

Excess liquidity and the yield curve

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Note: The views expressed in this presentation do not necessarily reflect those of the European Central Bank or the Eurosystem.

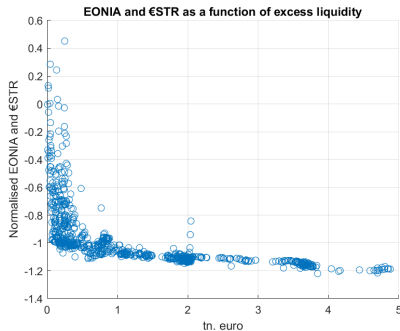
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Motivation

I. Schnabel (2024): “While aggregate *excess liquidity* would still be abundant [...] – around €2.1 trillion by the end of 2025 –, potential structural changes to reserve demand, [...], imply that there is *significant uncertainty* about *when*, and to what extent, *the fall in reserves* may put *upward pressure on overnight money market rates*, which could potentially affect the *monetary policy stance*.”



Notes: Weekly series of the scaled EONIA spread = $(\text{EONIA} - \text{MRO spread}) / (\text{MRO to DFR spread})$. Before scaling EONIA is reduced by the long-term historical spread between EONIA and €STR of 8.5 bps. Observations for October 2008 to July 2023.

Research question and contributions

Idea: model the nexus of excess liquidity and term structure of spreads

- ▶ Changes in expectations and uncertainty of future excess liquidity \Rightarrow
- ▶ impacts expectations and uncertainty of future spreads over policy rates \Rightarrow
- ▶ affects the yield curve today

Contributions:

- ▶ A novel nonlinear term structure model linking excess liquidity to the term structure of spreads
- ▶ Closed form pricing formulae for the spread
- ▶ **Policy application:** tool for (i) inferring excess liquidity perceptions (expectations, uncertainty) from information on spreads and (ii) scenario analyses

Outline

1. Motivation
2. Model
3. Case study
4. Summary
5. Background

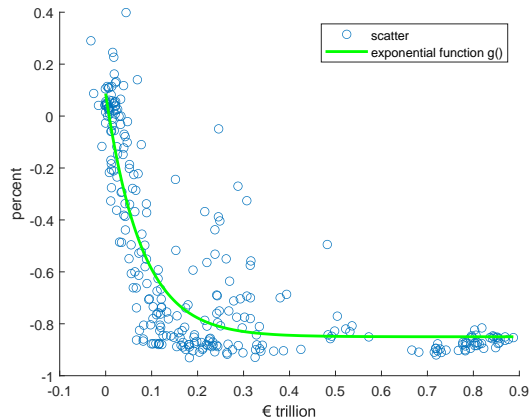
The nonlinear term structure model

Building blocks:

1. Mapping of excess liquidity (X_t) into overnight money market spread (S_t):

$$S_t = g(X_t) + \epsilon_t = a + b \cdot \exp(cX_t) + \epsilon_t, \quad b > 0, c < 0, \text{ for all periods } t, \quad \theta_1 = (a, b, c)$$

Example of nonlinear mapping $g(\cdot)$ over 2007-2013



Notes: Weekly series of the scaled EONIA spread = $(\text{EONIA} - \text{MRO spread}) / (\text{MRO to DFR spread})$. Observations for Aug 2007 to mid-Jan 2013.

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2. Dynamics of future excess liquidity X_t

- ▶ Ensuring $X_{t+h} > 0$

$$X_{t+h} = \max(0, Z_{t+h}), \quad Z_{t+h} \text{ is "shadow excess liquidity"}$$

- ▶ Gaussian process of Z_t , e.g. AR(1)

$$Z_t = \mu + \alpha(Z_{t-1} - \mu) + \nu_t, \quad \nu_t \sim N(0, \sigma^2), \quad \theta_2 = (\mu, \alpha, \sigma)$$

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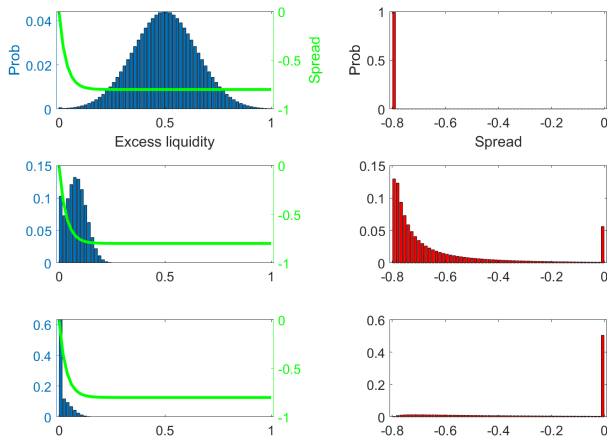
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Pricing implications:

- ▶ $Z_t, \theta_1 = (a, b, c)$ and $\theta_2 = (\mu, \alpha, \sigma) \Rightarrow$ **Cond. distribution of X_{t+h} and S_{t+h}**
- ▶ Model delivers closed form solutions, e.g. $E_t(S_{t+h}) = f_h(Z_t, \theta_1, \theta_2)$

Distributions of excess liquidity X_{t+h} and spread S_{t+h} : 3 constellations



Notes: Blue bars represent a distribution of excess liquidity X_{t+h} . The green line depicts the exponential mapping $g(X_t) = a + b \cdot \exp(cX_t)$. The red bars capture the corresponding distribution of spread S_{t+h} .

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25 Jan 2013: Surprise of early repayment of LTRO loans of €137bn (vs average expectations of €100bn)



German debt prices fell and banking stocks and the euro rose on news of the early repayment, which exceeded the 100 billion euros forecast in a Reuters poll of traders. Banks can repay the money early on a voluntary basis weekly from now on. Repayment of the second LTRO starts on February 27.

Banks to make big early payback of ECB crisis cash

By Paul Carrel

January 25, 2013 2:16 PM GMT+1 · Updated 11 years ago

LONDON, Jan 24 (Reuters) - Money markets are bracing for volatile trading in coming weeks which could lift short-term rates as banks start paying back the 1 trillion euros of ultra-cheap European Central Bank loans that have kept them afloat over the past year.

Front-end capitulates on LTRO payback concerns

By Reuters

January 17, 2013 2:55 PM GMT+1 · Updated 11 years ago

Aa



The capitulation stems from concerns over the return of a large chunk of LTRO funds at the end of the month, allied to market rumours that the ECB is considering new rules that would require banks to provide more information about loans used as collateral for LTRO borrowing.

MONEY MARKETS-ECB payback pushes markets into uncharted water

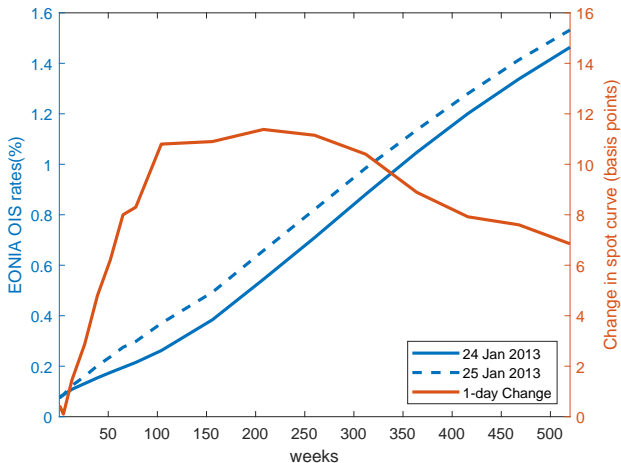
By Reuters

January 24, 2013 3:50 PM GMT+1 · Updated 11 years ago

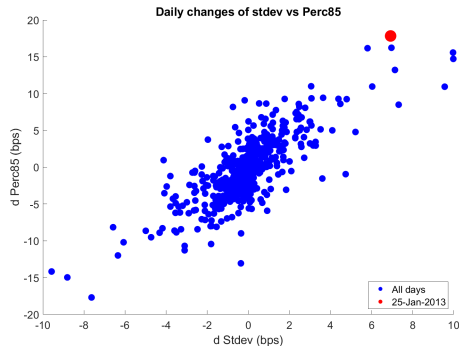
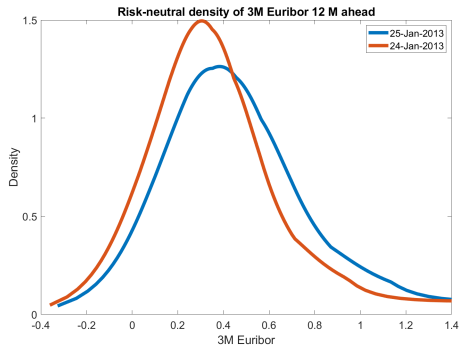
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No reaction of EONIA rate, yet strong increase of EONIA *OIS* spot curve



... and strong increase of interest rate uncertainty



Notes: Left panel depicts in red (blue) the option-implied density of the 3m Euribor in 12m on 24 (25) January 2013. Right panel plots pairs of 1-day changes in the standard deviation and changes in the implied 85th percentile of these option-implied densities for the sample Jan 2012 - Jan 2013.

What does the spot curve reaction tell about excess liquidity perceptions?

Narrative:

- ▶ News about stronger-than-expected excess liquidity reduction in one week...
- ▶ leads to a re-assessment of future excess liquidity over several years, ...
- ▶ specifically, lower future excess liquidity ($E_t(X_{t+h}) \downarrow$) and/or change in surrounding uncertainty ($Var_t(X_{t+h}) \uparrow$ or \downarrow), ...
- ▶ implying higher expected future spreads $E_t(S_{t+h})$, ...
- ▶ and – in the absence of policy news – higher forward and spot rates (expected policy rate plus expected spread) and surrounding rate uncertainty.

Inferring changing excess liquidity perceptions from changing spreads

**Observed changes in the spot curve \equiv changes in expected spot spreads
(absent policy rates news)**

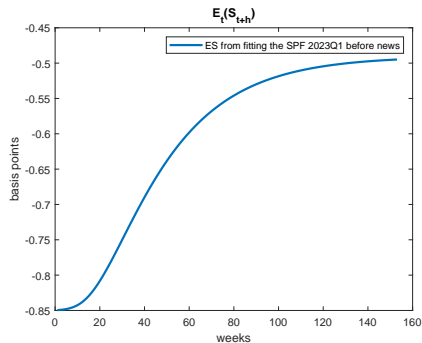
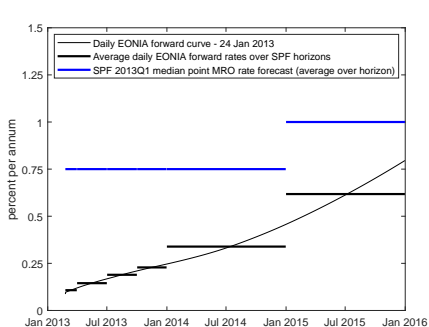
- ▶ For (1M, 3M, 6M, 12M, 18M, 2Y, 3Y, 5Y, 7Y, 10Y)

$$y_t^{o,n_k'} - y_t^{o,n_k} \approx y_t^{n_k'} - y_t^{n_k} = \underbrace{\frac{1}{n_k} \sum_{h=1}^{n_k-1} [E_t(S_{t+h-1} | Z'_{t+1}; \theta_1, \theta_2')]}_{\text{new spot spread after news}} - \underbrace{\frac{1}{n_k} \sum_{h=1}^{n_k-1} [E_t(S_{t+h-1} | Z_{t+1}; \theta_1, \theta_2)]}_{\text{initial spot spread}}$$

- ▶ Perfect-foresight assumption: $Z_{t+1} = Z_t - \text{€}100\text{bn}$; $Z'_{t+1} = Z_t - \text{€}100\text{bn} - \text{€}37\text{bn}$
- ▶ $g(X_t) = a + b \cdot \exp(cX_t)$ assumed unchanged (θ_1 estimated over 2007-2013)

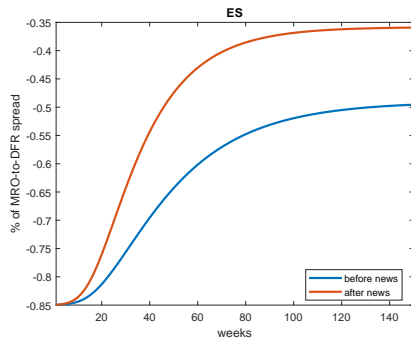
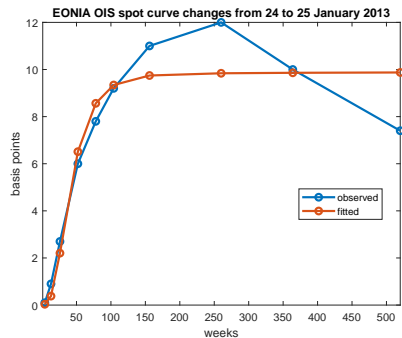
Re-assessment of perceptions of future excess liquidity X_{t+h} modelled by new parameters $\theta_2' = (\mu', \alpha', \sigma')$ governing Z dynamics

Term structure of spreads before news informed by the ECB's SPF 2013Q1



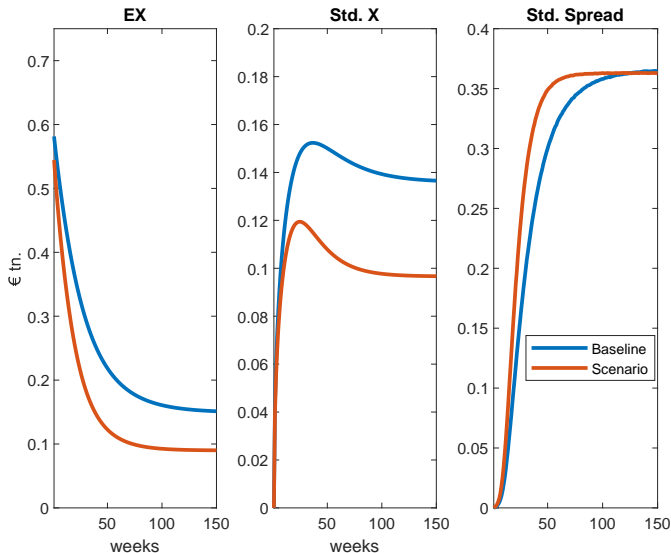
Notes: Right panel is the term structure of model-fitted forward spreads of the overnight money market rate (EONIA) to the MRO rate. Inputs are: a) estimates of the exponential function $g(X_t) = a + b \cdot \exp(cX_t)$ over the sample 2007-2013 and b) estimates of μ, α, σ of the shadow excess liquidity process Z by matching the term structure of spreads between EONIA fwd rate curve and ECB SPF's 2023Q1 MRO rate forecasts from left panel.

Higher forward spreads to policy rates following news

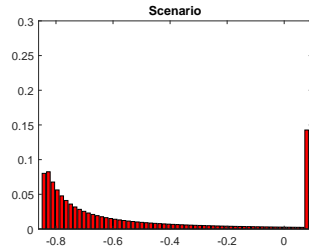
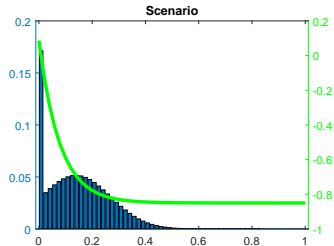
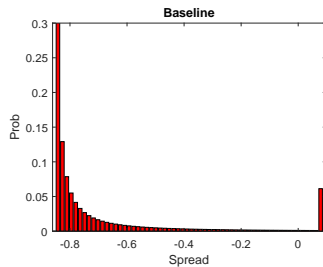
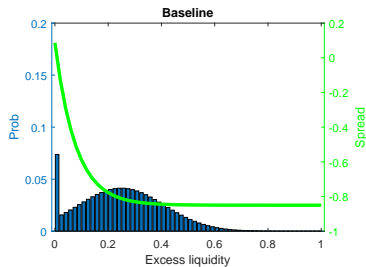


Notes: In left panel, the blue line are forward scaled spreads before news, red line are forward scaled spreads using a) estimates of the exponential function $g(X_t) = a + b \cdot \exp(cX_t)$ over the sample 2007-2013 and b) estimates $\theta'_2 = \{\mu', \alpha', \sigma'\}$ of the shadow excess liquidity process Z by matching the changes between the red and the blue lines over the spot horizons to the 1-day change in the EONIA spot rate curve from right panel (blue line).

Lower expected $E_t(X_{t+h})$ and higher uncertainty of future spreads S_{t+h}



Distributions of X_{t+9m} and S_{t+9m} before and after news



Conclusion

Summary:

- ▶ Novel nonlinear term structure model linking excess liquidity to forward spreads
- ▶ Formalizes the idea that changing perceptions of future money market conditions (esp. excess liquidity) can affect monetary policy stance today
- ▶ Case study of 2013 LTRO payback surprise: infer changes in excess liquidity perceptions from changes in forward spreads

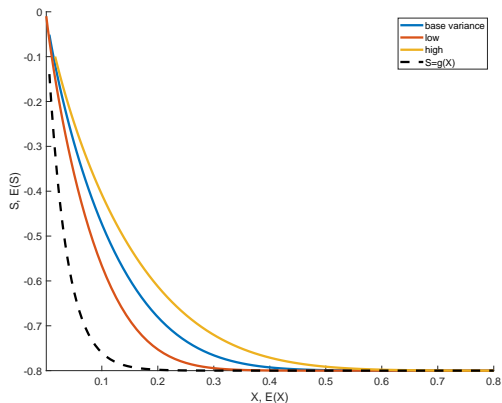
Policy use: quantify yield curve impact (level and uncertainty) of scenarios:

- ▶ rising uncertainty about excess liquidity
- ▶ (expected) change in interbank market affecting liquidity-spread schedule $g()$

Thank you for your attention!

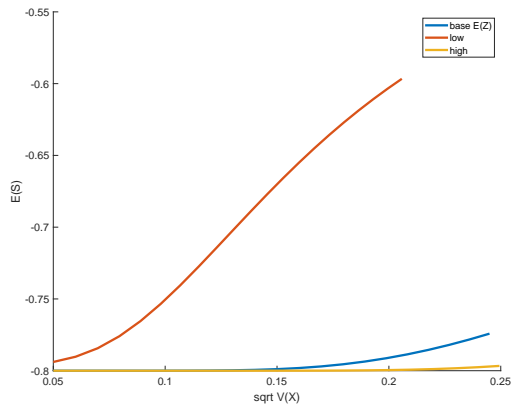
Analytical conditional expectation of S_{t+h}

$$E_t(S_{t+h}) = a + b \left[\Phi \left(-\frac{\mu_{t,h}}{\sigma_{t,h}} \right) + \exp \left(c\mu_{t,h} + \frac{1}{2}c^2\sigma_{t,h}^2 \right) \Phi \left(\frac{\mu_{t,h}}{\sigma_{t,h}} + c\sigma_{t,h} \right) \right] \gg g(E_t(X_{t+h})),$$



$E_t(S_{t+h})$ as a function of $Var_t(X_{t+h})$

$E_t(S_{t+h})$ as a function of $\text{Var}_t(X_{t+h})$



Main