International Yield Co-movements

Geert Bekaert[1] Andrey Ermolov[2]

18^{th} Paris December Finance Meeting - December 17, 2020

[1]Columbia Business School and NBER
[2]Gabelli School of Business, Fordham University

Research Question

- What drives nominal and inflation-linked yield (co-)variation?
- Time t n-period nominal zero-coupon yield:

$$y_t^{N,n} = \underbrace{r_t^n}_{\text{real yield}} + \underbrace{E_t[\pi_{t,t+n}]}_{\text{expected inflation}} + \underbrace{\varphi_t^n}_{\text{inflation risk premium}}$$

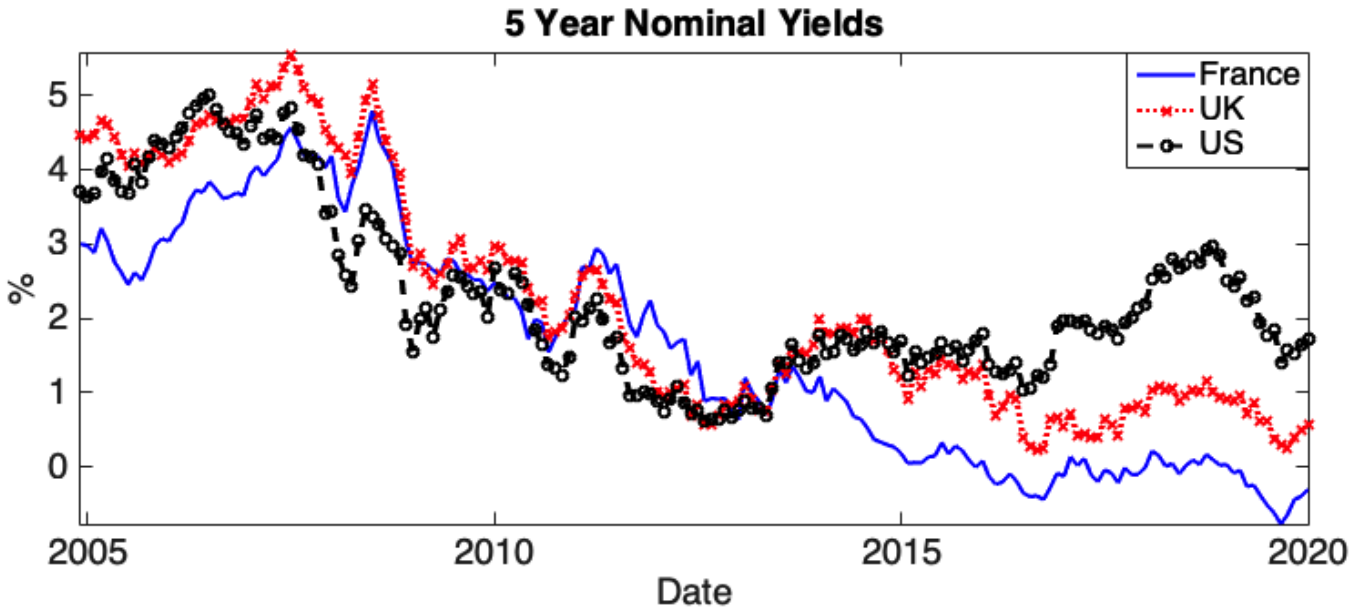
- Time t n-period inflation-linked yield:

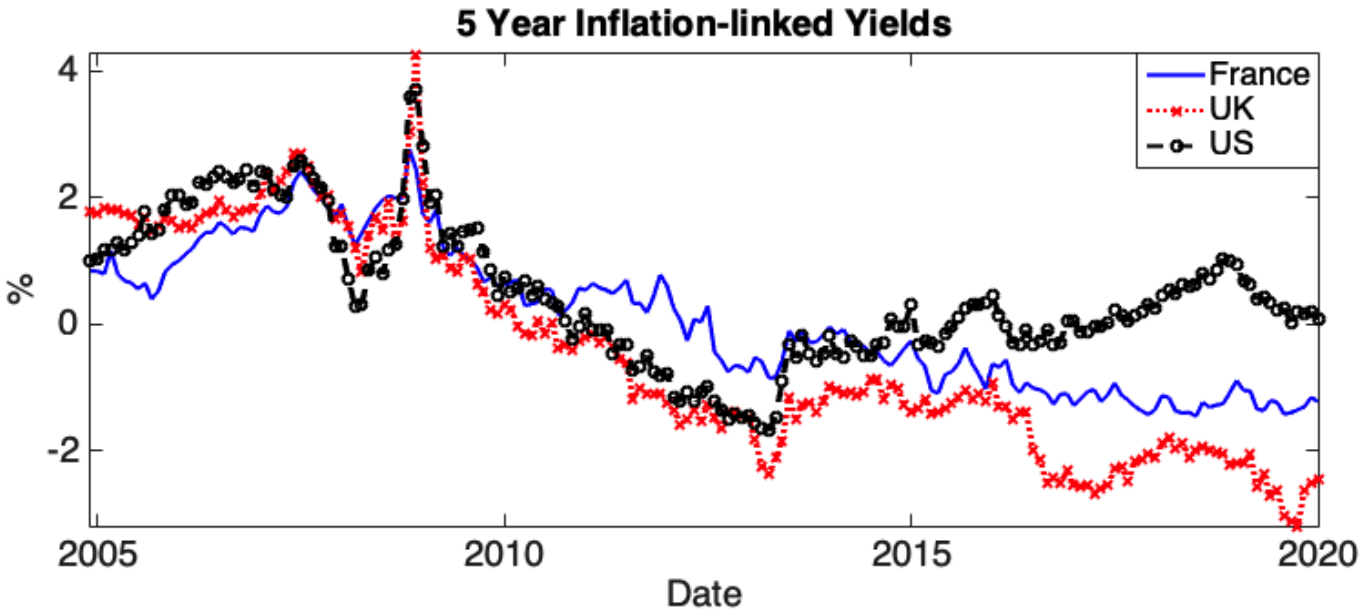
$$y_t^{IL,n} = \underbrace{r_t^n}_{\text{real yield}} + \underbrace{l_t^n}_{\text{liquidity premium}}$$

Research Question

- How do yields and their components comove across countries? Jotikasthira, Le, and Lundblad (2015): nominal yields highly correlated across US, UK, and Germany, driven by the inflation component
- What has changed since the Great Recession? Is inflation "dead"?
- Can we explain yield (co-)variation with economic determinants?: habit model of interest rates

Yields


5 Year Nominal Yields
France
UK
US
%
5
4
3
2
1
0
2005
2010
2015
2020
Date


5 Year Inflation-linked Yields
France
UK
US
%
4
2
0
-2
2005
2010
2015
2020
Date

Yields: Summary statistics

Full sample: 2004M11-2019M12						
	Nominal yields			Inflation-linked yields		
	France	UK	US	France	UK	US
Average	1.61%	2.23%	2.32%	0.11%	-0.43%	0.48%
	(0.59%)	(0.56%)	(0.38%)	(0.43%)	(0.60%)	(0.38%)
Standard deviation	1.56%	1.58%	1.19%	1.12%	1.68%	1.10%
	(0.12%)	(0.16%)	(0.14%)	(0.12%)	(0.14%)	(0.12%)
Correlation with US	0.67	0.85	1.00	0.66	0.78	1.00
	(0.14)	(0.07)		(0.17)	(0.12)	
Correlation with UK	0.93	1.00	0.85	0.94	1.00	0.78
	(0.08)		(0.07)	(0.08)		(0.12)

Yields: Subsamples

Subsample 1: 2004M11-2012M5						
	Nominal yields			Inflation-linked yields		
	France	UK	US	France	UK	US
Average	2.99%	3.47%	2.95%	1.08%	0.93%	1.08%
Standard deviation	0.86%	1.32%	1.30%	0.67%	1.24%	1.15%
Correlation with US	0.76	0.93	1.00	0.79	0.93	1.00
Correlation with UK	0.89	1.00	0.93	0.83	1.00	0.93
Subsample 2: 2012M6-2019M12						
	Nominal yields			Inflation-linked yields		
	France	UK	US	France	UK	US
Average	$0.23\%^{***}$	$0.99\%^{***}$	$1.69\%^{**}$	$-0.86\%^{***}$	$-1.80\%^{***}$	$-0.12\%^{***}$
Standard deviation	$0.53\%^{*}$	$0.46\%^{**}$	$0.58\%^{**}$	$0.42\%^{*}$	$0.60\%^{**}$	$0.63\%^{**}$
Correlation with US	-0.38^{***}	0.08^{***}	1.00	-0.50^{***}	-0.25^{***}	1.00
Correlation with UK	0.61^{*}	1.00	0.08^{***}	0.76	1.00	-0.25^{***}

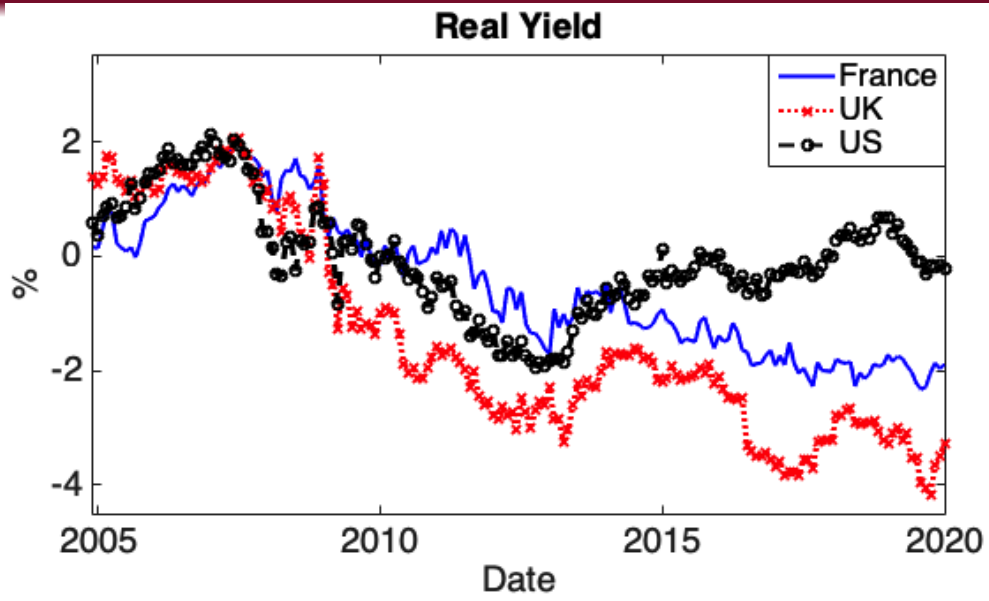
Yield Decompositions

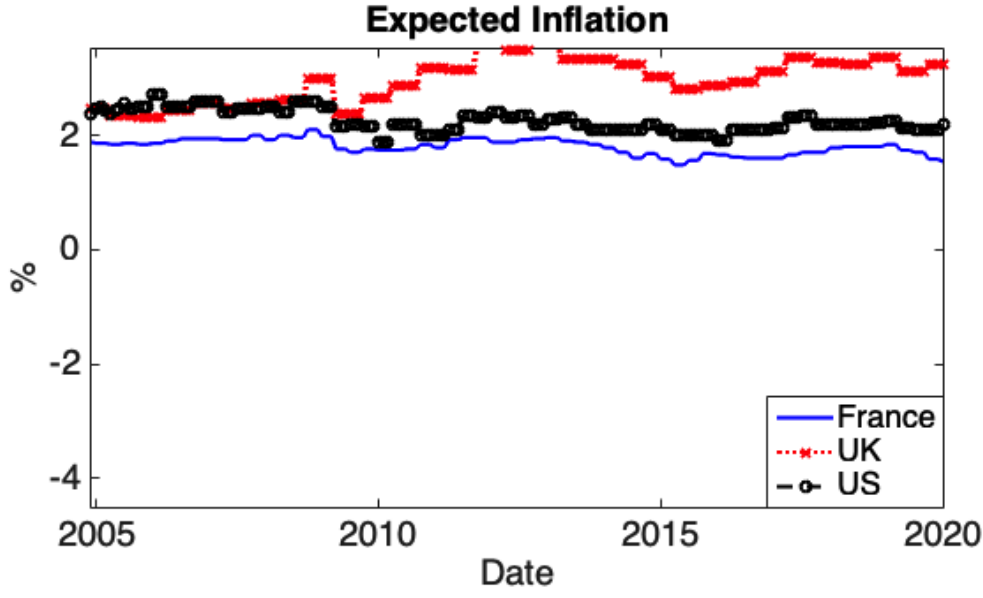
- Expected inflation from survey forecasts (e.g., Ang et al., 2007)
- Liquidity premium estimated by regressing the difference between nominal and inflation-linked yields adjusted for expected inflation on liquidity proxies (e.g., Gürkaynak et al., 2010):

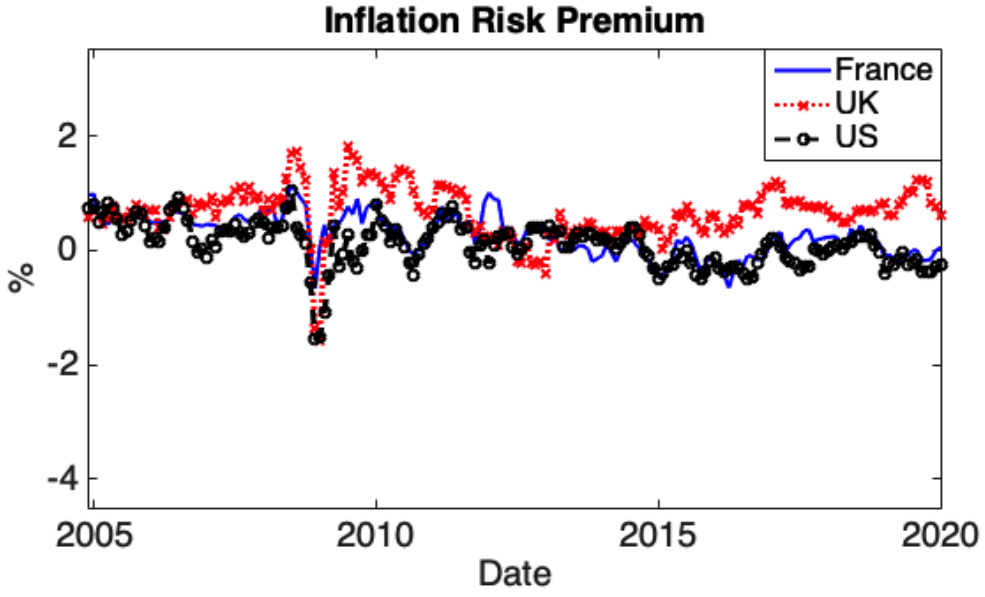
  $y_{t,i}^{N,n} - y_{t,i}^{IL,n} - E_{t,i}[\pi_{t,t+n}] = c_1 + c_2' lp_{t,i} + \epsilon_{t,i}$,
  $i =$ France, UK, US

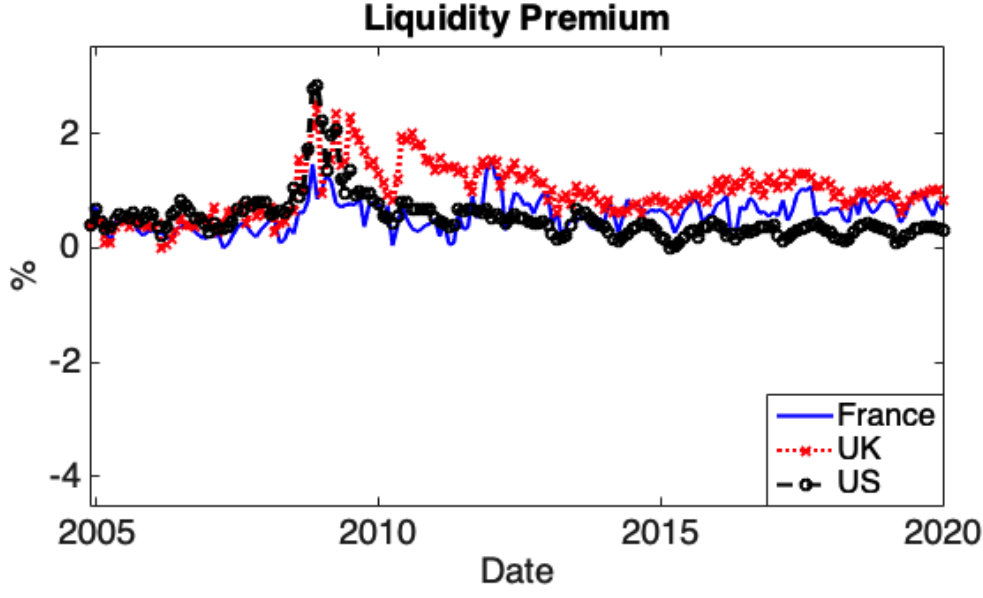
- Liquidity proxies ($lp_{t,i}$): inflation swap spread, log(share of inflation-linked debt), log(months since inception of inflation-linked debt)
- Inflation risk premium: $\varphi_t^n = y_t^{N,n} - E_t[\pi_{t,t+n}] - r_t^n$

5 Year Zero-coupon Yield Components









Variance Decompositions

$$\frac{Var(\text{nominal yield})}{Var(\text{nominal yield})} = \frac{Cov(\text{nominal yield}, \text{nominal yield})}{Var(\text{nominal yield})} = \frac{Cov(\text{real yield} + \text{expected inflation} + \text{inflation risk premium}, \text{nominal yield})}{Var(\text{nominal yield})} = \frac{Cov(\text{real yield}, \text{nominal yield})}{Var(\text{nominal yield})} + \frac{Cov(\text{expected inflation}, \text{nominal yield})}{Var(\text{nominal yield})} + \frac{Cov(\text{inflation risk premium}, \text{nominal yield})}{Var(\text{nominal yield})}$$

Nominal yield variance decomposition			
	France	UK	US
$\frac{Cov(\text{real yield}, \text{nominal yield})}{Var(\text{nominal yield})}$	77.22%	112.67%	75.27%
	(3.62%)	(4.06%)	(7.57%)
$\frac{Cov(\text{expected inflation}, \text{nominal yield})}{Var(\text{nominal yield})}$	6.29%	-19.65%	10.34%
	(1.18%)	(3.00%)	(2.75%)
$\frac{Cov(\text{inflation risk premium}, \text{nominal yield})}{Var(\text{nominal yield})}$	16.49%	6.98%	14.39%
	(2.74%)	(4.61%)	(5.22%)
Inflation-linked yield variance decomposition			
	France	UK	US
$\frac{Cov(\text{real yield}, \text{inflation-linked yield})}{Var(\text{inflation-linked yield})}$	107.30%	105.59%	81.74%
	(5.00%)	(6.43%)	(12.07%)
$\frac{Cov(\text{liquidity premium}, \text{inflation-linked yield})}{Var(\text{inflation-linked yield})}$	-7.30%	-5.59%	18.26%
	(5.00%)	(6.43%)	(12.07%)

- Similar results for subsamples

Nominal Yield Correlation Decomposition

$$\frac{Cov(\text{nominal yield}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)} = \frac{Cov(\text{real yield}_1 + \text{expected inflation}_1 + \text{inflation risk premium}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)} =$$
$$\frac{Cov(\text{real yield}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)} + \frac{Cov(\text{expected inflation}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)} + \frac{Cov(\text{inflation risk premium}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)}$$

	France-UK	France-US	UK-US
Full sample: 2004M11-2019M12			
$\frac{Cov(\text{real yield}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)}$	0.74	0.53	0.94
$\frac{Cov(\text{expected inflation}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)}$	0.05	0.03	-0.19
$\frac{Cov(\text{inflation risk premium}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)}$	0.14	0.11	0.09
Total correlation	0.93	0.67	0.85
Subsample 1: 2004M11-2012M5			
$\frac{Cov(\text{real yield}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)}$	0.78	0.67	1.12
$\frac{Cov(\text{expected inflation}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)}$	0.03	0.02	-0.24
$\frac{Cov(\text{inflation risk premium}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)}$	0.08	0.07	0.06
Total correlation	0.89	0.76	0.93
Subsample 2: 2012M6-2019M12			
$\frac{Cov(\text{real yield}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)}$	0.63	-0.43***	-0.27***
$\frac{Cov(\text{expected inflation}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)}$	0.01	-0.03	-0.03
$\frac{Cov(\text{inflation risk premium}_1, \text{nominal yield}_2)}{SD(\text{nominal yield}_1)SD(\text{nominal yield}_2)}$	-0.03**	0.07	0.38*
Total correlation	0.61*	-0.38***	0.08***

Consumption-based Asset Pricing Model

- External habit model with log pricing kernel:
$$m_{t+1} = \ln \beta - \gamma \cdot \underbrace{\Delta c_{t+1}}_{\text{consumption growth}} + \gamma \cdot \Delta \underbrace{q_{t+1}}_{\text{"risk aversion"}}$$

- Consumption growth: $\Delta c_{t+1} = g_t + \sigma_{cc}\sqrt{v_t}\epsilon^c_{t+1}$

- "Risk aversion":
$$q_{t+1} = \mu_q(1-\phi_{qq}) + \phi_{qq}q_t + \sigma_{qc}\sqrt{v_t}\epsilon^c_{t+1} + \sigma_{qq}\sqrt{q_t}\epsilon^q_{t+1}$$

- Expected consumption growth:
$$g_{t+1} = \mu_g(1-\phi_{gg}) + \phi_{gg}g_t + \sigma_{gc}\sqrt{v_t}\epsilon^c_{t+1} + \sigma_{gg}\epsilon^g_{t+1}$$

- Consumption growth uncertainty:
$$v_{t+1} = \mu_v(1-\phi_{vv}) + \phi_{vv}v_t + \sigma_{vc}\sqrt{v_t}\epsilon^c_{t+1} + \sigma_{vv}\sqrt{v_t}\epsilon^v_{t+1}$$

Model Solution

- With Gaussian shocks, real term structure is affine in the state variables: $r_t^n = r_{0,n} + r_{1,n}' X_t$
- Real short rate: $r_t = \mu_r + \gamma g_t + b_{rv} v_t + b_{rq} q_t$, where

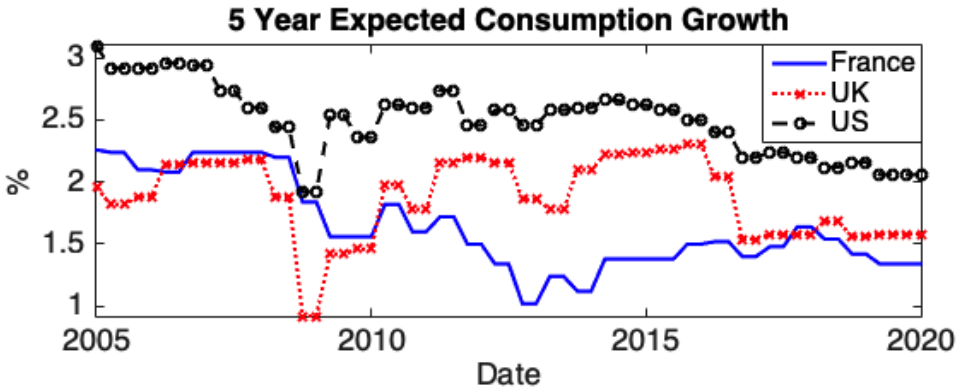
$$b_{rv} = \underbrace{-\frac{1}{2}\gamma^2(\sigma_{cc} - \sigma_{qc})^2}_{\text{precautionary savings}}$$

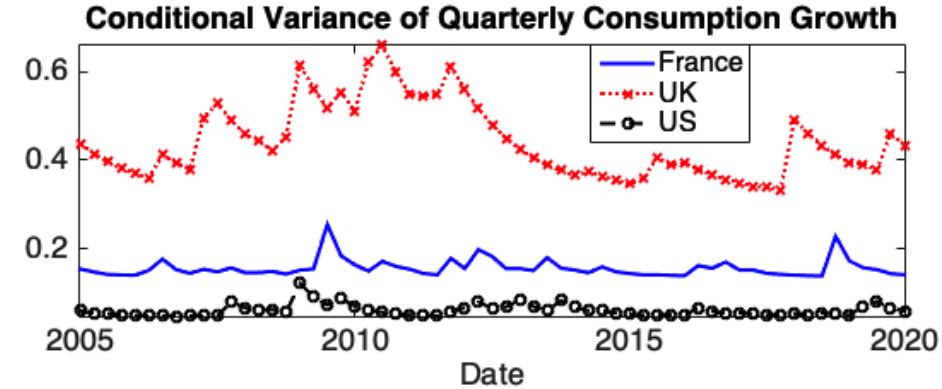
$$b_{rq} = \underbrace{\gamma(1 - \phi_{qq})}_{\text{intertemporal smoothing}} \underbrace{-\frac{1}{2}\gamma^2\sigma_{qq}^2}_{\text{precautionary savings}}$$

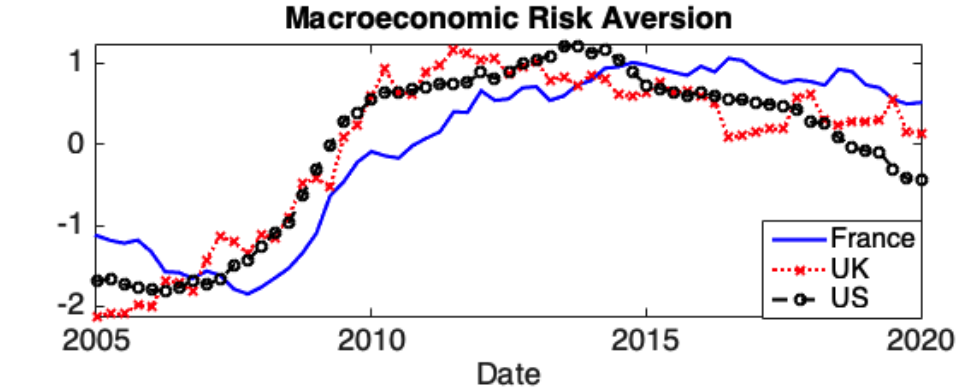
Variable Construction

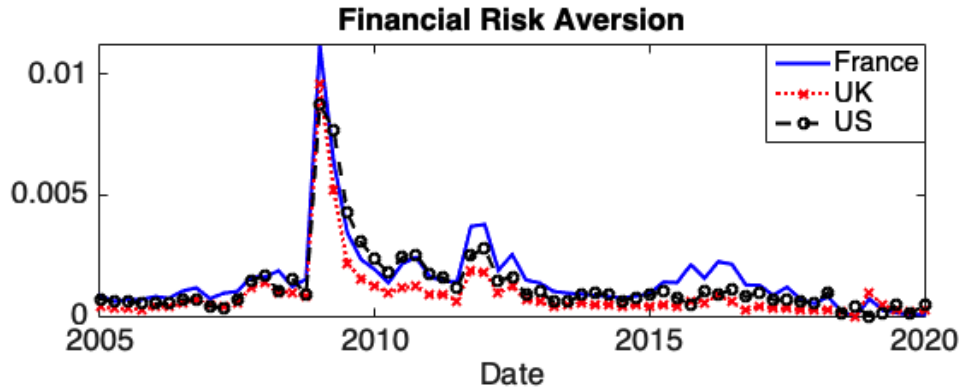
- g_t = survey expected consumption growth from Consensus Economics
- v_t = GRJ-GARCH model estimates on consumption growth residuals
- q_t-"macro" risk aversion: negative weighted average of past consumption shocks (Wachter, 2006)
- q_t-"financial" risk aversion: variance risk premium (Bekaert, Engstrom, and Xu, 2019)

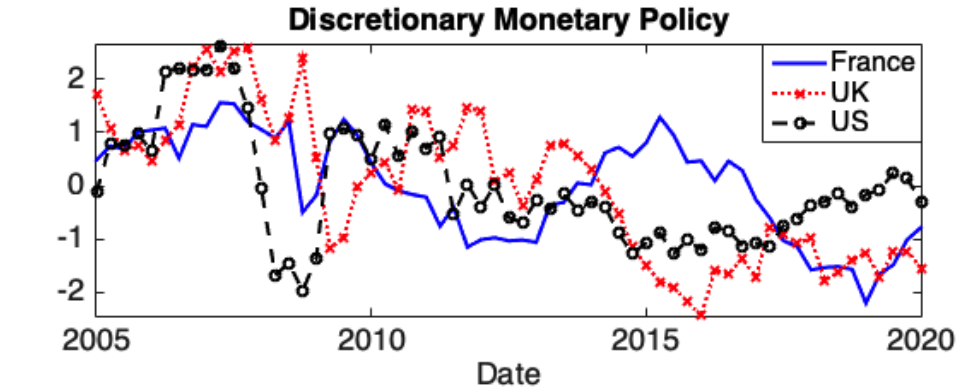
Variables

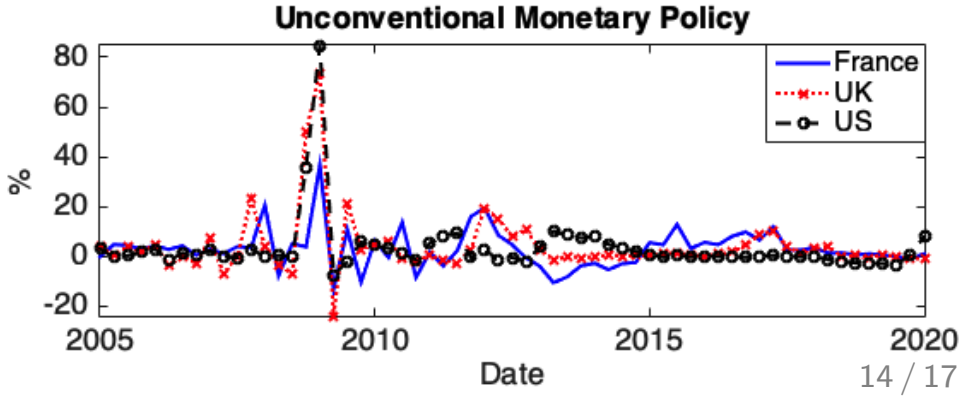

5 Year Expected Consumption Growth
%
Date
France
UK
US
2005
2010
2015
2020


Conditional Variance of Quarterly Consumption Growth
Date
France
UK
US
2005
2010
2015
2020


Macroeconomic Risk Aversion
Date
France
UK
US
2005
2010
2015
2020


Financial Risk Aversion
Date
France
UK
US
2005
2010
2015
2020


Discretionary Monetary Policy
Date
France
UK
US
2005
2010
2015
2020


Unconventional Monetary Policy
%
Date
France
UK
US
2005
2010
2015
2020

Estimation via OLS

Regressing 5 year real yields on economic factors

	France	UK	US
Expected consumption growth	-0.17	1.49*	-0.57
	(0.65)	(0.86)	(0.35)
Consumption growth variance	1.75	2.01	-18.48**
	(2.44)	(1.90)	(7.92)
Macroeconomic risk aversion	-1.03***	-1.32***	-0.57***
	(0.19)	(0.10)	(0.11)
Financial risk aversion	90.84	142.19	-81.63
	(99.09)	(96.95)	(56.41)
Discretionary monetary policy	0.26*	0.35***	0.36***
	(0.13)	(0.08)	(0.10)
Unconventional monetary policy	-0.01	0.02	0.01
	(0.02)	(0.01)	(0.01)
Adjusted R^2	84.69%	85.09%	79.04%

Model: Real Yield Correlations

France-UK			
	Full sample	Subsample 1	Subsample 2
Data	0.91	0.81	0.75
Model 1: Macro risk aversion	0.84	0.89	-0.15
Model 2: Discretionary monetary policy	0.35	0.14	-0.07
Model 3: Macro risk aversion+Discretionary monetary policy	0.92	0.88	-0.05
France-US			
	Full sample	Subsample 1	Subsample 2
Data	0.54	0.77	-0.51
Model 1: Macro risk aversion	0.86	0.92	0.26
Model 2: Discretionary monetary policy	0.33	0.46	-0.69
Model 3: Macro risk aversion+Discretionary monetary policy	0.82	0.88	-0.52
UK-US			
	Full sample	Subsample 1	Subsample 2
Data	0.71	0.90	-0.20
Model 1: Macro risk aversion	0.95	0.98	0.71
Model 2: Discretionary monetary policy	0.51	0.14	0.32
Model 3: Macro risk aversion+Discretionary monetary policy	0.88	0.92	-0.07

- The model also matches yield variance decompositions and yield level drops after GFC

Conclusion

- Real yields are the main driver of nominal and inflation-linked yield variances and correlations: inflation is "dead"
- Risk aversion variable from a habit model and discretionary monetary policy:
  - key drivers of the real yield variance
  - explain (the change in) the correlation of real yields across countries (across time)