

Pension Liquidity Risk

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Views expressed are our own and do not necessarily reflect official positions of DNB or the Eurosystem.

Conventional Wisdom: Pension funds are stable long-term investors

- ▶ Target asset allocations (e.g., 60% stocks - 40% bonds).
- ▶ Pension funds buy assets after negative realized returns (Grinblatt and Keloharju 2000; Timmer 2018).
- ▶ Not exposed to liquidity risk (i.e., no withdrawal risk).

UK pension crisis in 2022: Liquidity issues due to Liability Driven Investment (LDI) strategies.

Our study: Margin calls from derivative positions challenge this view.

Pension funds are large fixed receivers in long-dated swaps

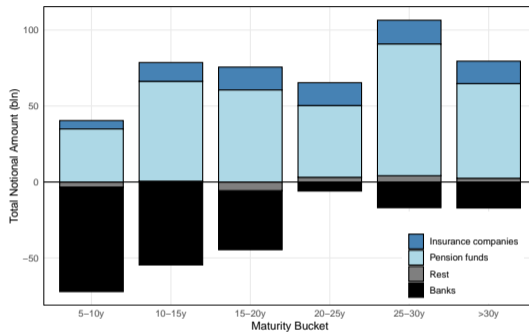


Figure 1: Net notional values of euro-denominated interest rate swaps for Dutch counterparties.
Source: EMIR data.

- ▶ Pension funds are net fixed receivers in long-dated swaps.
- ▶ At the long end, net positions exceed those of other counterparties.

This Paper

Step #1: Link pension funds' swap usage to pension regulation.

- ▶ Pension regulation targets interest rate risk.
- ▶ More swap usage when (regulatory) constraints more binding.

Step #2: Study liquidity risk due to swap usage.

- ▶ Margin call risk due to rising interest rates: 3-6% of AUM.
Cash buffers are significantly smaller ($\approx 2\%$ of AUM).
- ▶ Rate surges prompt forced sales of safe short-term euro bonds.

Step #3: Price impact of bond sales.

- ▶ Pension funds' selling amplified rate surges by 12% in 2022.

The Dutch pension sector as a useful laboratory

- ▶ Large pension sector that is representative for the euro area.
 - ▶ Pension sector is \$2.04 trillion and covers 53% of euro area pension assets (OECD, 2021).
 - ▶ As comparison, US corporate DB plans equal \$2.78 trillion.
- ▶ Detailed data on asset holdings, derivative positions, and liabilities.
 - ▶ Data on all three sources simultaneously typically scarce.

Pension regulation

- ▶ Standalone defined-benefit pension schemes.
- ▶ Pension funds are evaluated based on the ratio between pension assets and liabilities, or the **funding ratio**.
 - ▶ Liabilities are valued against 'risk-free' market interest rates: the euro swap rates.
- ▶ **Required funding ratio**: funding ratio pension fund should have to withstand adverse market shocks.
 - ▶ Key risk factor: interest rate risk (*not* liquidity risk).
 - ▶ If not compliant, file recovery plan to the supervisor.
- ▶ Pension funds must exchange collateral on derivatives (EMIR).

Data

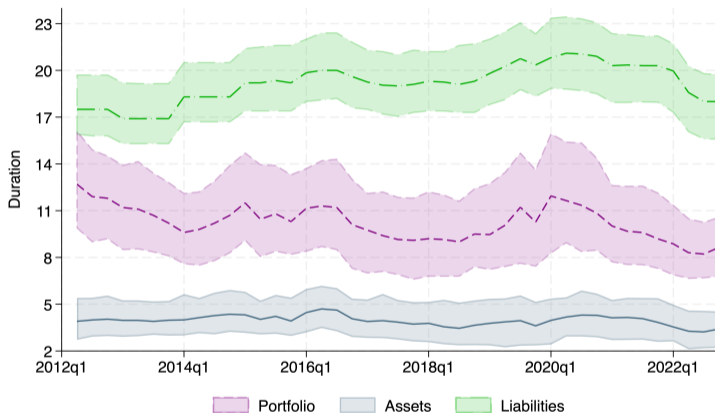
- ▶ Quarterly regulatory filings of Dutch pension funds over the period 2012q1-2022q4 (*source*: Dutch Central Bank).
 - ▶ Funding ratios, swap usage, liability durations etc.
 - ▶ 258 pension funds.
- ▶ Monthly portfolio holdings (*source*: Dutch Central Bank).
 - ▶ 42 pension funds: 85-90% in terms of total pension assets.

Summary statistics

	mean	sd	p5	p50	p95
AUM (bln)	6.74	34.02	0.06	0.75	24.35
Funding ratio	110.17	14.47	92.30	108.56	133.00
Required funding ratio	116.92	5.74	109.10	116.50	124.80
Net contributions (% AUM)	0.26	0.83	-0.74	0.10	1.69
Allocation fixed income	55.70	21.30	19.63	56.15	87.18
Allocation cash	2.26	4.69	-0.36	1.12	8.62
Allocation equity	33.31	12.23	16.21	32.04	53.89
Duration liabilities	19.38	3.67	13.95	19.00	25.89
Duration portfolio	10.65	4.17	4.40	10.30	17.70
Duration assets	4.29	2.23	1.09	4.00	8.44
Duration swaps	6.53	4.46	0.00	6.18	14.39

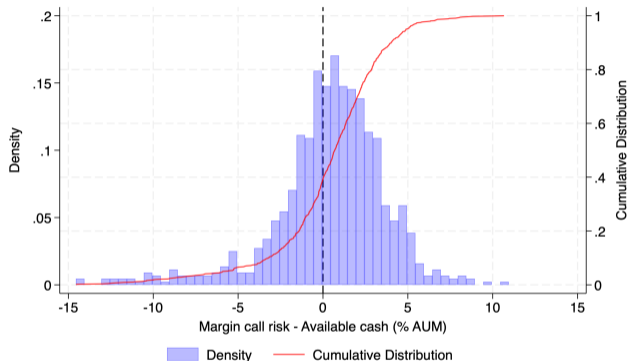
Bond-country allocations

Stylized fact #1: Pension funds use swaps to hedge their liabilities



- ▶ Portfolio Duration = Asset Duration + Swap Duration
- ▶ Adjustments in portfolio duration mainly come from swaps.

Stylized fact #2: Margin calls usually exceed available cash buffers



Margin call proxy: $Dur_{i,t-1}^S \times \Delta y_t$

- ▶ Dur^S : swap duration
- ▶ Δy : realized change in interest rates

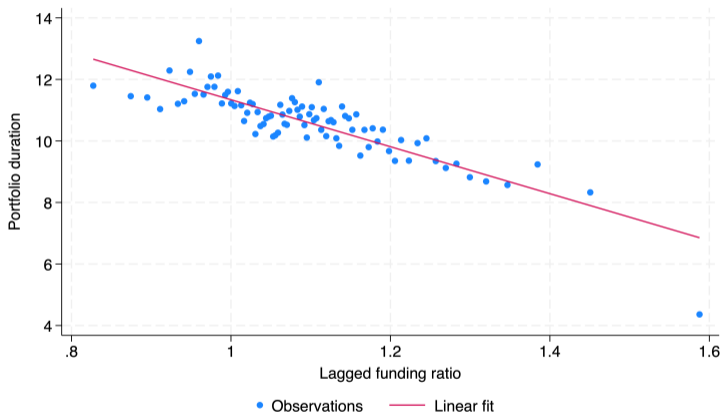
Hypotheses

- ▶ **Hypothesis 1:** Worse funding ratio \Rightarrow more swap usage (higher duration of swap portfolio).
- ▶ **Hypothesis 2:** Higher swap duration \Rightarrow more exposure to margin calls \Rightarrow forced selling of safe and liquid assets during rate surges (pecking order).
- ▶ **Hypothesis 3:** Forced selling has adverse price impact on safe assets.

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The correlation between funding ratios and portfolio duration



- ▶ Portfolio duration increases when lagged funding gap is high.

Does portfolio duration increase because of bonds or swaps?

$$Dur_{i,t} = \beta \text{ Funding Ratio}_{i,t-1} + \gamma C_{i,t-1} + \alpha_i + \lambda_t + \varepsilon_{i,t}$$

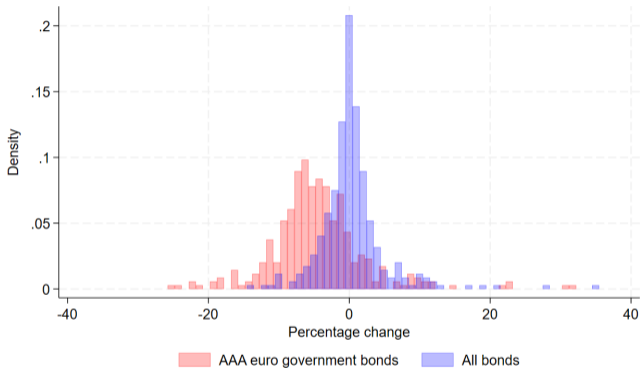
	Portfolio Duration		Swap Duration		Asset Duration	
	(1)	(2)	(3)	(4)	(5)	(6)
Funding Ratio ($t - 1$)	-2.806*	-3.853**	-3.479**	-4.072**	0.511	-0.323
	[1.575]	[1.811]	[1.480]	[1.903]	[0.568]	[1.020]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	Yes	No	Yes	No	Yes
Fund FE	No	Yes	No	Yes	No	Yes
Obs.	7366	7366	7178	7177	7375	7375
R^2	0.308	0.782	0.252	0.779	0.245	0.745

- Increase in portfolio duration in response to decline in funding ratio fully driven by swaps.

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Selling behavior when interest rates surge



- ▶ Interest rate surges: May and June 2015, March 2020, and several months 2022.
- ▶ Euro-area AAA government debt: Germany + the Netherlands.
- ▶ Aggregate sales of euro-area AAA government bonds.

Pension funds with large swap exposures sell their most liquid bonds

- Pension fund-bond level regressions (months large IR surges):

$$\Delta\%Hold_{i,j,t} = \beta Dur_{i,t-1}^S \times \mathbb{1}\{AAA_{j,t}\} \times \mathbb{1}\{T \leq 7\}_{j,t} + \gamma C_{i,j,t} + \delta_j + \alpha_{i,t} + \varepsilon_{i,j,t}$$

	%Hold					
	(1)	(2)	(3)	(4)	(5)	(6)
$Dur^S(t-1) \times \mathbb{1}\{AAA\ Bond\}$	-0.086*** [0.028]	-0.085*** [0.029]	-0.080*** [0.029]	-0.007 [0.036]	-0.006 [0.034]	0 [0.033]
$Dur^S(t-1) \times \mathbb{1}\{AAA\ Bond\} \times \mathbb{1}\{T < 7\}$				-0.196*** [0.053]	-0.220*** [0.059]	-0.221*** [0.059]
$Dur^S(t-1) \times \mathbb{1}\{T < 7\}$				0.01 [0.008]	0.012 [0.009]	0.01 [0.009]
$\mathbb{1}\{AAA\ Bond\} \times \mathbb{1}\{T < 7\}$				1.426** [0.599]		
$Dur^S(t-1)$	0.011*** [0.004]	0.037*** [0.010]		0.006 [0.006]	0.030** [0.012]	
$\mathbb{1}\{AAA\ Bond\}$	0.607* [0.321]			0.051 [0.402]		
$\mathbb{1}\{T < 7\}$				-0.084 [0.114]		
Security FE	No	No	No	No	No	No
Security-Time FE	No	Yes	Yes	No	Yes	Yes
Fund-Time FE	No	No	Yes	No	No	Yes
Obs.	420118	355131	355131	420118	355131	355131
R^2	0.00	0.54	0.55	0.00	0.54	0.55

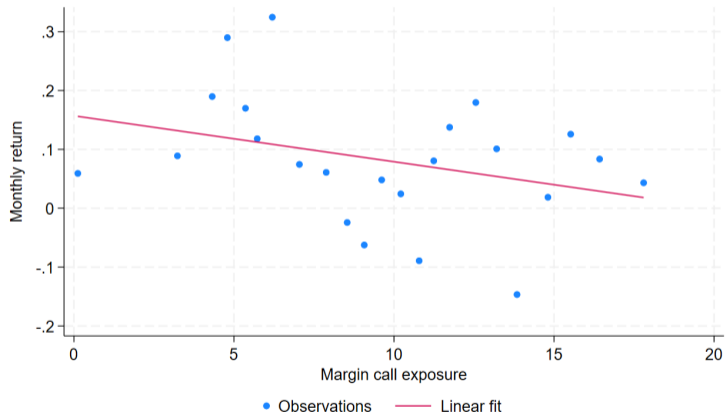
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The price impact of margin call sales

- ▶ We test if bonds held by pension funds subject to margin call risk experience greater price drops during interest rate surges.
- ▶ Bond-level measure of margin call risk: $MC_t^b = \sum_i Dur_{i,t}^{Swap} \frac{N_{i,t}^b}{\sum_i N_{i,t}^b}$.
 - ▶ $Dur_{i,t}^{Swap}$: swap duration of fund i .
 - ▶ $N_{i,t}^b$: nominal value of bond b held by fund i .
- ▶ **Intuition**: MC_t^b higher if pension funds with larger margin call risk hold the bond.

Negative correlation between returns and margin call measure during interest rate surges



Bonds subject to selling pressure from margin calls drop more in value

Bond-level regression: $r_{t+10d}^b = \alpha + \beta MC_t^b + \gamma C_t^b + \varepsilon_{t+10d}^b$

	Margin Call Proxy			Margin Call Realized		
	(1)	(2)	(3)	(4)	(5)	(6)
MC ($t - 1$)	-0.012** [0.006]	-0.058** [0.024]	-0.088*** [0.027]	-0.046*** [0.005]	-0.127*** [0.018]	-0.132*** [0.020]
Add. controls	Yes	Yes	Yes	Yes	Yes	Yes
Year-to-maturity FE	No	No	Yes	No	No	Yes
Obs.	510	510	510	390	390	390
R^2	0.53	0.53	0.54	0.55	0.56	0.56

Add. controls include: Age, Coupon, Log(Outst), 1(*Inflation Linked*), 1(*Dutch*)

- ▶ August 2022: Pension funds sold **0.61%** of safe short-term bonds outstanding.
- ⇒ Selling due to margin calls increased 3-year yield by **10.4 bps** (12% of increase).

Conclusion

Pension funds use swaps as hedging tool for interest rate risk.

- ▶ Pension funds increase swap usage when funding ratios deteriorate.
- ▶ This raises margin risk: collateral requirements can be as large as 3-6% of AUM.

Consequence:

- ▶ When interest rates surge: they sell safe bonds to fulfill margin calls which further amplifies rate surges.

Bond-country allocations

[back](#)

Panel B: Monthly Bond Holdings Data

	mean	sd	p5	p50	p95	<i>N</i>
% in the Euro area	70.04	18.52	35.91	70.77	100.00	5490
% in corporate bonds	34.07	20.78	0.00	34.06	69.09	5490
% in government debt	65.93	20.78	30.91	65.94	100.00	5490
% of gov debt in DE	31.67	18.55	5.51	29.34	66.66	5483
% of gov debt in NL	20.86	18.97	0.00	18.43	58.62	5483
