Inflation Risk in Corporate Bonds

The Journal of Finance

Johnny Kang and Carolin Pflueger

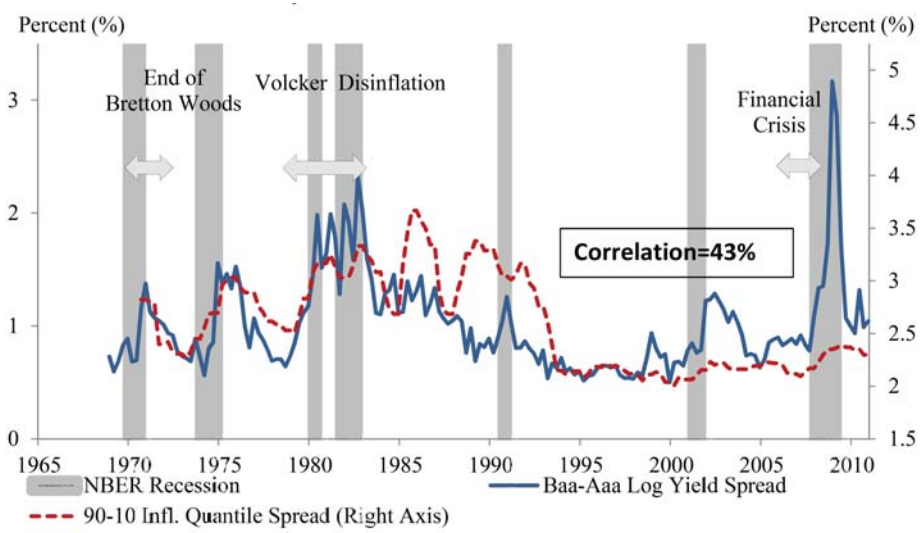
09/17/2013

Introduction

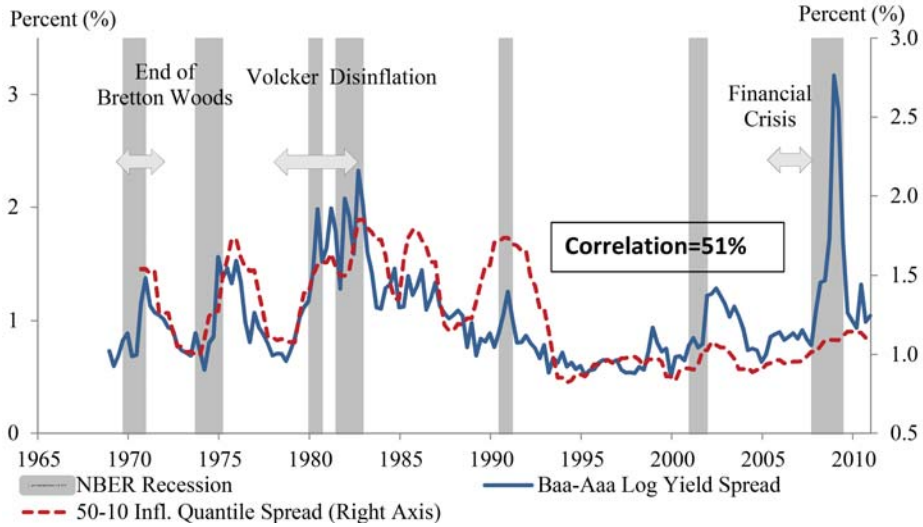
- Do inflation uncertainty and fear of debt deflation increase firms' cost of financing?
- Corporate debt in developed economies largely nominal
  - Lower than expected inflation raises real liabilities (Fisher, 1933)
- Firms' ex ante default risk and credit spreads should increase in volatility of *nominal* cash flows

U.S. Credit Spreads and Inflation Uncertainty

Panel A: Inflation Uncertainty



Panel B: Lower Inflation Tail



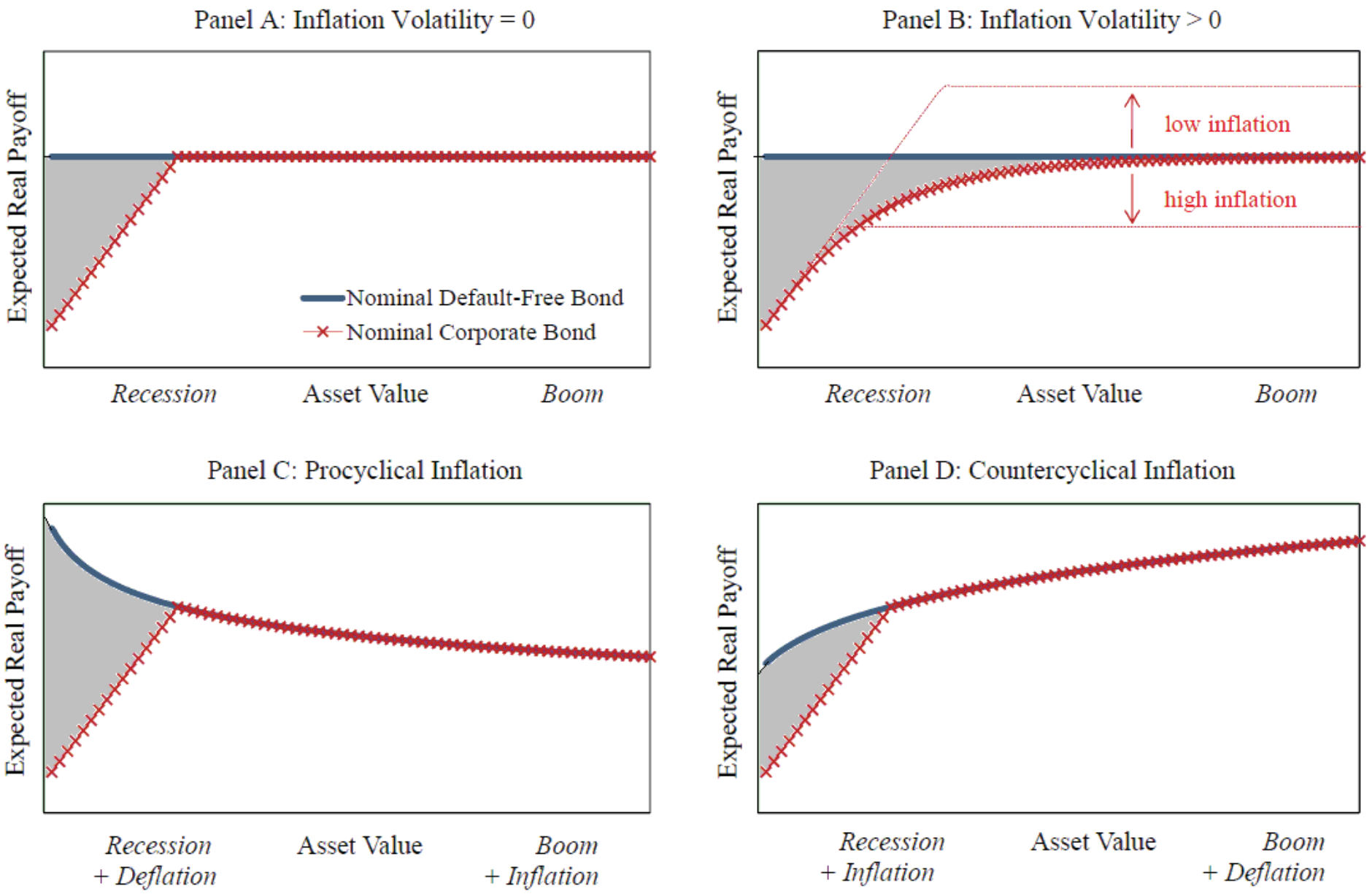
Outline

- Model
- Calibration
- Empirical Results

Literature

- Time-varying inflation risk: Campbell, Sunderam, and Viceira (2013), Pflueger and Viceira (2011), Engle (1982)
- Credit risk with endogenous leverage: Leland and Toft (1996), Chen, Collin-Dufresne and Goldstein (2009), Bhamra, Fisher, and Kuehn (2011), Gourio (2013)
  - Transition dynamics increase impact of inflation risk
- Empirical determinants of corporate bond spreads: Collin-Dufresne, Goldstein, and Martin (2001), Campbell and Taksler (2003)

Model Intuition: Corporate Bonds as Contingent Claims



Model Overview

- Debt is long-term and nominal
- Inflation volatility and inflation cyclicality vary over time
  - Inflation expectations highly persistent
- Firms choose leverage
  - Expected bankruptcy costs induce lower leverage
  - Tax and agency benefits of debt induce higher leverage
  - Overlapping generations of firms generate sticky capital structure

Calibration Parameters

General Parameters	
Period	5 Years
Discount Rate	3%*
Risk Aversion	10
Capital Share	0.33
Depreciation	8%*
Trend Growth	2.8%*
Recovery Rate	0.40
Benefit of Debt	1.40
Vol. TFP Shock	26%*
Idioysncratic Vol.	17%*

Model 1: Time-Varying Inflation Vol.	
Inflation-TFP Corr.	0
High Inflation Vol.	2%*
Low Inflation Vol.	0%*
$p\left(\sigma^{\pi,H} \rightarrow \sigma^{\pi,H}\right)$	0.60
$p\left(\sigma L \rightarrow \sigma^{\pi,L}\right)$	0.80

Model 2: Time-Varying Inflation-TFP Corr.	
Inflation Vol.	1%*
High Infl.-TFP Corr.	0.60
Low Infl.-TFP Corr.	-0.60
$p\left(\rho^{\pi,H} \rightarrow \rho^{\pi,H}\right)$	0.70
$p\left(\rho^{\pi,L} \rightarrow \rho^{\pi,L}\right)$	0.70

* per annum

Model Regressions: Time-Varying Inflation Volatility

$$spread_t^{seas} = \lambda_1^0 + \lambda_1^{\sigma^\pi}\sigma_t^\pi + \lambda_1^{\sigma^{eq}}\sigma_t^{eq} + \lambda_1^{DP} DP_t^{seas} + \lambda_1^{eq} r_t^{eq} + \lambda_1^\pi \epsilon_t^\pi + \eta_{1,t}$$

Seas. credit spread (%)	(1)	(2)	(3)	(4)
Inflation volatility (Ann.)		27.10		27.13
		(9.37)		(8.51)
Equity volatility (Ann.)			8.69	2.2716
			(6.67)	(6.96)
Dividend-price ratio (Ann.)			17.51	30.16
			(14.12)	(14.63)
Equity return	-1.36	-1.36	-1.71	-1.45
	(0.21)	(0.21)	(0.34)	(0.34)
Inflation shock	-10.75	-10.76	-10.58	-10.70
	(2.39)	(2.16)	(2.30)	(2.11)
Constant	2.27	2.09	1.03	1.29
	(0.12)	(0.09)	(0.50)	(0.50)
R^2	0.75	0.79	0.81	0.85

Model Regressions: Time-Varying Inflation Cyclicality

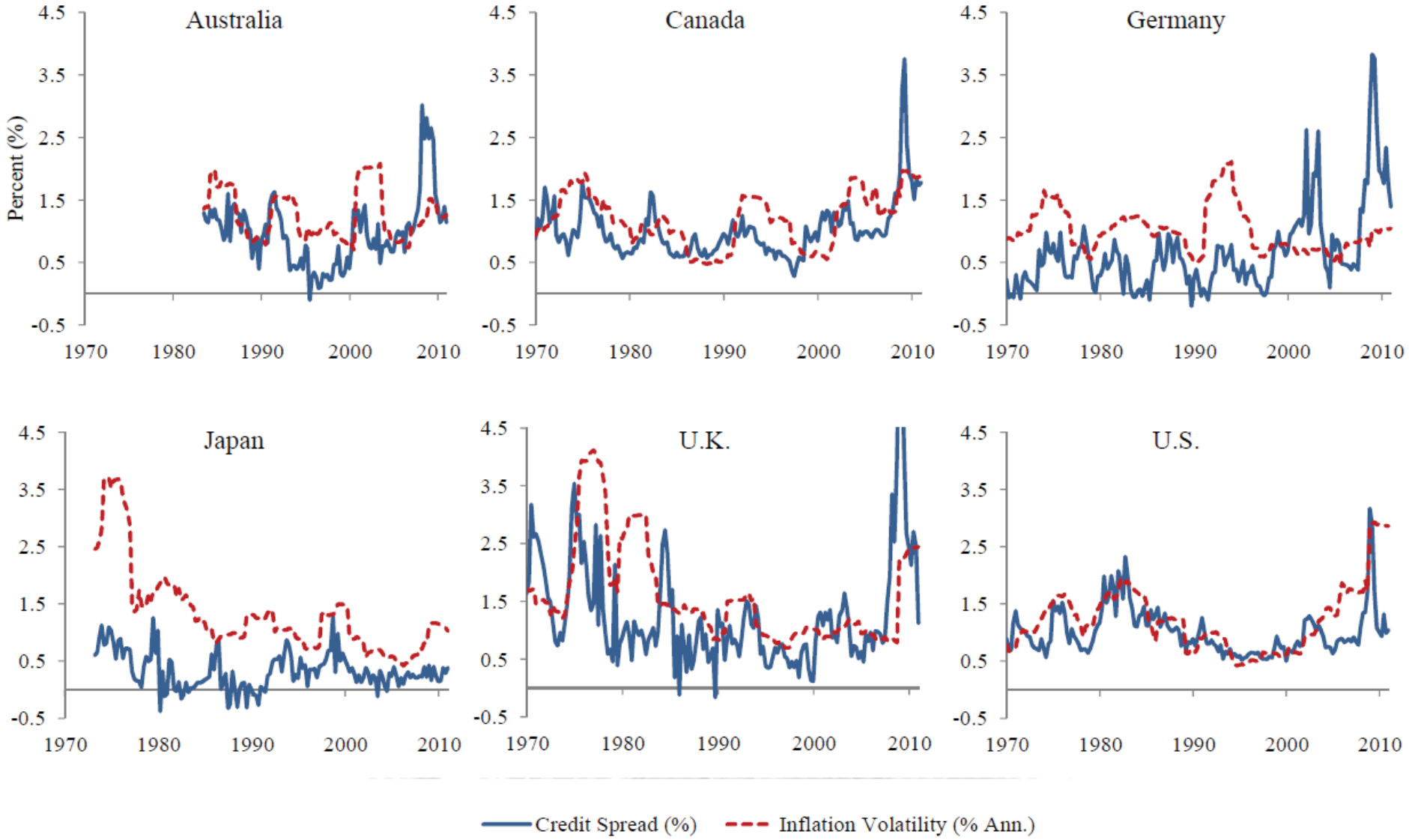
$$spread_t^{seas} = \lambda_2^0 + \lambda_2^{\rho^\pi} \rho_t^\pi + \lambda_2^{\sigma^{eq}} \sigma_t^{eq} + \lambda_2^{DP} DP_t^{seas} + \lambda_2^{eq} r_t^{eq} + \lambda_2^\pi \epsilon_t^\pi + \eta_{2,t}$$

Seas. credit spread (%)	(1)	(2)	(3)	(4)
Inflation-stock correlation		26.62		19.70
		(9.75)		(11.94)
Equity volatility (Ann.)			10.84	4.91
			(4.19)	(6.12)
Dividend-price ratio (Ann.)			12.96	24.00
			(10.53)	(14.17)
Equity return	-1.41	-1.40	-1.85	-1.61
	(0.21)	(0.20)	(0.26)	(0.32)
Inflation shock	-9.29	-9.31	-9.11	-9.20
	(1.14)	(1.09)	(0.97)	(0.96)
Constant	2.18	2.15	0.83	1.21
	(0.11)	(0.11)	(0.31)	(0.42)
R^2	0.72	0.74	0.80	0.81

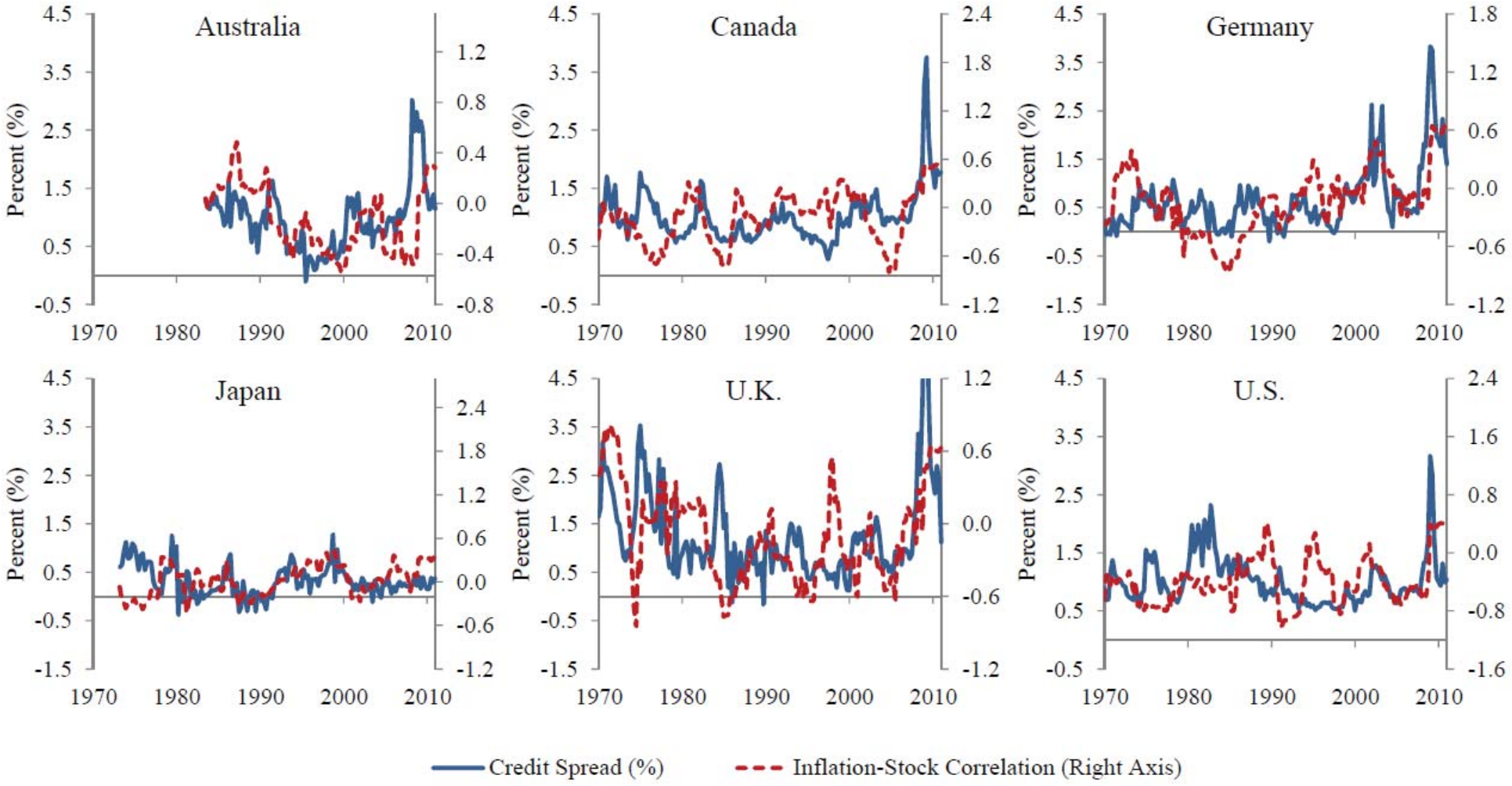
Measuring Corporate Bond Spreads and Inflation Risk

- United States: Moody's Baa minus Aaa spread
- Corporate bond yields from Global Financial Data (GFD)
  - Durations between 5 and 12 years
  - Subtract duration-matched government bond yields (GFD)
- Inflation volatility and inflation-stock correlation : Three year rolling window inflation surprises and stock returns
- Non-seasonally adjusted quarterly CPI inflation and equity return indices from GFD

International Spreads and Inflation Volatility



International Spreads and Inflation-Stock Return Corr.



Control Variables

- Time-varying risk aversion: Log dividend yields (MSCI equity indices, Datastream)
- Real uncertainty:
  - Three-year backward looking standard deviation of quarterly equity returns and GDP growth
  - Idiosyncratic stock return volatility as in Campbell, Lettau, Malkiel and Xu (2001) from CRSP, Compustat Global, and Datastream
- Leverage: Equal-weighted market leverage from Compustat North America and Compustat Global.
- Business cycle and inflation shock variables: unexpected inflation, stock returns, GDP growth, unemployment

International Credit Spreads and Inflation Risk (1969.Q4-2010.Q4)

$$spread_{i,t} = \lambda_i^0 + \lambda^{\sigma^\pi}\sigma_{i,t}^\pi + \lambda^{\rho^\pi}\rho_{i,t}^\pi + \lambda^{\sigma^{eq}}\sigma_{i,t}^{eq} + \lambda^{DP}DP_{i,t} + \Lambda \times X_{i,t} + \eta_{i,t}$$

	(1)	(2)	(3)	(4)	(5)
Inflation risk					
Inflation volatility (Ann.)		29.71**	28.04**		24.61**
		(8.36)	(6.96)		(6.97)
Inflation-stock correlation			40.42**		42.37**
			(9.10)		(10.22)
Real uncertainty and other control variables					
Equity volatility (Ann.)				1.26	0.86
				(0.86)	(0.88)
Dividend-price ratio (Ann.)				8.68*	8.41
				(4.32)	(4.50)
Business cycle and inflation shock variables					
	Yes	Yes	Yes	Yes	Yes
Residual R^2	0.19	0.25	0.28	0.22	0.30

International Credit Spreads and Inflation Risk (Continued)

Additional Controls

	(5)	(6)	(7)	(8)	(9)
Inflation risk					
Inflation volatility (Ann.)	24.61**	12.49**	15.09**	22.94**	22.76**
	(6.97)	(4.30)	(4.50)	(6.22)	(5.66)
Inflation-stock correlation	42.37**	39.99**	27.80**	44.88**	26.81**
	(10.22)	(8.62)	(9.65)	(7.66)	(3.94)
Real uncertainty and other control variables					
Equity volatility (Ann.)	0.86	1.52*	1.35*	1.62*	-0.18
	(0.88)	(0.59)	(0.66)	(0.62)	(0.85)
Dividend-price ratio (Ann.)	8.41	14.65**	4.65	26.00**	28.77**
	(4.50)	(5.28)	(3.43)	(7.42)	(10.22)
GDP vol.				6.77	
				(4.68)	
Log T-bill				-11.78**	
				(3.46)	
Log yield curve slope				-9.64*	
				(4.36)	
Idiosyncratic volatility (Ann.)					0.87
					(0.58)
Leverage					-1.19**
					(0.44)
Bond volatility (Ann.)					56.21*
					(23.28)
Bond-stock correlation					71.35**
					(19.66)
Business cycle and inflation shock variables (Logs)	Yes	Yes	Yes	Yes	Yes
Residual R2	0.30	0.30	0.27	0.41	0.55
Time fixed effects		Yes			
Period	Full	Full	69.Q4-07.Q4	Full	89.Q1-09.Q4

Predicting U.S. Baa Credit Loss Rates (1969-2010)

$$\underbrace{loss_{US,t\to t+n}}_{\text{Loss rate}} = \lambda^0_{US} + \lambda^{\sigma^\pi}\sigma^\pi_{US,t} + \lambda^{\rho^\pi}\rho^\pi_{US,t} + \lambda^{\sigma^{eq}}\sigma^{eq}_{US,t} + \lambda^{DP}DP_{US,t} + \Lambda X_{US,t} + \eta_{US,t}$$

	(1)	(2)	(3)	(4)	(5)
Horizon n (Years)	1	2	3	4	5
Inflation risk					
Inflation volatility (Ann.)	2.66	13.89*	19.34**	16.97**	17.31**
	(4.89)	(5.69)	(2.71)	(3.61)	(5.58)
Inflation-stock correlation	7.52	11.74**	21.83**	17.05**	18.47**
	(6.84)	(3.71)	(7.85)	(5.51)	(6.52)
Real uncertainty and other control variables					
Idiosyncratic volatility (Ann.)	0.19	0.51*	0.62*	0.52*	0.20
	(0.36)	(0.23)	(0.24)	(0.25)	(0.34)
Dividend-price ratio (Ann.)	-0.20	-1.45	-1.65	-0.53	-0.81
	(1.33)	(1.78)	(1.07)	(1.04)	(0.94)
Business cycle and inflation shock variables (Logs)					
	Yes	Yes	Yes	Yes	Yes
R2	0.29	0.48	0.75	0.69	0.59

Conclusion

- Credit spread indexes from six developed countries price risk of debt deflation
  - One standard deviation move in inflation volatility or inflation-stock return correlation increases spreads by 14 bps compared to average spread of 100 bps
- Inflation volatility and inflation-stock correlation forecast U.S. Baa credit losses
- Empirical magnitudes consistent with real business cycle model
- Above average inflation-stock correlation contributes 34 bps to 104 bps U.S. Baa-Aaa credit spread (2010.Q4)