs, and international stock
- An average portfolio in each asset class
- A cross-section in each asset class, in total 38 portfolios
  portfolios
- An expanded cross-section in each class for within-class study

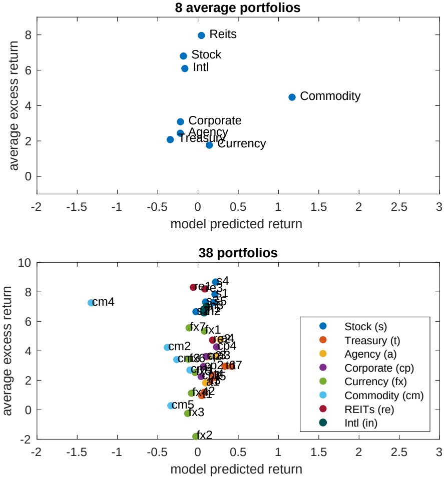
Inflation Betas of 8 Asset Classes



8-asset betas
38-asset betas

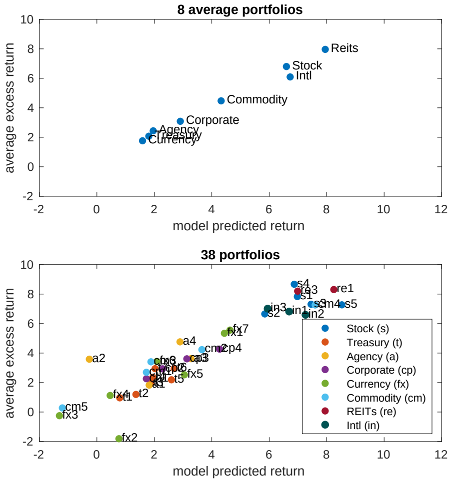
Expected Return Data vs. Model: Headline

Model: $E[R] = \lambda' \beta$ estimated with headline inflation risk



Expected Return Data vs. Model: Core and Energy

Model: $E[R] = \lambda' \beta$ estimated with core and energy inflation risk



Core Inflation Factor Mimicking Portfolios

- Portfolio weights $\omega = (\beta\beta')^{-1}\beta$, where β's are the first-stage estimates (Fama and MacBeth, 1973)

	Stock	Treasury	Agen	Corp	Curr	Comm	REIT	Intl	Aver	All
					A. Core					
mean	**-1.26**	**-0.86**	**-0.68**	**-1.05**	**-1.13**	-1.38	**-1.05**	**-0.97**	**-0.91**	**-0.99**
t-stat	(-3.31)	(-2.84)	(-2.09)	(-3.06)	(-3.92)	(-1.16)	(-3.25)	(-2.09)	(-2.92)	(-3.61)
SR	-0.44	-0.36	-0.27	-0.49	-0.64	-0.17	-0.51	-0.31	-0.40	-0.49
					B. Energy					
mean	2.02	0.64	-8.25	**6.66**	1.34	12.73	3.47	8.08	**5.23**	**5.71**
t-stat	(0.61)	(0.19)	(-1.30)	(2.07)	(0.18)	(1.88)	(0.55)	(1.58)	(2.03)	(2.10)
SR	0.09	0.03	-0.18	0.30	0.03	0.36	0.09	0.24	0.28	0.29
					C. Headline					
mean	**-2.81**	**-0.80**	**-1.39**	**-1.40**	0.79	1.07	0.89	**-2.92**	0.13	-0.11
t-stat	(-3.36)	(-2.24)	(-3.07)	(-2.85)	(0.88)	(1.61)	(1.12)	(-2.34)	(0.42)	(-0.35)
SR	-0.45	-0.30	-0.46	-0.42	0.17	0.29	0.18	-0.34	0.06	-0.05

- The average return and SR of core FMP consistent across classes
- Robust to controlling for standard macroeconomic factors

Other macro factors | Currencies | Commodities

Core Inflation and Growth

- Fama (1981) proxy effect hypothesis: stock return-inflation relation due to inflation proxying for real variables

	headline	*t*-stat	R^2	core	*t*-stat	energy	*t*-stat	R^2
				1 quarter				
GDP	-0.14	(-1.21)	0.02	-0.21	(-1.88)	0.00	(-0.23)	0.03
Cons	**-0.22**	(-2.42)	0.08	**-0.22**	(-2.32)	-0.01	(-0.86)	0.07
Div	-0.27	(-1.15)	0.02	**-0.67**	(-4.27)	0.04	(0.96)	0.06
				1 year				
GDP	**-0.75**	(-2.34)	0.08	**-0.70**	(-2.24)	-0.05	(-1.05)	0.07
Cons	**-0.66**	(-2.24)	0.09	-0.46	(-1.81)	-0.05	(-1.12)	0.05
Div	-1.26	(-1.12)	0.03	**-2.93**	(-5.78)	0.18	(0.95)	0.11

- Core inflation negatively predicts future GDP, consumption, and dividends, especially at 1-year horizon

Cash Flow and Discount Rate News

- Return news can be decomposed into CF and DR news

$$(E_{t+1}-E_t)r_{t+1} = \underbrace{(E_{t+1}-E_t)\sum_{j=0}^{\infty}\rho^j \Delta d_{t+1+j}}_{N_{CF}} - \underbrace{(E_{t+1}-E_t)\sum_{j=1}^{\infty}\rho^j r_{t+1+j}}_{N_{DR}}$$

	Cash Flow News				Discount Rate News			
	Core β	t-stat	Energy β	t-stat	Core β	t-stat	Energy β	t-stat
Mkt	**-2.14**	(-4.12)	-0.01	(-0.23)	**4.23**	(3.47)	**-0.19**	(-2.05)
Gr	**-4.96**	(-5.58)	-0.11	(-1.60)	**2.57**	(2.57)	**-0.24**	(-3.14)
BM2	**-2.44**	(-2.83)	0.00	(-0.03)	**3.07**	(3.55)	-0.10	(-1.55)
BM3	**-2.28**	(-2.76)	-0.03	(-0.47)	**2.73**	(3.37)	**-0.14**	(-2.26)
BM4	0.71	(0.80)	0.12	(1.80)	**6.27**	(4.33)	-0.12	(-1.07)
Vl	1.27	(1.17)	0.08	(0.92)	**7.17**	(4.35)	-0.14	(-1.09)

- For the stock market portfolio, negative core betas come from both CF and DR news, positive energy betas mainly come from DR news

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- For the stock market portfolio, negative core betas come from both CF and DR news, positive energy betas mainly come from DR news
- Growth vs. value portfolios's negative core beta
  - Growth portfolio: mainly comes from CF news
  - Value portfolio: mainly comes from DR news

Inflation, Fed Response, and Asset Returns

Are inflation betas driven by the Fed response?

- Event study around inflation announcement

	A. Fed Funds Futures			
	core	*t*-stat	headline	*t*-stat
(1)	**2.05**	(3.33)		
(2)			0.50	(1.11)
(3)	**2.18**	(3.15)	-0.20	(-0.41)

	B. Stock futures					
	core	*t*-stat	headline	*t*-stat	FFF	*t*-stat
(1)	**-1.49**	(-6.33)				
(2)			**-0.73**	(-4.57)		
(3)	**-1.25**	(-5.02)	**-0.44**	(-2.68)		
(4)					-0.11	(-3.93)
(5)	**-1.32**	(-5.37)			-0.08	(-3.08)

- Fed funds rate mainly responds to core inflation
- While the Fed response accounts for some stock return decline, negative core betas remain sizable after FFF control

Time-varying Exposure

- Stock-bond correlation turned negative after 1999 (Song, 2016; Campbell et al, 2017)

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	A. Headline		B. Core and Energy			
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			1963-1999			
Stock	**-5.42**	(-4.20)	**-5.19**	(-3.26)	-0.24	(-1.01)
Treasury	**-2.88**	(-5.52)	**-2.77**	(-4.31)	**-0.20**	(-2.03)
			2000-2019			
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Note: * indicates a significant change across the two subsamples.

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- Inflation and asset returns
  - First subsample: negative for stocks and bonds
  - Second subsample: positive for stock, negative for bonds
    - Driven by energy (switched signs, increased contribution)

Time-varying price of risk

Expected Inflation and Unexpected Inflation

	core exp	*t*-stat	core shock	*t*-stat	energy	*t*-stat
Stock	-0.44	(-0.44)	**-4.14**	(-3.12)	0.40	(1.41)
Trea	-0.38	(-1.06)	**-1.41**	(-2.11)	**-0.21**	(-3.15)
Agency	-0.13	(-0.76)	**-2.11**	(-7.48)	**-0.11**	(-2.64)
Corp	-0.30	(-0.89)	**-2.57**	(-4.45)	-0.04	(-0.44)
Curncy	1.48	(1.66)	-0.92	(-0.37)	**0.26**	(2.27)
Comm	0.42	(0.30)	**-4.68**	(-3.21)	**2.00**	(6.23)
REIT	-1.24	(-0.78)	-3.01	(-1.19)	0.73	(1.72)
Intl	-0.14	(-0.18)	**-4.66**	(-3.63)	0.34	(0.93)

- None of the 8 asset classes' excess returns have significant exposures to expected core inflation, only to core inflation shock
- Risk-free rate largely includes information about expected inflation

Model

Households

- Representative agent with utility function

$$E \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\gamma} - 1}{1-\gamma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right]$$

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- Consumption aggregator of core good and energy good

$$C_t^{\frac{\phi-1}{\phi}}=\alpha_c C_{c,t}^{\frac{\phi-1}{\phi}}+(1-\alpha_c)\left(e^{\delta_t}C_{e,t}\right)^{\frac{\phi-1}{\phi}}$$

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- Aggregate core consumpion

$$C_{c,t}=\left[\int_i C_{c,t}(i)^{\frac{\varepsilon_t-1}{\varepsilon_t}}di\right]^{\frac{\varepsilon_t}{\varepsilon_t-1}}$$

Energy Good and Monetary Policy

- Energy goods are endowed, exogenously
  - Capture the inelastic feature of energy supply
- Interest rate follows a Taylor rule $i_t = \bar{i} + \phi_\pi \pi_t$
  - Consistent with evidence: Fed responses to core inflation

Firms and the Philips Curve

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    Evidence
- Log-linearize the optimality condition → New Keynesian Philips Curve

$$\pi_t = \beta E_t \pi_{t+1} + \lambda(mc_t + \mu_t)$$

where μ_t is the desired markup, mc_t is the real marginal cost, and π_t is the inflation in core good

  - Markup shock: a modeling device for inflation driver (Smets and Wouters, 2007)

Solution

- All endogenous variables can be solved as linear functions in $\mu_t, c_{e,t}$, and δ_t

$$c_{c,t} = c_{c,\mu}\mu_t + c_{c,e}c_{e,t} + c_\delta\delta_t$$

$$\pi_t = \pi_\mu\mu_t + \pi_e c_{e,t} + \pi_\delta\delta_t$$

- The real stochastic discount factor

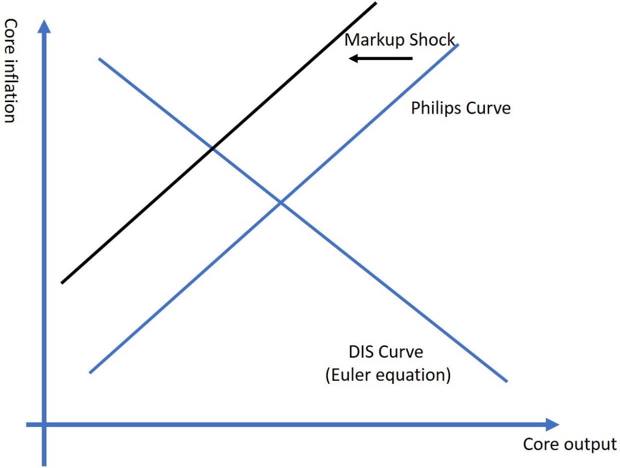
$$m_{t+1} = E_t m_{t+1} - \lambda_\mu\mu_{t+1} - \lambda_e c_{e,t+1} - \lambda_\delta\delta_{t+1}$$

- Solve for asset prices using the Euler equation $E(MR) = 1$

$$r_{i,t} = r_{i,\mu}\mu_t + r_{i,e}c_{e,t} + r_{i,\delta}\delta_t$$

  where i represents stocks (s), bonds (b), currencies (fx), and commodities (cm)
- Goal: to determine the signs of the coefficients

Markup Shock



- $c_{c,\mu} < 0, \pi_{\mu} > 0$. A higher markup shifts up the Philips curve, lowers core output and raises core inflation in equilibrium

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- $r_{fx,\mu} < 0$. Domestic real SDF $\uparrow$ dominate the nominal effect $\rightarrow$ **Foreign currency** $\downarrow$
- $r_{cm,\mu}$ ambiguous. Core output $\downarrow$, but nominal inflation $\uparrow$
  - Commodity future: future on energy good

Energy Shocks, Core Output and Energy Inflation

- Positive energy shocks increases the marginal utility of core goods when core and energy goods are substitutes
  - Philips curve: Lower wage, rightward shift

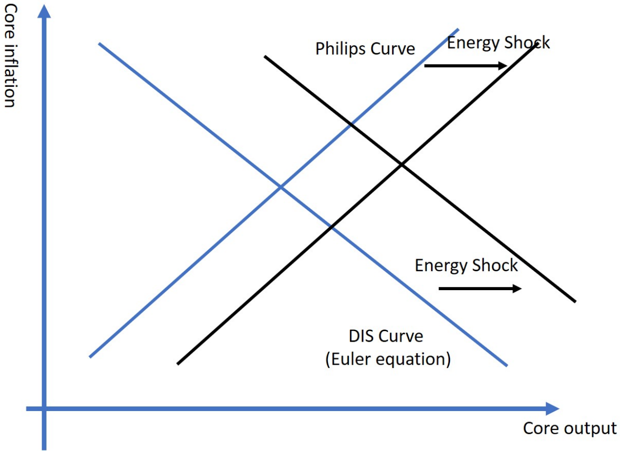
$$\log MU_t + w_t - p_t = \varphi n_t$$

  - Dynamic IS curve: Higher aggregate demand, rightward shift

$$E_t \log MU_{t+1} - \log MU_t + \phi_\pi \pi_t - E_t \pi_{t+1} = 0$$

- Supply (demand) shock lowers (raises) energy price

Energy Shocks



- $c_{c,e}, c_{c,\delta} > 0$. A higher energy shock raises the equilibrium core output.

Energy Shocks, Asset Prices, and Energy Inflation

- Energy demand and supply shock have similar effect on SDF but opposite effects on energy inflation — **the price of energy inflation risk is ambiguous**
  - Price of energy inflation risk

$$\lambda_{\text{energy}} \propto -\frac{1}{\phi}\lambda_e \sigma_e^2 + \frac{\phi - 1}{\phi}\lambda_\delta \sigma_\delta^2$$

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- $r_{s,e}, r_{fx,e}, r_{cm,e} > 0,\ r_{s,\delta}, r_{fx,\delta}, r_{cm,\delta} > 0.$ Expansionary energy shocks $\rightarrow$ **Stock return, foreign currency, commodity** $\uparrow$

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$$\beta_{s,\text{energy}} \propto -\frac{1}{\phi} r_{s,e} \sigma_e^2 + \frac{\phi - 1}{\phi} r_{s,\delta} \sigma_\delta^2$$

- Evidence of positive energy beta indicates energy demand shocks being dominant post-2000

Conclusion

- Shed new light on the nature of inflation risk: core and energy
  - Conventional inflation “hedges" only protect against energy inflation, not the core inflation
  - Core inflation carries a negative risk premium, consistently estimated within and across asset classes
- New insights into the changing stock-bond correlation
- A two-sector NK model qualitatively rationalizes these facts
  - Energy demand the dominant driver of energy prices post-2000

VAR Estimates and Inflation Expectation

- VAR estimates (t-stats in the parenthese)

	core	energy
core	0.46 (7.41)	1.74 (2.15)
food	0.08 (2.96)	0.28 (0.77)
energy	0.01 (1.22)	-0.02 (-0.29)
rf	1.81 (3.02)	0.02 (0.00)
pd	-1.23 (-3.19)	6.13 (1.22)
output	0.06 (1.32)	0.30 (0.49)
R^2	0.70	0.04

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core	0.46 (7.41)	1.74 (2.15)
food	0.08 (2.96)	0.28 (0.77)
energy	0.01 (1.22)	-0.02 (-0.29)
rf	1.81 (3.02)	0.02 (0.00)
pd	-1.23 (-3.19)	6.13 (1.22)
output	0.06 (1.32)	0.30 (0.49)
R^2	0.70	0.04

- Expected inflation AY_t and change of expected inflation Au_t
- Core shock u_t and shock to expected core Au_t correlation 0.90
- Energy inflation largely unpredictable

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Portfolio Details

- Stocks: 5 industry portfolios
- Treasuries: 7 maturity-sorted portfolios
- Agency bonds: 4 maturity-sorted portfolios
- Corporate bonds: 4 maturity-sorted portfolios
- Currencies: dollar carry and 6 carry portfolios
- Commodities: livestock, precious metal, industrial metal, energy, and agriculture
- REITs: equity, mortgage, hybrid
- International stocks: MSCI North America, Europe, Far East

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Inflation Exposure: 8 Average Portfolios

	A. Headline			B. Core and Energy			
	Mean	Headline β	t-stat	Core β	t-stat	Energy β	t-stat
Trea	2.07	-2.53	(-7.06)	-2.51	(-4.27)	-0.20	(-4.57)
Agen	2.44	-1.62	(-5.42)	-2.25	(-4.28)	-0.09	(-2.75)
Corp	3.08	-1.60	(-4.38)	-2.98	(-4.91)	-0.05	(-1.08)
Stock	6.80	-1.33	(-1.38)	-5.60	(-3.69)	0.21	(1.81)
Intl	6.09	-1.20	(-1.23)	-5.78	(-3.74)	0.19	(1.70)
REIT	7.96	0.31	(0.27)	-6.54	(-3.30)	0.31	(2.48)
Curr	1.76	1.04	(2.02)	-1.04	(-0.65)	0.13	(2.54)
Comm	4.47	8.59	(7.53)	-0.07	(-0.04)	1.10	(8.21)

- Fixed-income exposed negatively to both core and energy
- Stocks and REITs have significant negative core beta and positive energy beta
- Currencies and commodities only hedge energy inflation

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Inflation Exposure: 38 Portfolios

	A. Headline			B. Core and energy			
	Mean	headline β	t-stat	core β	t-stat	energy β	t-stat
			Stock				
Cons	7.83	-2.62	(-2.61)	-6.34	(-3.97)	0.06	(0.48)
Manu	6.65	0.32	(0.35)	-4.20	(-3.02)	0.36	(3.39)
HiTech	7.31	-1.17	(-1.00)	-6.07	(-3.29)	0.26	(1.86)
Health	8.67	-2.73	(-2.70)	-6.30	(-3.91)	0.04	(0.34)
Others	7.27	-2.38	(-2.08)	-7.40	(-4.09)	0.17	(1.22)
			Treasury				
1-year	0.96	-0.56	(-5.60)	-0.84	(-5.20)	-0.03	(-2.20)
3-year	1.19	-0.97	(-5.70)	-1.44	(-5.26)	-0.05	(-2.24)
5-year	1.93	-1.85	(-5.90)	-2.21	(-4.34)	-0.13	(-3.28)
7-year	2.35	-2.33	(-6.31)	-2.46	(-4.08)	-0.18	(-3.89)
10-year	2.19	-2.68	(-6.07)	-3.10	(-4.30)	-0.19	(-3.40)
20-year	2.95	-4.16	(-7.05)	-3.79	(-3.92)	-0.35	(-4.82)
30-year	2.94	-5.18	(-7.60)	-3.72	(-3.33)	-0.51	(-6.00)
			Agency Bond				
1-5 year	1.83	-1.17	(-4.99)	-1.90	(-4.66)	-0.05	(-2.03)
5-10 year	3.58	-1.48	(-3.89)	-0.26	(-0.21)	-0.14	(-3.70)
10-15 year	3.62	-2.84	(-5.69)	-3.71	(-4.25)	-0.18	(-3.10)
>15 year	4.76	-3.42	(-5.72)	-3.63	(-3.44)	-0.26	(-3.66)
			Corporate Bond				
1-3 year	2.26	-0.48	(-2.44)	-1.56	(-4.69)	0.02	(0.70)
3-5 year	2.93	-0.84	(-2.78)	-2.14	(-4.17)	0.00	(0.06)
5-10 year	3.61	-1.25	(-2.93)	-2.98	(-4.05)	-0.01	(-0.26)
>15 year	4.27	-2.85	(-4.98)	-4.47	(-4.66)	-0.13	(-1.91)

Inflation Exposure: 38 Portfolios (Cont'ed)

	A. Headline			B. Core and energy			
	Mean	Headline β	t-stat	core β	t-stat	energy β	t-stat
			Currency				
Dcarry	5.34	-0.98	(-1.52)	-4.17	(-2.08)	0.00	(-0.04)
Carry-1	-1.81	0.33	(0.57)	-0.52	(-0.28)	0.06	(0.95)
Carry-2	-0.25	1.60	(2.99)	1.72	(1.03)	0.14	(2.55)
Carry-3	1.12	1.02	(1.92)	-0.04	(-0.02)	0.11	(2.02)
Carry-4	2.53	0.45	(0.74)	-2.50	(-1.34)	0.10	(1.60)
Carry-5	3.43	1.44	(2.28)	-1.28	(-0.65)	0.19	(2.94)
Carry-6	5.56	1.38	(1.87)	-3.62	(-1.60)	0.20	(2.72)
			Commodity				
Live	2.70	1.24	(1.24)	-1.09	(-0.66)	0.15	(1.22)
Indmetal	4.23	4.73	(2.98)	-1.07	(-0.39)	0.66	(3.66)
Premetal	3.41	3.28	(2.65)	-0.22	(-0.11)	0.43	(2.96)
Energy	7.26	16.51	(7.05)	-0.76	(-0.11)	1.78	(7.54)
Agri	0.28	4.20	(3.28)	2.06	(0.96)	0.26	(1.66)
			REIT				
Equity	8.31	0.72	(0.61)	-6.48	(-3.20)	0.35	(2.77)
Mort	4.73	-2.25	(-1.63)	-8.61	(-3.56)	0.04	(0.25)
Hyb	8.20	-1.05	(-0.79)	-6.14	(-2.60)	0.12	(0.79)
			International Stock				
NorthAme	6.82	-0.92	(-0.96)	-5.47	(-3.57)	0.23	(2.02)
Europe	6.60	-0.93	(-0.85)	-6.09	(-3.48)	0.20	(1.56)
FarEast	7.01	-1.33	(-0.99)	-5.05	(-2.32)	0.15	(0.93)

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Price of Risk Estimates

	A. 8 Average Portfolios		B. 38 Portfolios	
headline	0.14		-0.08	
t-stat	(0.47)		(-0.32)	
core		-1.03		-1.07
t-stat		(-2.94)		(-3.72)
energy		3.86		3.81
t-stat		(1.35)		(1.36)
R^2	0.44	0.98	0.41	0.82

- Only core inflation carries a significant price of risk
- The price of risk estimate is consistent using both sets of portfolios

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Inflation Risk Within and Across Asset Classes

	Stock	Trea	Agen	Corp	Curr	Comm	REIT	Intl	Aver	All
core	-1.26	-0.89	-0.68	-1.09	-0.99	-0.80	-1.06	-0.97	-1.03	-1.07
t-stat	(-2.51)	(-2.43)	(-1.57)	(-2.75)	(-1.96)	(-0.75)	(-2.70)	(-1.69)	(-2.94)	(-3.72)
energy	2.02	0.56	-8.25	7.65	2.37	4.18	3.27	8.08	3.86	3.81
t-stat	(0.50)	(0.14)	(-1.06)	(2.01)	(0.26)	(1.41)	(0.41)	(1.31)	(1.35)	(1.36)
R^2	0.26	0.93	0.96	0.75	0.63	0.89	0.23	0.49	0.98	0.82

- Magnitude of the price of core inflation risk consistently estimated both within and across asset classes

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Other Macroeconomic Factors

- Does core inflation proxy for known macroeconomic factors? No!

	Cons	Cons/Dur	IP	Pay	Unem	HHL	Unf Cons	Cap
core	-1.06	-1.04	-1.07	-1.07	-1.06	-1.04	-1.07	-1.08
t-stat	(-3.69)	(-3.67)	(-3.51)	(-3.27)	(-3.39)	(-3.48)	(-3.70)	(-3.72)
energy	3.90	4.38	4.08	3.68	3.84	3.97	3.98	3.94
t-stat	(1.29)	(1.36)	(1.38)	(1.33)	(1.36)	(1.29)	(1.44)	(1.38)
macro	0.10	0.17	-0.34	-0.08	0.11	0.46	0.00	-0.31
t-stat	(0.18)	(0.32)	(-0.24)	(-0.16)	(0.26)	(0.62)	(0.26)	(-0.59)
macro2		-2.62				-0.01		
t-stat		(-0.67)				(-0.58)		
R^2	0.82	0.82	0.82	0.82	0.82	0.81	0.82	0.80

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Conventional Wisdom Revisited: Currencies

	A. Headline			B.Core and energy			
	Mean	Headline β	t-stat	Core β	t-stat	Energy β	t-stat
Dol-carry	5.34	-0.98	(-1.52)	-4.17	(-2.08)	0.00	(-0.04)
Carry-1	-1.81	0.33	(0.57)	-0.52	(-0.28)	0.06	(0.95)
Carry-2	-0.25	1.60	(2.99)	1.72	(1.03)	0.14	(2.55)
Carry-3	1.12	1.02	(1.92)	-0.04	(-0.02)	0.11	(2.02)
Carry-4	2.53	0.45	(0.74)	-2.50	(-1.34)	0.10	(1.60)
Carry-5	3.43	1.44	(2.28)	-1.28	(-0.65)	0.19	(2.94)
Carry-6	5.56	1.38	(1.87)	-3.62	(-1.60)	0.20	(2.72)
Value-1	-0.01	1.65	(2.32)	-2.12	(-0.96)	0.21	(2.94)
Value-2	1.16	1.48	(2.15)	-2.53	(-1.19)	0.20	(2.85)
Value-3	2.52	1.54	(2.23)	-1.74	(-0.82)	0.20	(2.84)
Value-4	4.14	1.43	(2.22)	-2.73	(-1.38)	0.21	(3.24)
Dol-β-1	0.83	-0.37	(-1.24)	-0.04	(-0.04)	-0.04	(-1.39)
Dol-β-2	1.68	-0.82	(-1.90)	-1.46	(-1.04)	-0.05	(-1.20)
Dol-β-3	2.57	-0.30	(-0.56)	-1.77	(-1.01)	0.02	(0.34)
Dol-β-4	3.65	0.57	(0.90)	-3.27	(-1.61)	0.12	(1.99)
Dol-β-5	3.13	-0.79	(-1.02)	-3.85	(-1.52)	0.01	(0.07)
Dol-β-6	4.87	-0.62	(-0.75)	-5.05	(-1.91)	0.04	(0.46)

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Conventional Wisdom Revisited: Currencies

- Seven (dollar-)carry portfolios' core betas decline and energy betas increase, largely in line with averege returns
- Dollar carry portfolio (conditioning on AFD)'s core beta is more negative and energy beta is insignificant
- Four value portfolios have similar exposures to inflation
- The six dollar beta sorted portfolios (conditional on AFD) have negative core betas
  - The larger the dollar beta, the more negative the core exposure
  - Important to condition on AFD
  - Core betas in line with average returns

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Conventional Wisdom Revisited: Commodities

	A. Headline			B. Core and Energy			
	Mean	Headline β	t-stat	Core β	t-stat	Energy β	t-stat
Agriculture	0.28	4.20	(3.28)	2.06	(0.96)	0.26	(1.66)
Energy	7.26	16.51	(7.05)	-0.76	(-0.11)	1.78	(7.54)
Ind metals	4.23	4.73	(2.98)	-1.07	(-0.39)	0.66	(3.66)
Livestock	2.70	1.24	(1.24)	-1.09	(-0.66)	0.15	(1.22)
Pre metals	3.41	3.28	(2.65)	-0.22	(-0.11)	0.43	(2.96)
Gold	1.98	2.14	(1.97)	1.74	(0.91)	0.24	(1.92)
Silver	3.52	4.95	(2.63)	-0.09	(-0.03)	0.68	(3.06)
Platinum	4.36	3.40	(2.29)	7.51	(1.63)	0.26	(1.69)

- Commodities hedge against energy inflation, including gold

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Time-varying Price of Risk

How does the price of inflation risk covary with other macroeconomic variables? (Adrian et al, 2015)

- Conditioning variable F_t: term spread $10y - 3m$
- Suppose the SDF follows

$$\frac{M_{t+1} - E_t M_{t+1}}{E_t M_{t+1}} = -\lambda_t u_{t+1}, \text{where } \lambda_t = \Sigma_u^{-\frac{1}{2}} (\lambda_0 + \lambda_1 F_t)$$

- Then $E_t R^i_{t+1} = \beta_i' (\lambda_0 + \lambda_1 F_t)$
- Result with 38 portfolios

	Estimate	t-stat
λ_0	-0.94	(-1.70)
λ_1	-0.52	(-1.58)

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Price Stickiness and Core Inflation

- Flexible and sticky inflation
  - Sticky inflation: a basket of items that change price slowly
  - Flexible inflation: the rest
  - Core inflation and sticky inflation correlation about 0.8

A. Asset Return Exposures				
	sticky	*t*-stat	flexible	*t*-stat
Stock	-4.68	(-2.99)	0.25	(0.61)
Trea	-1.12	(-1.86)	-0.93	(-5.93)
Agen	-0.94	(-1.93)	-0.51	(-4.20)
Corp	-1.61	(-2.70)	-0.39	(-2.56)
Curr	-1.14	(-0.69)	0.41	(2.16)
Comm	-1.53	(-0.87)	3.88	(8.51)
REIT	-4.35	(-2.38)	0.61	(1.38)
Intl	-4.95	(-3.27)	0.23	(0.58)
B. Price of Risks				
8 portfolios	-1.50	(-2.61)	0.45	(0.47)
38 portfolios	-1.45	(-3.49)	-0.21	(-0.24)

- Sticky inflation resembles core Back