Long-term Investors and the Yield Curve

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What shapes the yield curve?

- Affine term structure models
- Consumption based models
- Preferred habitat models

What we know

- Pension funds and insurers (P&I) are key investors in government bond markets.
- P&Is' demand for long-term bonds affects yields.
  - Klingler & Sundaresan (2018); Greenwood & Vissing-Jorgensen (2010; 2018)

What we do not know

- How sizeable are the effects of demand shifts on yields?
- What are the motives behind demand shifts?
- How do different policy changes affect yields?

What I do

- Quantify the shift in demand following a regulatory reform.
- Show that heterogeneity in demand shifts has two drivers.
  - Liability duration and regulatory constraints of P&Is
- Estimate the direct effect of demand shifts on changes in yields.

Identification: change in the regulatory discount curve

- P&Is value liabilities and solvency positions using the regulatory discount curve.
- The new regulatory discount curve became a weighted average between market interest rates and a fixed rate (the UFR).

Figure 1: Regulatory discount curve

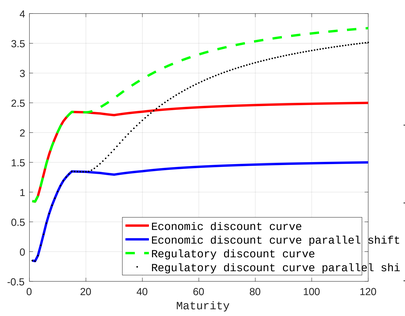
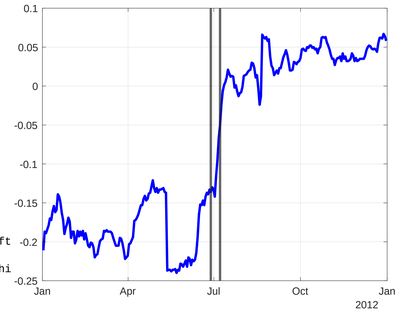


Figure 2: 30-20 year government bond spread



Model to explain demand shifts

- Optimal solution mean-variance problem of assets − liabilities:

$$w_{i,t}^{B*} = \underbrace{\frac{\mathbb{E}_{i,t}[r_{t+1}^B - r_f]}{(\gamma + \lambda(F_{i,t}^R))\mathrm{Var}_{i,t}[r_{t+1}^B]}}_{\text{speculative portfolio}} + \underbrace{\frac{\gamma}{\gamma + \lambda(F_{i,t}^R)} a_{i,t} \frac{1}{F_{i,t}^E}}_{\text{economic hedging portfolio}} + \underbrace{\frac{\lambda(F_{i,t}^R)}{\gamma + \lambda(F_{i,t}^R)} (\boldsymbol{\xi_L} \circ a_{i,t}) \frac{1}{F_{i,t}^R}}_{\text{regulatory hedging portfolio}},$$

with $a_{i,t}$ the distribution over liabilities; $F_{i,t}^E$ ($F_{i,t}^R$) the (regulatory) funding ratio.

- Regulatory reform changed $\xi_L = 1$ to $\xi_L < 1$ for long maturities.

Two predictions:

1. P&Is with long liability durations decrease long-term bond holdings more compared to the ones with short liability durations.
2. P&Is close to their capital requirement decrease bond long-term holdings more compared to less constraint ones.

Combining three data sources

- Security holdings database (2009Q1-2019q1)
  - Pension funds, insurers, banks, and mutual funds in the Netherlands
- CSDB database
  - Market information, e.g. price, currency, coupons, maturities, YTM
- Supervision database
  - Solvency positions and liability durations of insurers and pension funds

Regulatory reform decreased long-term bond holdings

Testing the two predictions:

1. $w_{it}^B(h) = \alpha + \beta_0 \mathrm{UFR}_t + \beta_1 \mathrm{UFR}_t \times D_{2012q1,i}^L + \beta_2 \mathrm{Controls}_{it} + \nu_i + \epsilon_{it}(h)$
2. $w_{it}^B(h) = \alpha + \beta_0 \mathrm{UFR}_t + \beta_1 \mathrm{UFR}_t \times D_{2012q1,i}^L \times \mathrm{FR}_{2012q1,i}^{-1} + \beta_2 \mathrm{Controls}_{it} + \nu_i + \epsilon_{it}(h)$

where $D_{2012q1,i}^L$ equals the liability duration and $\mathrm{FR}_{2012q1,i}^{-1}$ the inverse of the funding ratio prior to the regulatory reform.

Figure 3: Long-term bond holdings

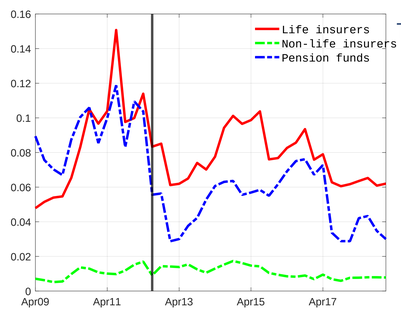


Table 1: Changes in long-term bond holdings

	Holdings $T \geq 30$			
UFR	0.0115		0.0128	
	(0.0080)		(0.0088)	
UFR × D_{2012q1}^L	−0.0023***	−0.0018***		
	(0.0007)	(0.0007)		
UFR × D_{2012q1}^L × $\mathrm{FR}_{2012q1}^{-1}$			−0.0027***	−0.0021**
			(0.0009)	(0.0009)
Controls	Yes	Yes	Yes	Yes
Fund FE	No	Yes	No	Yes
Time FE	No	Yes	No	Yes
N	2,376	2,376	2,349	2,349
R^2	0.11	0.61	0.11	0.61

Changes in bond holdings affected long-term yields

- Demand curves (Koijen and Yogo 2019; 2020):

$$\ln w_{i,t}(h) A_t = \ln H_{i,t}(h) = \alpha_i + \beta_{0i} y_t(h) + \beta_{1i}' x_t(h) + \beta_{2i} \ln(H_{i,2009q2}(h)) + \beta_{3i} y_t^{DE} + \epsilon_{i,t}(h).$$

- Challenge: we need an instrument for $y_t(h)$.
- UFR weights as exogenous demand shocks for each maturity.
- The instrument $z_t(h)$ is the average weight assigned to the UFR.
- Price elasticity of demand: $\frac{\partial q_{it}(h)}{\partial p_{it}(h)} = 1 + 100 \frac{\beta_{0i}}{T_{ht}} (1 - w_{it}(h))$.

Figure 4: Weights investor types over maturities

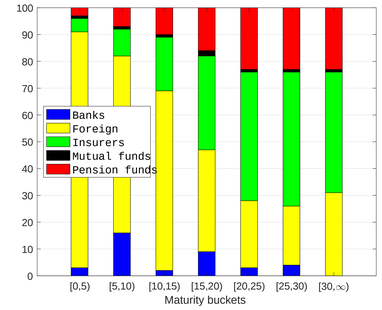


Table 2: Price elasticity of demand

	obs.	mean	std.dev.	min	max
Banks	209	23.93	25.57	5.67	83.88
Foreign investors	243	4.53	1.89	1.84	11.28
Insurance companies	243	−29.95	31.68	−102.44	−6.93
Mutual funds	243	8.30	6.82	1	22.23
Pension funds	243	−18.61	20.19	−63.63	−3.97
Total	2.05				

- Back-of-the-envelope: P&Is sold 22 percent of 30-year Dutch government bonds outstanding. This implies an increase in the 30-year yield of $22\%/2.05/30 = 36$ bps.

Key findings

- P&Is decreased long-term bond holdings by 42% on average.
  - Effects stronger for long liability durations or binding capital constraints.
- The effect on long-term bond yields equals 24 bps on average.
  - Effect is stronger for longer maturity bonds.

Policy implications for QE

- Mechanism in the way the regulatory reform and QE affect yields is similar → shock in demand from preferred habitat investors.
- Compared to QE, this regulatory reform unlikely affected expectations → well identified evidence for the workings of QE.

- My findings suggest to incorporate the regulatory framework of long-term investors when assessing the effects of QE.