Valuation, Credit Risk, and Liquidity in Government Bond Markets

Carlo Favero, Marco Pagano

and Ernst-Ludwig von Thadden

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The Question

What are the determinants of government bond yields in the Euro zone?

Candidates:
- liquidity,
- country risk,
- international risk factors.

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Background

- With EMU, Euro-area public bonds should be very close substitutes: offer the same yield.
- Yield spreads did converge between 1997 and 2001 – from over 300 b.p. to less than 30 b.p.
- Yet, differentials have persisted even for equally rated countries and fluctuate over time.

Why?

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The Standard View:

- Differences in levels of yield differentials stem from differences in fundamental risk (country-specific risk) or from differences in the (average) liquidity of different markets.
- Fluctuations of yield differentials stem from fluctuating liquidity.

But:

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Puzzle

- Differences in country risk (default risk) do not fluctuate nearly as much as yield differentials. So they cannot explain the daily time-series pattern.
- Liquidity differentials fluctuate on a daily basis. But bid-ask spreads are very small and fluctuate in a very narrow band.
- Worse: yield differentials fluctuate together, much more than measures of liquidity.

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Investigating the puzzle

- Principal component analysis of the time series of yield differentials reveals a first principal component that explains 90 percent of the variance of the series.
- This is consistent with Geyer, Kossmeyer and Pichler (RoF 2004) and Codogno, Favero and Missale (EP 2003) who show that European sovereign bond yields are almost exclusively driven by international risk factors, and that liquidity indicators are insignificant.

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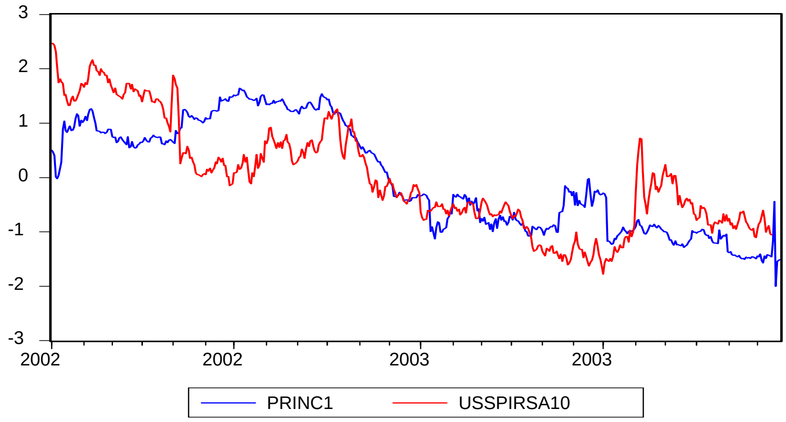
In our case:



International factor: the spread between the yield on 10-year fixed interest rates on swaps and the yield on 10-year US government bonds

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But:

- If liquidity is not priced at all, why is there this emphasis on market liquidity by practitioners?
- And what explains country-specific fluctuations?
- And why have yield differentials changed over the medium run (between Q1 2002 and Q4 2003)?

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Our idea

Liquidity differentials interact with an international, common risk factor

$\Rightarrow$ this factor affects yields differentially

$\Rightarrow$ induce fluctuations in yield differentials.

Q1: is this interaction consistent with an asset pricing model?

Q2: is it consistent with the data?

Model: ingredients

3-period partial equilibrium model that combines:

- bonds with different **fundamental risk**,
- alternative investment with exposure to **aggregate (international) risk factor,**
- endogenous **liquidity risk** caused by idiosyncratic trading opportunities,
- exogenous (iceberg) **transactions costs**.

Model: basic assumptions

- 3 dates: 0, 1, 2
- One consumption good, costlessly storable at interest rate r (“safe asset”)
- Continuum of identical investors at date 0, who
  - are risk neutral
  - want to maximize date 2 consumption
  - have different trading needs at date 1

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Model: investments (I)

- 2 bonds traded at dates 0 and 1, pay out at 2:
  - bond i=A, B pays $\tilde{V}_i = \begin{cases} 0 & \text{with proba } q_i \\ V & \text{with proba } 1-q_i \end{cases}$
  - w.l.o.g. assume A is benchmark
  - country risks depend on a common aggregate factor $q_i = q_i(\rho)$
    linear version: $q_i = k_i \rho + c_i$
  - trading at date 1: competitive market with proportional transactions costs: bid price $(1-t_i)p_{1i}$
    ask price p_{1i}
  - buying at date 0 at prices p_{0i}

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Model: investments (II)

- Idiosyncratic investment opportunity at date 1:
  - yields $\tilde{z}^h = \begin{cases} 0 & \text{with proba } a^h\rho \\ Z & \text{with proba } 1-a^h\rho \end{cases}$

    where $a^h \in [0, A]$ are i.i.d. random variables with c.d.f. G and ρ is the aggregate risk factor.

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Analysis: date-1 trading

Investor h sells her stock of bond i if the outside investment yields more in expectation:

$$(1-a^h\rho)Z > \frac{(1-q_i)V}{(1-t_i)\,p_{1i}}$$

Hence, the (ex-ante) probability of selling is

$$\pi_i = G\left(\frac{1}{\rho} - \frac{(1-q_i)V}{\rho Z(1-t_i)\,p_{1i}}\right)$$

Note: demand for liquidity is price-elastic.

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Analysis: date-1 equilibrium

Necessary for demand for bonds to exist: return on bonds not smaller than return on storage:

$$p_{1i} \leq \frac{(1-q_i)V}{1+r} \equiv R_i$$

Competition between buyers will equalize returns on bonds and storage:

$$p_{1i} = R_i$$

Hence, equilibrium trade:

$$\pi_i = G\left(\frac{1}{\rho} - \frac{1+r}{\rho Z(1-t_i)}\right)$$

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Analysis: date-0 prices

- With rational expectations, at date 0 bond i trades at price

$$p_{0i} = \pi_i \frac{(1-t_i)p_{1i}}{1+r} + (1-\pi_i)\frac{(1-q_i)V}{(1+r)^2}$$

$$= \frac{(1-\pi_i t_i)(1-q_i)V}{(1+r)^2}$$

Interaction: trading motive and transaction cost

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Analysis: date-0 yields

- Hence, pledged yield to maturity:

$$1+Y_i = \frac{V}{p_{0i}} = \frac{(1+r)^2}{(1-\pi_i t_i)(1-q_i)}$$

- Hence, yield ratio:

$$\frac{1+Y_B}{1+Y_A} = \frac{(1-\pi_A t_A)(1-q_A)}{(1-\pi_B t_B)(1-q_B)}$$

$\ln(1+x) \approx x$

- Hence, the yield differential is approximately:

$$\Delta Y = Y_B - Y_A \approx \pi_B t_B + q_B - \pi_A t_A - q_A$$

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Interpretation: the basics

If liquidity demand were exogenous, then the yield differential would:

- increase in the fundamental risk differential $q_B - q_A$
- depend on aggregate risk in the same way as the fundamental risk differential
- increase in the transactions costs differential $t_B - t_A$
- and the impact of transactions costs would be amplified by the size of liquidity demand.

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Interpretation: the twist

But remember that liquidity demand is endogenous:

- liquidity demand decreases with transactions costs:

$$\frac{\partial \pi_i}{\partial t_i} < 0$$

- liquidity demand decreases with aggregate risk:

$$\frac{\partial \pi_i}{\partial \rho} < 0$$

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Interpretation: the full effects

$$\frac{\partial \Delta Y}{\partial t_B} = \pi_B + \frac{\partial \pi_B}{\partial t_B} t_B$$

small

$$\frac{\partial \Delta Y}{\partial \rho} = \frac{\partial (q_B - q_A)}{\partial \rho} + \frac{\partial \pi_B}{\partial \rho} t_B - \frac{\partial \pi_A}{\partial \rho} t_A$$

small

$$\frac{\partial^2 \Delta Y}{\partial t_B \partial \rho} = \frac{\partial \pi_B}{\partial \rho} + \frac{\partial^2 \pi_B}{\partial t_B \partial \rho} t_B$$

small

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Predictions:

If transactions costs are small, then

- The yield differential varies positively with the transactions costs differential:

$$\frac{\partial \Delta Y}{\partial \Delta t} > 0$$

• This effect is dampened by changes in aggregate risk:

$$\frac{\partial^2 \Delta Y}{\partial \Delta t \partial \rho} < 0$$

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Predictions: the intuition

- The impact of transactions costs on the yield differential reflects the cost of unwinding the asset position, hence is positive and proportional to anticipated liquidity demand,
- but liquidity demand decreases in aggregate risk (the "flight to safety").

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Data

- Bond prices for 5 and 10-year maturities, Jan. 2002 – Dec. 2003, from the Euro MTS European Benchmark Market (EBM) trading platform.
- Snapshot of super-best prices (best bid and ask prices) taken at 11 a.m. for the cash markets.
- Liquidity variables: bid-ask spread, aggregate quantity of outstanding proposals at the best bid and ask prices, and daily trading volume
- International risk factor: spread between the yield on 10-year fixed interest rates on swaps and the yield on 10-year US government bonds.

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Data (2)

- From these data we calculate redemption yields, maturities and a set of liquidity variables for benchmark bonds.
- Nine countries: Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Portugal and Spain.
- Reference country:
  - 5 year: France
  - 10 year: Germany
- In the estimation, we use the bid-ask spread as the most significant liquidity indicator.

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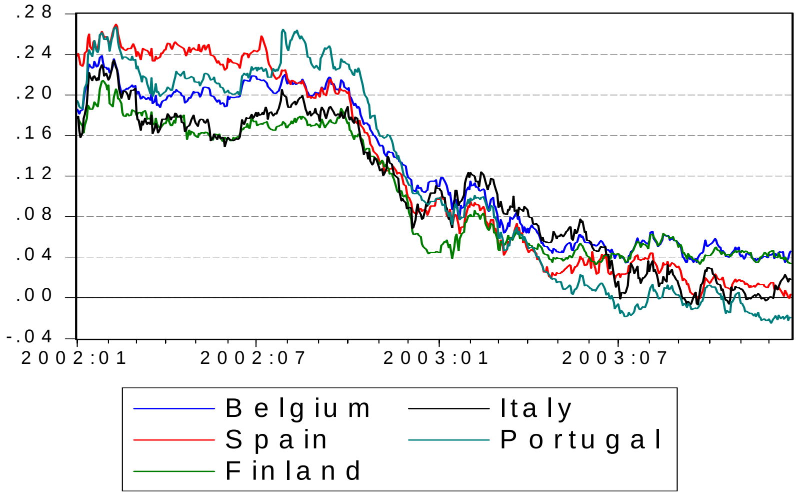
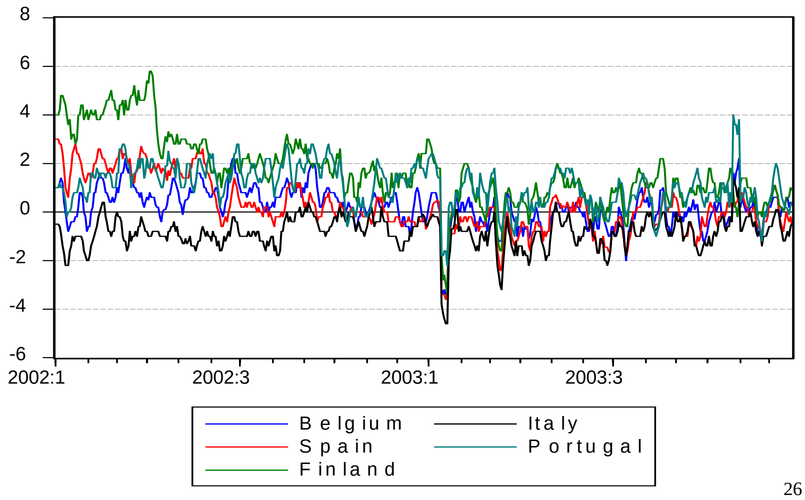
Data: Yield differentials



Data: bid-ask spread differentials



Estimation technique

- For each country, seemingly unrelated regression (SURE) of local yield spread on
  - international factor,
  - bid-ask spread,
  - interaction term
- Correct for
  - Maturity mismatch
  - Persistence (1-period lag)

Results: 10-year bonds

Panel A. 10-year yield differentials

Variable	Austria	Belgium	Spain	Finland	France	Italy	Netherl.	Portugal
Constant	-0.167*	-0.129*	-0.135*	-0.159*	-0.119*	-0.007	-0.076*	-0.150*
	(0.026)	(0.021)	(0.034)	(0.049)	(0.038)	(0.021)	(0.019)	(0.044)
Own Lag	0.857*	0.936*	0.867*	0.956*	0.945*	0.912*	0.891*	0.920*
	(0.016)	(0.007)	(0.018)	(0.006)	(0.010)	(0.010)	(0.012)	(0.010)
Maturity	0.280*	0.357*	0.349*	0.207*	0.184*	0.288*	0.314*	0.384*
	(0.034)	(0.040)	(0.061)	(0.045)	(0.077)	(0.037)	(0.029)	(0.052)
Risk Factor	0.546*	0.497*	0.485*	0.467*	0.321*	0.290*	0.305*	0.633*
	(0.060)	(0.043)	(0.077)	(0.118)	(0.072)	(0.047)	(0.042)	(0.099)
Bid-Ask Spread	0.043*	0.052*	0.007	-0.010	0.016	0.017	0.034*	0.080*
	(0.014)	(0.022)	(0.024)	(0.024)	(0.038)	(0.018)	(0.016)	(0.033)
Interaction	-0.077*	-0.099*	-0.009	0.033	-0.025	-0.042	-0.052†	-0.139*
	(0.026)	(0.048)	(0.047)	(0.044)	(0.079)	(0.043)	(0.032)	(0.070)

Results: Interpretation

- The international risk factor is economically and statistically highly significant, with positive sign: an increase in international risk increases the yield spread over Germany (for 10 year bonds) or over France (for 5 year bonds)
- When doing the 5-year regression with Germany as a benchmark, the estimates deteriorate markedly. This confirms the finding by Dunne, Moore, and Portes (2002) that the data identify France as the 5-year benchmark.

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Results: Interpretation (2)

- Liquidity has the predicted sign (positive), except for Finland, but is statistically significant only for 4 countries.
- The cross-effect has the predicted sign (negative), except for Finland, and is statistically significant for the same 4 countries.
- Remarkably, when taking the 5-year and 10-year data together, the cross-effect is significant if and only if the liquidity effect is significant, and this in 9 out of 16 cases.

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Results: Interpretation (3)

- When the coefficient on the cross-effect is restricted to 0, liquidity becomes insignificant throughout.

- This is not a small-country effect:
  - For the 10-year sample, the liquidity effect is significant for Austria, Belgium, Netherlands, and Portugal, but not for Finland.
  - For the 5-year sample, the liquidity effect is significant for Austria, Spain, Italy, Netherlands, and Portugal, but not for Belgium and Finland.

Robustness: time effects

- Is it possible that for less liquid bonds prices simply take more time to absorb the change in risks?
- Note: we control for different dynamic effects across countries by having potentially different coefficients on the lagged dependent variable.
- Moreover: adding further lags of the included variables yields non-significant parameters for higher order dynamics.

Robustness: panel effects

- Can valid cross-equation restrictions be imposed on the model (which would make the SURE inefficient and allow panel estimation)?
- We test for the validity of cross-equation restrictions on each coefficient separately and on the full set of coefficients.
- The Wald statistics show that the panel restrictions can be validly imposed on the liquidity indicators at the 10-year maturity and yield significant coefficients in line with the prediction of the theory.
- This does not carry over to the 5-year maturity.

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Conclusion

- Liquidity matters, but …
  - It can only be detected if its indirect effect is separated from the direct effect,
  - International risk is the dominant driver of European bond yields.

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