Good Inflation, Bad Inflation, and the Dynamics of Credit Risk

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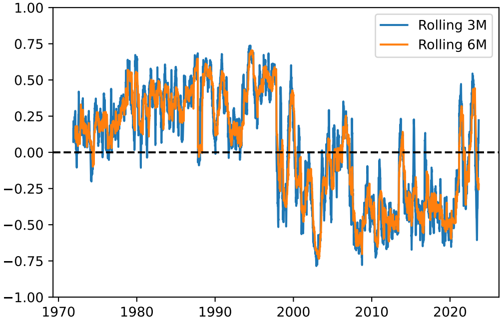
Motivation

- Post-pandemic inflation renewed focus on how markets price inflation risk
- Classic theories (e.g., Fisher (1933)): higher inflation lowers real debt burdens and credit spreads
- These theories assume real cash flows are uncorrelated with inflation
- But recent work (e.g., David and Veronesi (2013)) shows that the relationship between inflation and growth is time-varying

  ⇒ strongly associated with shifts in economic conditions over time



Stock–bond return correlation is a market proxy for the evolving inflation–growth relationship

While the correlation has switched signs post-1999, there has been increased volatility in the last two decades

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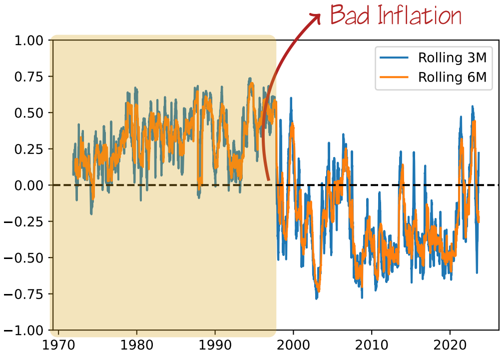

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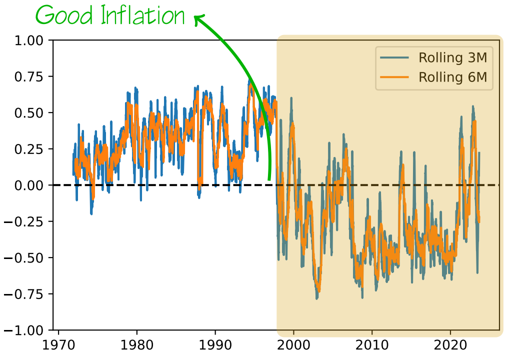

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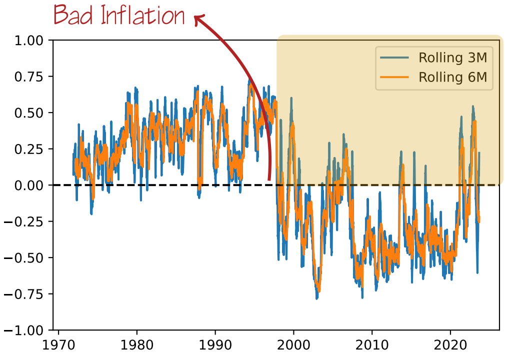

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Our Contribution

- We examine the **time varying response** of credit markets to revisions in inflation expectations
- **Empirical Strategy**: Exploit movements in inflation expectations around macroeconomic news
  - Measure changes in inflation expectations using daily and intraday inflation swaps
  - Condition these inflation surprises with lagged stock–bond return correlation
- **Main Findings**: Financial markets exhibit time-varying sensitivity to inflation expectations
  - In procyclical regimes (low stock–bond correlation): $\uparrow$ expected inflation $\rightarrow$ $\downarrow$ CDS spreads
    - Time variation operates primarily through a risk premia and exhibits cross-sectional heterogeneity
  - Inflation swap movements: inflation swaps well capture inflation expectations
    - Movements in narrow event windows highlight the importance of non-headline components
  - Stock–bond correlation as a macroeconomic indicator: subsumes macro-based measures of nominal-real covariance
    - Stronger results when we purge the effect of convenience yield
- **Model**: A long-run risks framework linking inflation–growth relationship to inflation beta
  - Endogenously delivers the stock-bond correlation as a proxy for the nominal-real covariance

Empirical Overview – Key Data

- Main sample from 2004 to 2023
- Corporate CDS
  - Firm-level 5Y CDS quotes from Markit
- Stock-Bond Correlation
  - Rolling 3-month (3M) and 6-month (6M) correlations of daily VW CRSP stock returns and nominal 5Y Treasury bond returns
- Zero Coupon Inflation Swaps ▸ Plot
  - Daily swap spreads from Bloomberg, 5-year horizon to match the maturity of CDSs
  - Minute-by-minute data from Refinitiv Tick History available from October 2007 (1-10Y maturity)
- Focus on days when there are macroeconomic announcements related to:
  - Key price movements (CPI, core CPI, PPI, core PPI)
  - Economic activity (nonfarm payroll, initial GDP release)

↳ Greater sensitivity to information about the future path of inflation on these days
The variance of swap movements on announcement days is 2 to 3.5x larger

▸ Variance Differences ▸ Summary Stats

Unconditional Response: A Good Inflation Regime

$$\Delta s_{it} = \beta_i + \beta_\pi \Delta\pi^{swap} + \beta_X' X_{i,t-1} + \epsilon_{it}$$

Δs_{it} is the daily change in CDS. Firm-level controls (X_i) include lagged CDS spreads

	(1)	(2)	(3)
$\Delta\pi^{swap,5Y}$	-0.90***	-0.81***	-0.79***
	(-5.19)	(-5.27)	(-5.27)
$\tilde{\rho}_{-1}^{bond-mkt,3M}$		-0.03	
		(-0.38)	
$\tilde{\rho}_{-1}^{bond-mkt,6M}$			-0.12
			(-1.57)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{swap,5Y}$		0.61***	
		(5.05)	
$\tilde{\rho}_{-1}^{bond-mkt,6M} \times \Delta\pi^{swap,5Y}$			0.52***
			(4.48)
Correlation Horizon	–	3M	6M
Firm FE	Y	Y	Y
Obs	418,777	410,129	410,129
$Adj.R^2$	0.019	0.024	0.023

1-$\sigma \uparrow \Delta\pi^{swap} \implies$ 0.90 b.p. $\downarrow$ CDS

Time Variation in Inflation Beta

Idea: Relate the time-variation in inflation beta to the expected inflation–growth covariance

Assume that the coefficient on inflation swap movements is a function of the above covariance:

$$\begin{aligned}\Delta s_{it} &= \beta_0 + \beta_1 \left(\sigma_{xc\pi,t-1}\right) \Delta\pi_t \\ &\approx \beta_0 + \beta_1 \left(\tilde{\rho}_{t-1}\right) \Delta\pi_t\end{aligned}$$

Baseline Specification:

$$\Delta s_{it} = \beta_i + \beta_\pi \Delta\pi_t^{swap} + \beta_\rho \tilde{\rho}_{t-1} + \beta_{\rho\pi} \left(\tilde{\rho}_{t-1} \cdot \Delta\pi_t^{swap}\right) + \beta' X_{i,t-1} + \varepsilon_{it}$$

Proxy for $\tilde{\rho}_{t-1}$: Stock–bond return correlation (3M or 6M horizon)

Interpretation:

– When $\tilde{\rho}_{t-1}$ is high $\Rightarrow$ inflation is bad news for growth

– When $\tilde{\rho}_{t-1}$ is low $\Rightarrow$ inflation is good news for growth

Time Variation in Inflation Beta

$$\Delta s_{it} = \beta_i + (\beta_\pi + \beta_{\rho\pi}\tilde{\rho}_{t-1}) \times \Delta\pi^{swap} + \beta_\rho \tilde{\rho}_{t-1} + \beta'_X X_{i,t-1} + \varepsilon_{it}$$

	(1)	(2)	(3)
$\Delta\pi^{swap,5Y}$	-0.90***	-0.81***	-0.79***
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Correlation Horizon	–	3M	6M
Firm FE	Y	Y	Y
Obs	418,777	410,129	410,129
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– When inflation signals stronger growth (negative $\tilde{\rho}$), credit spreads fall more after inflationary news

Credit Risk Premia

– We decompose CDS spreads into expected losses and risk premia following Berndt et al. (2018)

$$s_{it} = \text{ExpLoss}_{it} + \text{RiskPrem}_{it}$$

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\pi^{swap,5Y}$	-0.82***	-0.25***	-0.53***	-0.79***	-0.25***	-0.51***
	(-5.28)	(-3.07)	(-3.97)	(-5.24)	(-3.14)	(-3.93)
$\tilde{\rho}_{-1}^{bond-mkt,3M}$	-0.06	-0.02	-0.04			
	(-0.85)	(-0.67)	(-0.63)			
$\tilde{\rho}_{-1}^{bond-mkt,6M}$				-0.15**	-0.03	-0.12*
				(-1.97)	(-0.98)	(-1.90)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{swap,5Y}$	0.63***	0.16**	0.44***			
	(5.15)	(2.48)	(4.16)			
$\tilde{\rho}_{-1}^{bond-mkt,6M} \times \Delta\pi^{swap,5Y}$				0.54***	0.13**	0.38***
				(4.56)	(2.01)	(3.85)
Dependent Variable	Δs_i (b.p.)	ΔEL_i	ΔRP_i	Δs_i (b.p.)	ΔEL_i	ΔRP_i
Correlation Horizon		3M			6M	
Firm FE	Y	Y	Y	Y	Y	Y
Clustering		Firm-Time			Firm-Time	
Obs	200,303	200,281	200,279	200,303	200,281	200,279
$Adj.R^2$	0.026	0.010	0.013	0.025	0.009	0.013

Time-Variation in the Cross-Section

- We assess cross-sectional heterogeneity by splitting firms by CDS spreads before each macro day

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta\pi^{swap,5Y}$	-0.82***	-0.20***	-0.77***	-2.21***	-0.53***	-0.17***	-0.59***	-1.21***
	(-5.29)	(-4.54)	(-5.38)	(-4.74)	(-3.98)	(-4.14)	(-4.17)	(-3.33)
$\tilde{\rho}_{-1}^{bond-mkt,3M}$	-0.05	-0.02	0.01	-0.11	-0.02	-0.01	0.04	-0.02
	(-0.69)	(-0.97)	(0.17)	(-0.41)	(-0.28)	(-0.74)	(0.64)	(-0.08)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{swap,5Y}$	0.63***	0.16***	0.54***	1.74***	0.44***	0.14***	0.40***	1.06***
	(5.15)	(4.55)	(4.78)	(4.81)	(4.16)	(4.22)	(3.61)	(3.78)
$s_{i,-1}$	0.20**	0.11	0.62	0.24***	0.15**	0.09	0.61	0.19***
	(2.51)	(0.41)	(1.40)	(2.98)	(2.28)	(0.33)	(1.44)	(2.76)
Dependent Variable	Δs_i				ΔRP_i			
Which Risk Group	–	1	3	5	–	1	3	5
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Clustering	Firm-Time				Firm-Time			
Obs	200,279	41,610	46,006	30,322	200,279	41,610	46,006	30,322
$Adj.R^2$	0.025	0.070	0.069	0.034	0.011	0.052	0.038	0.010

- Results are skewed: the riskiest firms show the strongest time-variation
- Focusing on unconditional responses limits our understanding of the firm-level response

Interpreting $\Delta\pi^{\text{swap}}$: Beyond Headline Surprises

- Macroeconomic surprises affect **forward inflation expectations** (e.g., Bauer (2015))
  - But explain only a small share of asset prices variation (in swap case: $R^2 \approx 12\%$).
- Focusing on headline surprises overlooks information in announcements priced into swaps

- **Key Question**: do credit spreads reflect *macro news* or the *endogenous update* afterwards?

- **Two approaches** (yielding similar results):
  1. **Regression decomposition** of daily swap changes: $\Delta\pi_t^{\text{swap}} = \underbrace{\Delta\hat{\pi}_{\text{surp}_t}}_{\text{news}} + \underbrace{\Delta\hat{\pi}_{\text{resid}_t}}_{\text{belief update}}$

  2. **Heteroskedasticity-based identification** (Gürkaynak, Kısacıkoğlu, and Wright, 2020)
     - Use the cross-section of intraday swaps at maturities $i \in \{1, 2, 3, 5, 7, 10\}$ over the same time window on announcement vs. non-announcement days, to estimate:

$$\Delta\pi_t^{\text{swap},i} = \beta_i h_t + \gamma_i d_t f_t + \eta_t^i$$

     - h_t = surprise (realized – median forecast)
     - d_t = announcement day dummy
     - f_t = latent common component: *belief update*, explains over 60% of the variation in 5Y swaps

Approach 1: Daily Decomposition

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All Announcements				*Price-Based Announcements*			
$\Delta\pi^{swap,5Y}$	-0.90***	-0.81***			-0.95***	-0.96***		
	(-5.19)	(-5.27)			(-3.82)	(-4.14)		
$\Delta\pi^{surp,5Y}$			-0.16	-0.23*			-0.12	-0.20
			(-1.42)	(-1.93)			(-0.92)	(-1.32)
$\Delta\pi^{resid,5Y}$			-0.89***	-0.79***			-0.97***	-0.95***
			(-5.38)	(-5.46)			(-4.04)	(-4.19)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{swap,5Y}$		0.61***				0.75***		
		(5.05)				(4.33)		
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{surp,5Y}$				0.28***				0.30***
				(3.68)				(3.21)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{resid,5Y}$				0.53***				0.65***
				(4.59)				(3.81)
$\tilde{\rho}_{-1}^{bond-mkt,3M}$		-0.03		-0.04		0.04		-0.05
		(-0.38)		(-0.51)		(0.46)		(-0.52)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Obs	418,777	410,129	418,777	410,129	250,980	247,215	250,980	247,215
$Adj. R^2$	0.019	0.024	0.019	0.024	0.023	0.030	0.024	0.031

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	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All Announcements				*Price-Based Announcements*			
$\Delta\pi^{swap,5Y}$	-0.90***	-0.81***			-0.95***	-0.96***		
	(-5.19)	(-5.27)			(-3.82)	(-4.14)		
$\Delta\pi^{surp,5Y}$			-0.16	-0.23*			-0.12	-0.20
			(-1.42)	(-1.93)			(-0.92)	(-1.32)
$\Delta\pi^{resid,5Y}$			-0.89***	-0.79***			-0.97***	-0.95***
			(-5.38)	(-5.46)			(-4.04)	(-4.19)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{swap,5Y}$		0.61***				0.75***		
		(5.05)				(4.33)		
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{surp,5Y}$				0.28***				0.30***
				(3.68)				(3.21)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{resid,5Y}$				0.53***				0.65***
				(4.59)				(3.81)
$\tilde{\rho}_{-1}^{bond-mkt,3M}$		-0.03		-0.04		0.04		-0.05
		(-0.38)		(-0.51)		(0.46)		(-0.52)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Obs	418,777	410,129	418,777	410,129	250,980	247,215	250,980	247,215
$Adj.R^2$	0.019	0.024	0.019	0.024	0.023	0.030	0.024	0.031

Heteroskedasticity Decomposition

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\pi^{swap,5Y}$	-1.00***	-0.85***				
	(-5.41)	(-5.12)				
$\tilde{\rho}_{-1}^{bond-mkt,3M}$		-0.02		-0.04		-0.05
		(-0.28)		(-0.39)		(-0.59)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{swap,5Y}$		0.59***				
		(4.34)				
$\Delta\pi^{idswap,5Y}$			-0.22	-0.28*		
			(-1.55)	(-1.79)		
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{idswap,5Y}$				0.37***		
				(2.77)		
$\Delta\pi^{surp,5Y}$					-0.12	-0.20
					(-0.89)	(-1.31)
$\Delta\pi^{latent,5Y}$					-0.34***	-0.39***
					(-2.64)	(-2.76)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{surp,5Y}$						0.23***
						(2.64)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{latent,5Y}$						0.33**
						(2.58)
Firm FE	Y	Y	Y	Y	Y	Y
Obs	358,035	350,067	358,035	350,067	358,035	350,067
$Adj.R^2$	0.024	0.028	0.011	0.012	0.012	0.015

– Latent component plays a larger role in driving time-varying inflation sensitivity in credit spreads.

Interpreting $\Delta\pi^{swap}$: Inflation Expectations vs Inflation Risk Premia

- We decompose swap rate movements into inflation expectation and risk premia using:
  1. **Term structure model of D'Amico, Kim, and Wei (2018)**
  2. **PCA decomposition of relevant data series**
     - Novel approach : real bond yields correlate negatively with expected inflation measures (e.g., Pennacchi (1991), Kandel, Ofer, and Sarig (1996), Ang, Bekaert, and Wei (2008)).
- We extract an inflation expectation and a risk premium using daily changes in inflation swaps, treasury yields and real bond yields component

	Δ Inflation Swaps		Δ BE Inflation Rate		Δ Real Yield	
Expectation Component	3.937***	3.937***	4.063***	4.063***	-3.822***	-3.822***
	(90.42)	(146.42)	(129.07)	(135.72)	(-49.25)	(-300.52)
Risk Component		2.075***		0.590***		4.638***
		(77.17)		(19.73)		(364.66)
Obs.	3,672	3,672	3,672	3,672	3,672	3,672
R^2	0.690	0.882	0.819	0.837	0.398	0.984

▸ Figures

Interpreting $\Delta\pi^{swap}$: Inflation Expectations vs Inflation Risk Premia

	(1)	(2)	(3)	(4)
$\Delta\pi^{ExpInfl}$	-0.65***		-0.94***	
	(-4.70)		(-6.94)	
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{ExpInfl}$	0.41***		0.55***	
	(4.58)		(5.05)	
$\Delta\pi^{InflRP}$		-0.47***		-0.49***
		(-3.45)		(-3.92)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{InflRP}$		0.34***		0.41***
		(3.48)		(4.94)
Decomposition Methodology	DKW		PCA	
Firm FE	Y	Y	Y	Y
Clustering	Firm-Time		Firm-Time	
Obs	410,129	410,129	403,873	403,873
$Adj.R^2$	0.016	0.012	0.026	0.014

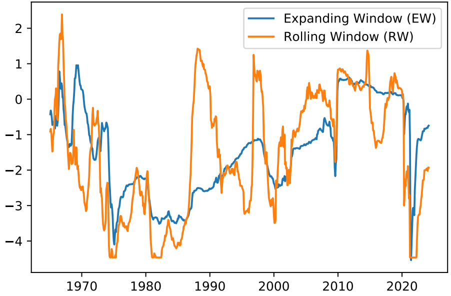
– Expected inflation plays a pivotal role in generating time-variation in the inflation sensitivity

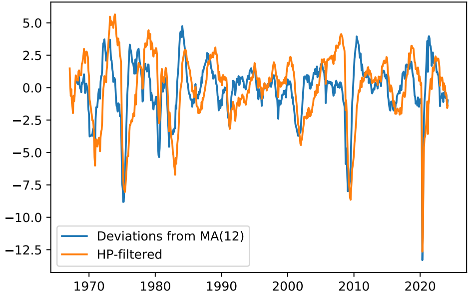
Information content of the Stock–Bond Correlation: Macro-Based Measures

- We compare the stock–bond return correlation with slow-moving measures of real-nominal covariance
- Measure the RNC through an expanding window, predictive regression (e.g., Boons et al. (2020))

$$\Delta C_{s+1:s+12} = \alpha_t + \beta_t \Pi_s + e_{s+1:s+12}, \quad \text{for } s = 1, \ldots, t-12$$

- Use a measure of economic slack (e.g., Elenev et al. (2024))





Stock–Bond Correlation vs. Macro-Based Measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta\pi^{swap,5Y}$	-0.81***	-1.01***	-0.93***	-0.78***	-0.89***	-0.83***	-0.76***
	(-5.27)	(-5.92)	(-5.35)	(-5.56)	(-6.06)	(-5.32)	(-5.59)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{swap,5Y}$	0.61***				0.53***	0.58***	0.60***
	(5.05)				(3.95)	(4.51)	(4.92)
$\widetilde{NRC}_{-1}^{EW} \times \Delta\pi^{swap,5Y}$		-0.41***			-0.20		
		(-3.59)			(-1.53)		
$\widetilde{NRC}_{-1}^{RW} \times \Delta\pi^{swap,5Y}$			-0.33***			-0.06	
			(-3.83)			(-0.63)	
$\widetilde{TCU}_{-1} \times \Delta\pi^{swap,5Y}$				0.17			0.09
				(1.34)			(0.77)
Firm FE	Y	Y	Y	Y	Y	Y	Y
Clustering		Firm-Time				Firm-Time	
Obs	410,129	418,777	418,777	418,777	410,129	410,129	410,129
$Adj.R^2$	0.024	0.021	0.021	0.021	0.024	0.024	0.025

- Stock–bond return correlation is extremely strong, even in horse race regressions.
- Subsumes a macro-based correlation that has a clear connection between expected inflation and future real growth

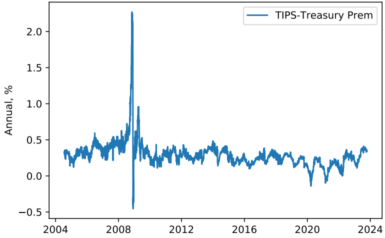
Information content of the Stock–Bond Correlation: Convenience Yield

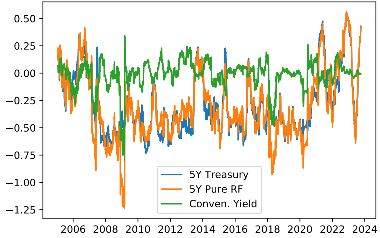
- We decompose the nominal Treasury yield at maturity n into three components (Acharya and Laarits (2025)):

$$yield^{n} = yield^{*,n} + CDS^{US,n} - convenyield^{n}$$

- Taking covariances with stock returns and dividing through by standard deviations we obtain:

$$\rho^{bond-mkt} = \underbrace{w_1 \rho^{bond^{*}-mkt}}_{\text{Frictionless}} + \underbrace{w_2 \rho^{CDS-mkt}}_{\text{Default}} - \underbrace{w_3 \rho^{conyld-mkt}}_{\text{Convenience}},$$





Time-Varying Inflation Sensitivity and the Convenience Yield

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta\pi^{swap,5Y}$	-0.81***	-0.78***	-0.78***	-0.83***	-0.83***	-0.89***	-0.95***	-0.97***
	(-5.27)	(-5.14)	(-5.14)	(-5.30)	(-5.26)	(-6.22)	(-6.39)	(-5.96)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{swap,5Y}$	0.60***					0.62***		
	(5.00)					(5.47)		
$\tilde{\rho}_{-1}^{bond^{*ND}-mkt,3M} \times \Delta\pi^{swap,5Y}$		0.39***		0.64***			0.70***	0.70***
		(3.83)		(4.79)			(5.26)	(5.56)
$\tilde{\rho}_{-1}^{bond^{*D}-mkt,3M} \times \Delta\pi^{swap,5Y}$			0.40***		0.62***			
			(3.91)		(4.89)			
$\tilde{\rho}_{-1}^{conyld-mkt,3M} \times \Delta\pi^{swap,5Y}$				-0.25**	-0.21**			0.04
				(-2.46)	(-2.15)			(0.28)
Which Sample		Full Sample		Full Sample			Non-GFC	
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
SE Clustering		Firm-Time		Firm-Time			Firm-Time	
Obs	409,903	409,903	409,903	409,903	409,903	374,600	374,600	374,600
$Adj.R^2$	0.024	0.023	0.022	0.025	0.025	0.017	0.018	0.018

– While relevant for Treasury, convenience yields play a minor role in inflation sensitivity beyond the GFC.

Model in a Nutshell

What model ingredients generate realistic patterns in expected inflation beta?

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What model ingredients generate realistic patterns in expected inflation beta?

– Endowment economy asset pricing model

Representative investor has Epstein and Zin (1989) recursive preferences:

$$V_t = \left[(1-\delta) C_t^{\frac{1-\gamma}{\theta}} + \delta \left(E_t \left(V_{t+1}^{1-\gamma} \right) \right)^{\frac{1}{\theta}} \right]^{\frac{\theta}{1-\gamma}}$$

The investor's (log) pricing kernel:

$$m_{t+1} = \theta \log \delta - \frac{\theta}{\psi} \Delta c_{t+1} - (1-\theta) r_{c,t+1},$$

$$r_{c,t+1} = \kappa_0 + \kappa_1 pc_{t+1} - pc_t + \Delta c_{t+1},$$

with Δc the log-growth rate of consumption, pc log price-to-consumption ratio, and r_c the return on the consumption asset

Model in a Nutshell

What model ingredients generate realistic patterns in expected inflation beta?

- **Endowment economy asset pricing model**
- **Persistent macro expectations (e.g., Bansal and Yaron (2004), Bansal and Shaliastovich (2012))**

Consumption and inflation follow:

$$\Delta c_{t+1} = \mu_c + x_{ct} + \sigma_c \varepsilon_{c,t+1},$$
$$\pi_{t+1} = \mu_\pi + x_{\pi t} + \sigma_\pi \varepsilon_{\pi,t+1},$$

where x_{ct} and $x_{\pi t}$ (expected real growth & inflation) are persistent processes:

$$X_t \equiv \begin{pmatrix} x_{ct} \\ x_{\pi t} \end{pmatrix} = \Pi X_{t-1} + \Sigma_{t-1}\eta_t, \quad \Sigma_t = \begin{pmatrix} \sigma_{xc} & 0 \\ 0 & \sigma_{x\pi} \end{pmatrix}$$

Model in a Nutshell

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Key difference: Markov-switching covariance $\sigma_{xc\pi}(s_t)$

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- **Endowment economy asset pricing model**
- **Persistent macro expectations (e.g., Bansal and Yaron (2004), Bansal and Shaliastovich (2012))**
- **Time-varying covariance between expected real growth and inflation shocks (e.g. Song (2017))**
- **Pricing of credit securities (Augustin (2018))**

Assume that default dynamics are exogenous and related to key state variables. Realized default at $t+1$ is given by:

$$D_{t,1} = \begin{cases} 0 & \text{w/probability } \exp\left(-\lambda_t\right) \\ 1 & 1-\exp\left(-\lambda_t\right) \end{cases} \qquad\qquad \lambda_t = \beta_{\lambda 0}(s_t) + \beta'_{\lambda x} X_t$$

As given in Berndt et al. (2018), CDS of maturity K periods is a rate C_t that satisfies:

$$\underbrace{\Delta C_t \sum_{k=1}^{K/\Delta} E_t\left[\tilde{M}^{\$}_{t+k\Delta}\left(1 - D_{t,(k-1)\Delta}\right)\right]}_{\text{protection holder}} = \underbrace{\sum_{k=1}^{K/\Delta} E_t\left[\tilde{M}^{\$}_{t+k\Delta} \times (1-R) \times D_{t+(k-1)\Delta,\Delta}\right]}_{\text{protection seller}}$$

where, Δ is the time between payments, $\tilde{M}^{\$}_{t+z}$ is the nominal SDF from t to $t+z$.

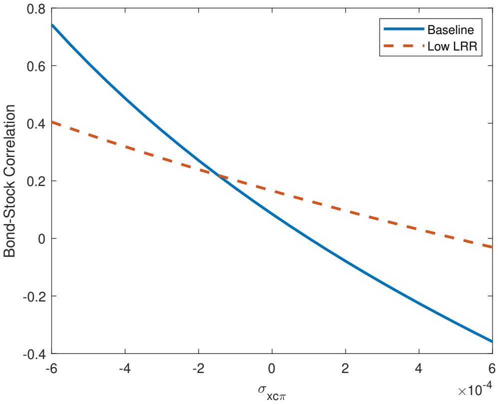
Model-Implied Stock Bond Correlation

- We compute the stock–bond return correlation using:
  - Nominal returns on the consumption claim ($r_{ct}^{\$}$)
  - Long-term risk-free bond ($r_{ft}^{5Y,\$}$)

- The covariance parameter $\sigma_{xc\pi}(s_t)$:
  - Governs expected inflation and growth shocks
  - Maps into the stock-bond correlation: $\rho(r_{ct}^{\$}, r_{ft}^{5Y,\$})$

- Persistence of expected growth component plays a key role:
  $\Rightarrow$ the more persistently expected inflation shocks affect consumption growth, the greater their impact on asset prices

Stock–bond correlation as a function of $\sigma_{xc\pi}$



Baseline Calibration

- Calibration is quarterly and parameter values are chosen to match standard macro-financial moments from the long-run risks literature
- Using simulated model data we run regressions similar to our data exercise:

$$\Delta s_t^{5Y} \quad = \quad \gamma_0 + \gamma_1 \Delta x_{\pi t} + \eta_t$$

- Model exhibits intuitive time-variation in stock–bond correlation and inflation beta of CDS

	Value	Notes
$\rho(r_{ct}^{\$}, r_{ft}^{5Y,\$})$	-0.148	Stock–bond correlation
$\rho(r_{ct}^{\$}, r_{ft}^{5Y,\$})$ – Regime 1	-0.451	–
$\rho(r_{ct}^{\$}, r_{ft}^{5Y,\$})$ – Regime 2	0.284	–
$\beta(\Delta s_t^{5Y} \sim \Delta x_{\pi t})$ (b.p.)	-1.603	Spread change regression coefficient
$\beta(\Delta s_t^{5Y} \sim \Delta x_{\pi t})$ – Regime 1	-6.265	
$\beta(\Delta s_t^{5Y} \sim \Delta x_{\pi t})$ – Regime 2	3.073	

▸ Parameters ▸ Other Moments

Comparative Statics

	$\sigma_{xc\pi} = 0$	Symmetric $\sigma_{xc\pi}$	$\Pi_{cc} = 0.85$	Baseline
$E\left[r_{ct} - r_{ft}\right]$	0.857	0.875	0.369	0.908
$E\left[s_t^{5Y}\right]$	1.332	1.326	1.284	1.337
$\sigma\left[\Delta s_t^{5Y}\right]$ (b.p.)	5.095	5.009	4.601	5.371
$\rho(r_{ct}^{\$}, r_{ft}^{5Y,\$})$	0.085	0.073	0.162	-0.148
$\rho(r_{ct}^{\$}, r_{ft}^{5Y,\$})$ – Regime 1	0.084	-0.289	-0.007	-0.451
$\rho(r_{ct}^{\$}, r_{ft}^{5Y,\$})$ – Regime 2	0.086	0.501	0.349	0.284
$\beta(\Delta s_t^{5Y} \sim \Delta x_{\pi t})$ (b.p.)	-0.005	-0.017	0.011	-1.603
$\beta(\Delta s_t^{5Y} \sim \Delta x_{\pi t})$ – Regime 1	0.042	-4.673	-2.417	-6.265
$\beta(\Delta s_t^{5Y} \sim \Delta x_{\pi t})$ – Regime 2	-0.052	4.641	2.439	3.073
$\beta(r_{ct} - r_{ft} \sim \Delta x_{\pi t})$	-0.009	-0.006	-0.007	0.231
$\beta(r_{ct} - r_{ft} \sim \Delta x_{\pi t})$ – Regime 1	-0.015	0.692	0.227	0.933
$\beta(r_{ct} - r_{ft} \sim \Delta x_{\pi t})$ – Regime 2	-0.003	-0.705	-0.241	-0.475

- Time-variation in $\sigma_{xc\pi}$ needed to match patterns in data
- Persistence of real growth expectations affects volatility of stock–bond correlations and magnitude of inflation beta (similar to Chernov, Lochstoer, and Song (2021))

Additional Robustness and Extensions

- Equity Results
  - We show that all our results hold in a matched equity sample
  - When inflation signals stronger growth (low $\tilde{\rho}$), equity prices increase more after inflationary news
- Sign Switches Across Regimes
  - We extend our analysis to pre-1999 using inflation expectations from D'Amico, Kim, and Wei (2018)
  - Results suggest a clear sign switch in inflation beta based on the sign of the stock-bond correlation
- Using Breakeven Inflation Expectations: Results hold using TIPS breakeven inflation expectations
- CDS Liquidity: Results are not driven by low liquidity periods in CDS markets
- Swap-Market Correlation: Results are robust to using correlation of changes in inflation swaps and market
- Non-Announcements: Time-variation is present also in non-announcements days

More Details

Conclusion

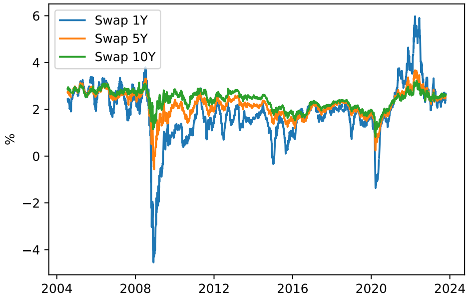
We empirically and theoretically explore time-variation in inflation beta

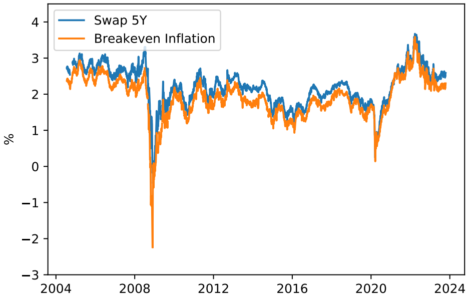
- **Empirics**:
  - Study transmission of macro news into inflation swaps at the daily and intra-day frequency
  - Display time-varying sensitivity of credit markets to inflation expectations movements
  - Highlight risk premia, cross-sectional effects, and role of headline vs non-headline news

- **Theory**:
  - Construct a parsimonious long-run risk model with time-varying inflation-growth covariance
  - Draws clear link between real-nominal relationship and endogenous stock–bond correlation
  - Generates regime-specific inflation beta for risky assets through cash flow channel

Appendix

Inflation Swaps





- Inflation swaps provide better forecasts of realized inflation than survey-based measures (Diercks et al. (2023))
- Significant illiquidity premium in TIPS (D'Amico, Kim, and Wei (2018))

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Summary Stats

	Count	Mean	Std. Dev.	Min	Max
Panel A: Aggregate Measures					
$\pi^{swap,1Y}$	730	1.903	1.168	-4.274	5.856
$\pi^{swap,5Y}$	730	2.222	0.533	-0.515	3.593
$\pi^{swap,10Y}$	734	2.423	0.379	0.992	3.190
$\Delta\pi^{swap,5Y}$	728	0.000	0.049	-0.285	0.191
$\rho\left(R_{bond}, R_{mkt}\right)^{3M}$	819	-0.293	0.280	-0.778	0.544
$\rho\left(\Delta\pi^{swap}, R_{mkt}\right)^{3M}$	701	0.292	0.218	-0.348	0.746
Panel B: Firm-Level Data					
$Spread$	418911	2.257	3.767	0.101	33.054
$\Delta Spread$ (b.p.)	418808	0.139	8.359	-52.475	65.279
$ExpLoss$	204936	0.639	1.529	0.029	14.191
$RiskPrem$	204757	1.206	1.922	-2.686	16.365
R_i (%)	207853	0.032	2.276	-9.615	9.253
$R_i - R_f$ (%)	207853	0.027	2.276	-9.619	9.250
Panel C: Intraday Swaps					
$\Delta\pi^{idswap,5Y}$	622	0.116	3.364	-28.000	24.500
$\Delta\pi^{surp,5Y}$	622	0.052	1.208	-5.279	10.559
$\Delta\pi^{latent,5Y}$	622	0.097	2.703	-29.574	22.233

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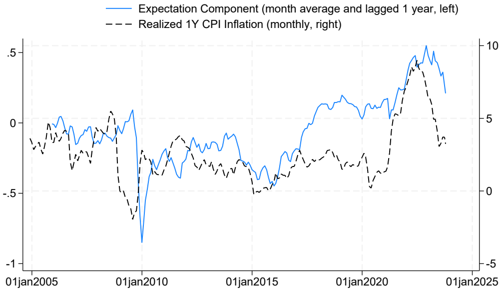
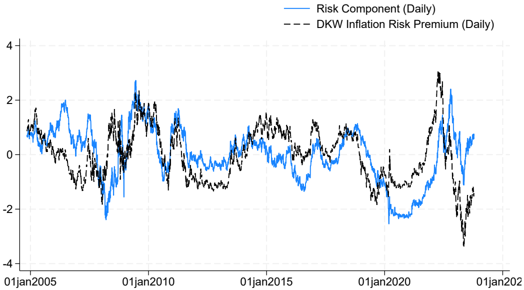
PCA-Derived Inflation Expectations and Risk Premium





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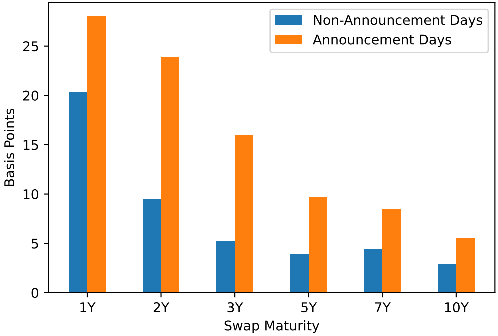
Inflation Swaps More Volatile on Macro Announcement Days

Following Gürkaynak, Kısacıkoğlu, and Wright (2020), extract announcement and non-announcement day residuals and compare variances:

$$\Delta\pi_t^{idswap,n} = \beta_0^n + \beta_s^{n'} s_t + \eta_t^A \qquad \text{where } t \in \{CPI, PPI, GDP, Nonfarm\}$$
$$\Delta\pi_t^{idswap,n} = \eta_t^{NA} \qquad \text{otherwise}$$



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Intraday Swap Prices and Macroeconomic Surprises

- Regression of 60-minute changes in inflation swaps onto standardized surprise measures
- Surprises are defined as the difference between a realized value and the Bloomberg median economist survey

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\varepsilon^{corecpi}$	1.75***						0.91***
	(8.18)						(2.95)
ε^{cpi}		1.89***					1.28***
		(9.13)					(4.17)
$\varepsilon^{nonfarm}$			0.42**				0.45**
			(2.04)				(1.98)
ε^{gdp}				1.18			1.18***
				(1.47)			(2.71)
$\varepsilon^{coreppi}$					0.40**		0.13
					(2.00)		(0.45)
ε^{ppi}						0.54***	0.46
						(2.72)	(1.63)
Dependent Variable	Intraday $\Delta\pi^{swap,5y}$ (b.p.)						
Obs	184	184	196	54	188	188	622
$Adj.R^2$	0.265	0.310	0.016	0.022	0.016	0.033	0.120

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Latent Factor Estimation from Intraday Swaps

	(1)	(2)	(3)	(4)	(5)	(6)
$\varepsilon^{corecpi}$	3.35***	2.79***	1.71***	0.90***	1.04***	0.65***
	(4.55)	(4.26)	(5.53)	(2.82)	(5.76)	(4.68)
ε^{cpi}	2.68***	2.41***	1.12***	1.30***	0.69***	0.79***
	(4.04)	(4.73)	(3.22)	(4.07)	(3.27)	(4.84)
$\varepsilon^{nonfarm}$	-0.11	0.01	0.06*	0.45***	0.38***	0.28***
	(-1.29)	(0.23)	(1.66)	(23.57)	(15.17)	(16.01)
ε^{gdp}	-0.19	-0.26	0.86	1.18***	-0.40	0.11
	(-0.23)	(-0.39)	(1.29)	(3.34)	(-1.08)	(0.42)
$\varepsilon^{coreppi}$	0.42	-0.71	0.73***	0.13	0.39***	-0.25
	(1.42)	(-0.98)	(2.78)	(1.19)	(2.61)	(-1.24)
ε^{ppi}	0.47**	0.41	0.48***	0.47***	0.44***	0.74***
	(2.34)	(1.42)	(2.92)	(3.56)	(3.27)	(3.28)
$\Delta\pi^{latent}$	2.56***	2.64***	3.46***	2.70***	2.33***	1.94***
	(4.09)	(6.32)	(21.15)	(29.57)	(17.21)	(16.23)
Dependent Variable			Intraday $\Delta\pi^{swap}$			
Horizon	1Y	2Y	3Y	5Y	7Y	10Y
Observations	622	622	622	622	622	622
R^2 without latent	0.235	0.208	0.119	0.120	0.091	0.096
R^2 with latent	0.410	0.434	0.769	0.771	0.665	0.709

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Equity Results

We run our regression using a matched sample of equity excess returns

	(1)	(2)	(3)
$\Delta\pi^{swap,5Y}$	0.38***	0.35***	0.35***
	(3.91)	(3.82)	(3.92)
$\tilde{\rho}_{-1}^{bond-mkt,3M}$		0.05	
		(1.00)	
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{swap,5Y}$		-0.22***	
		(-2.58)	
$\tilde{\rho}_{-1}^{bond-mkt,6M}$			0.07
			(1.59)
$\tilde{\rho}_{-1}^{bond-mkt,6M} \times \Delta\pi^{swap,5Y}$			-0.16**
			(-2.02)
$\left(R^i - R^f\right)_{-1}$	0.00	0.00	0.00
	(0.22)	(0.17)	(0.15)
$s_{i,-1}$	-0.00	-0.00	0.00
	(-0.10)	(-0.01)	(0.12)
Correlation Horizon	–	3M	6M
Firm FE	Y	Y	Y
Clustering		Firm-Time	
Obs	207,717	205,837	205,837
$Adj.R^2$	0.028	0.036	0.034

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Results Using Breakeven Inflation

Instead of daily movements in inflation swaps, we test TIPS-implied breakeven inflation movements on macroeconomic announcement days

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\pi^{be,5Y}$	-0.99***	0.37***	-0.30***	-0.65***	-0.94***	0.35***
	(-6.68)	(4.80)	(-4.07)	(-5.05)	(-7.07)	(4.73)
$\tilde{\rho}_{-1}^{bond-mkt,3M}$					0.02	0.04
					(0.29)	(0.83)
$\tilde{\rho}_{-1}^{bond-mkt,3M} \times \Delta\pi^{be,5Y}$					0.57***	-0.23***
					(4.99)	(-3.07)
$s_{i,-1}$	0.17***	-0.00	0.05	-0.00	0.17***	0.00
	(3.07)	(-0.14)	(1.42)	(-0.04)	(3.20)	(0.01)
$(R^i - R^f)_{-1}$		-0.00				-0.00
		(-0.01)				(-0.01)
$ExpLoss_{i,-1}$			-0.17***	0.55***		
			(-3.17)	(5.27)		
Dependent Variable	Δs_i	$R^i - R^f$	$\Delta ExpLoss_i$	$\Delta RiskPrem_i$	Δs_i	$R^i - R^f$
Firm FE	Y	Y	Y	Y	Y	Y
Clustering	Firm-Time		Firm-Time		Firm-Time	
Obs	440,133	223,199	210,332	210,330	432,551	221,319
$Adj.R^2$	0.020	0.028	0.009	0.012	0.025	0.038

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Alternative Correlation Measure

We replace daily bond returns with movements in inflation swaps and use a rolling swap-market return correlation measure

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\pi^{swap,5Y}$	-0.90***	-1.02***	-1.03***	0.38***	0.46***	0.47***
	(-5.19)	(-6.33)	(-6.04)	(3.91)	(4.97)	(4.92)
$\tilde{\rho}_{-1}^{swap-mkt,3M}$		-0.20**			0.02	
		(-2.58)			(0.55)	
$\tilde{\rho}_{-1}^{swap-mkt,6M}$			-0.20**			0.04
			(-2.55)			(0.84)
$\tilde{\rho}_{-1}^{swap-mkt,3M} \times \Delta\pi^{swap,5Y}$		-0.68***			0.38***	
		(-5.55)			(5.73)	
$\tilde{\rho}_{-1}^{swap-mkt,6M} \times \Delta\pi^{swap,5Y}$			-0.56***			0.34***
			(-4.56)			(4.91)
Dependent Variable		Δs_i			$R^i - R^f$	
Correlation Horizon	–	3M	6M	–	3M	6M
Firm FE	Y	Y	Y	Y	Y	Y
Clustering		Firm-Time			Firm-Time	
Obs	418,777	405,195	400,641	207,717	202,603	199,661
$Adj.R^2$	0.019	0.026	0.024	0.028	0.056	0.049

Results robust to alternative correlation measure.

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Time-Varying Inflation Sensitivities and CDS Liquidity

	(1)	(2)	(3)
$\Delta\pi^{swap,5Y}$	-0.81***	-1.11***	-0.42***
	(-5.27)	(-5.47)	(-4.18)
$\tilde{\rho}_{-1}^{swap-mkt,3M}$	-0.03	-0.02	-0.03
	(-0.38)	(-0.20)	(-0.51)
$\tilde{\rho}_{-1}^{swap-mkt,3M} \times \Delta\pi^{swap,5Y}$	0.61***	0.78***	0.38***
	(5.05)	(5.12)	(4.45)
$s_{i,-1}$	0.18***	0.22***	0.14***
	(3.21)	(2.62)	(2.65)
Number of Dealers	–	High ($\geq$ 50%)	Low ($<$ 50%)
Firm FE	Y	Y	Y
Clustering		Firm-Time	
Obs	410,129	234,586	175,517
$Adj.R^2$	0.024	0.037	0.020

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Long Sample Analysis

Using firm-level equity returns back to 1983 and daily inflation expectations estimates from D'Amico, Kim, and Wei (2018) we replicate our analysis:

	(1)	(2)	(3)	(4)
$\tilde{\rho}_{-1}^{bond-mkt,3M}$	0.045*			
	(1.875)			
$\tilde{\rho}_{-1}^{bond-mkt,6M}$		0.042*		
		(1.745)		
$1_{\{\rho^{3M}>0\}}$			0.069	
			(1.428)	
$1_{\{\rho^{6M}>0\}}$				0.090*
				(1.847)
$\Delta\pi^{exp,5Y}$	0.068**	0.055	0.341***	0.280***
	(2.124)	(1.629)	(5.292)	(4.769)
$\Delta\pi^{exp,5Y} \times \tilde{\rho}_{-1}^{bond-mkt,3M}$	-0.288***			
	(-9.578)			
$\Delta\pi^{exp,5Y} \times \tilde{\rho}_{-1}^{bond-mkt,6M}$		-0.253***		
		(-7.684)		
$\Delta\pi^{exp,5Y} \times 1_{\{\rho^{3M}>0\}}$			-0.539***	
			(-7.789)	
$\Delta\pi^{exp,5Y} \times 1_{\{\rho^{6M}>0\}}$				-0.470***
				(-7.305)
$r_{i,-1}$	-0.046***	-0.046***	-0.046***	-0.046***
	(-7.984)	(-7.884)	(-7.977)	(-7.889)
Firm FE	Y	Y	Y	Y
Observations	7,259,306	7,259,306	7,259,306	7,259,306
R^2	0.017	0.015	0.015	0.013

Longer sample allows us to uncover a sign switch in inflation beta

Model Setup (1)

- Representative investor has Epstein and Zin (1989) recursive preferences:

$$V_t = \left[(1-\delta)C_t^{\frac{1-\gamma}{\theta}} + \delta\left(E_t\left(V_{t+1}^{1-\gamma}\right)\right)^{\frac{1}{\theta}}\right]^{\frac{\theta}{1-\gamma}}$$

where δ is the time discount factor, γ risk aversion, ψ intertemporal elasticity of substitution, and $\theta \equiv \frac{1-\gamma}{1-\frac{1}{\psi}}$ preference for the early resolution of uncertainty

- The investor's (log) pricing kernel:

$$m_{t+1} = \theta \log\delta - \frac{\theta}{\psi}\Delta c_{t+1} - (1-\theta)r_{c,t+1},$$
$$r_{c,t+1} = \kappa_0 + \kappa_1 pc_{t+1} - pc_t + \Delta c_{t+1},$$

with Δc the log-growth rate of consumption, pc log price-to-consumption ratio, and r_c the return on the consumption asset

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Model Setup (2)

- Consumption and inflation follow:

$$\Delta c_{t+1} = \mu_c + x_{ct} + \sigma_c \varepsilon_{c,t+1},$$
$$\pi_{t+1} = \mu_\pi + x_{\pi t} + \sigma_\pi \varepsilon_{\pi,t+1},$$

where x_{ct} and $x_{\pi t}$ (expected real growth & inflation) are persistent processes:

$$X_t \equiv \begin{pmatrix} x_{ct} \\ x_{\pi t} \end{pmatrix} = \Pi X_{t-1} + \Sigma_{t-1}\eta_t, \quad \Sigma_t = \begin{pmatrix} \sigma_{xc} & \sigma_{xc\pi}(s_t) \\ 0 & \sigma_{x\pi} \end{pmatrix},$$

Key difference: Markov-switching covariance $\sigma_{xc\pi}(s_t)$

State variables: X_t and covariance regime s_t

$$pc_t = A_1' X_t + A_2(s_t)$$

$$\exp\left(r_{f,t+1}^{\$,n}\right) = \exp\left(p_{f,t+1}^{\$,n-1} - p_{f,t}^{\$,n}\right), \text{ where } p_{f,t}^{\$,n} = P_1^{n'} X_t + P_2^n(s_t)$$

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Extension to Credit Risk

- To derive implications for credit spreads (CDS), we extend Augustin (2018)
- As given in Berndt et al. (2018), CDS of maturity K periods is a rate C_t that satisfies:

$$\underbrace{\Delta C_t \sum_{k=1}^{K/\Delta} E_t\left[\tilde{M}^{\$}_{t+k\Delta}\left(1 - D_{t,(k-1)\Delta}\right)\right]}_{\text{protection holder}} = \underbrace{\sum_{k=1}^{K/\Delta} E_t\left[\tilde{M}^{\$}_{t+k\Delta} \times (1-R) \times D_{t+(k-1)\Delta,\Delta}\right]}_{\text{protection seller}}$$

  where, Δ is the time between payments, $\tilde{M}^{\$}_{t+z}$ is the nominal SDF from t to $t+z$, and $D_{t,z}$ is a default indicator between t and $t+z$

- We assume that default dynamics are exogenous and related to key state variables. Realized default at $t+1$ is given by:

$$D_{t,1} = \begin{cases} 0 & \text{w/probability } \exp\left(-\lambda_t\right), \\ 1 & 1 - \exp\left(-\lambda_t\right), \end{cases}$$

  where $\lambda_t = \beta_{\lambda 0}(s_t) + \beta'_{\lambda x} X_t$

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Extension to Credit Risk

- Assuming quarterly time frequency and that payments are made each quarter ($\Delta = 1$), 5Y CDS can be written as:

$$C_t = \frac{\sum_{k=1}^{20} E_t \left[\tilde{M}^{\$}_{t+k} \times (1-R) \times D_{t+k-1,1} \right]}{\sum_{k=1}^{20} E_t \left[\tilde{M}^{\$}_{t+k} \left(1 - D_{t,k-1}\right) \right]} = (1-R) \times \left(1 - \frac{\sum_{k=1}^{20} \exp\left(B_1^{k'} X_t + B_2^k(s_t) \right)}{\sum_{k=1}^{20} \exp\left(C_1^{k'} X_t + C_2^k(s_t) \right)} \right)$$

- The coefficients $\left\{ B_1^k, B_2^k(s_t), C_1^k, C_2^k(s_t) \right\}$ depend on the fundamental parameters of the model and are solved using a recursive numerical algorithm

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Model Parameters

Table 1: Model Parameters

	Value	Notes
γ	20	Bansal and Shaliastovich (2013)
ψ	2.5	Target risk-free rate
δ	0.998	Bansal and Shaliastovich (2013)
μ_c	0.00474	Target consumption growth mean
μ_π	0.009	Bansal and Shaliastovich (2013)
Π_{cc}	0.95	Bansal and Yaron (2004)
$\Pi_{\pi\pi}$	0.988	Bansal and Shaliastovich (2013)
σ_{xc}	0.0000583	Target expected growth vol
$\sigma_{x\pi}$	0.000986	Target expected inflation vol
$\sigma_{xc\pi}(s_1)$	0.0008	“Good Inflation” regime
$\sigma_{xc\pi}(s_2)$	-0.0004	“Bad Inflation” regime
p_{11}	0.9	–
p_{22}	0.9	–
σ_c	0.00359	Target consumption growth vol
σ_π	0.00557	Target inflation vol
$\beta_{\lambda 0}$	0.00505	Target 2% annual default rate
$\beta_{\lambda xc}$	-0.5	Countercyclical default rates
R	0.4	Average recovery rate from Markit

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Unconditional Model Moments

Table 2: Unconditional Model Moments

	Value	Notes
$E\left[pc_t\right]$	7.607	Log price-consumption ratio
$E\left[r_{ct}\right]$	2.011	Real return on consumption
$E\left[r_{ct}^{\$}\right]$	5.538	Nominal return on consumption
$E\left[r_{ft}^{\$}\right]$	4.629	Nominal risk-free rate
$E\left[r_{ct} - r_{ft}\right]$	0.908	Risk premium
$E\left[r_{ft}^{5Y,\$}\right]$	3.466	Nominal return on 5Y risk-free bond
$E\left[s_t^{5Y}\right]$	1.337	5Y CDS spread
$\sigma\left[\Delta s_t^{5Y}\right]$ (b.p.)	5.371	Volatility of spread changes

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