2nd Public Debt Management Conference

May 2022

Eurobond Yields and Market Liquidity

Daniel C. Hardy

Department of Economics
Wirtschaftsuniversität Wien
dclhardy@gmail.com

Overview

1. Yields and market liquidity
2. Bid-ask spreads
3. Eurobond market
4. Dataset
5. Determinants of liquidity and yields
6. Effect of liquidity on yields
7. Take-aways

Central themes in finance

- What determines yields?
- What makes a market liquid?

- Extensive theory and empirical research

Central theme in finance

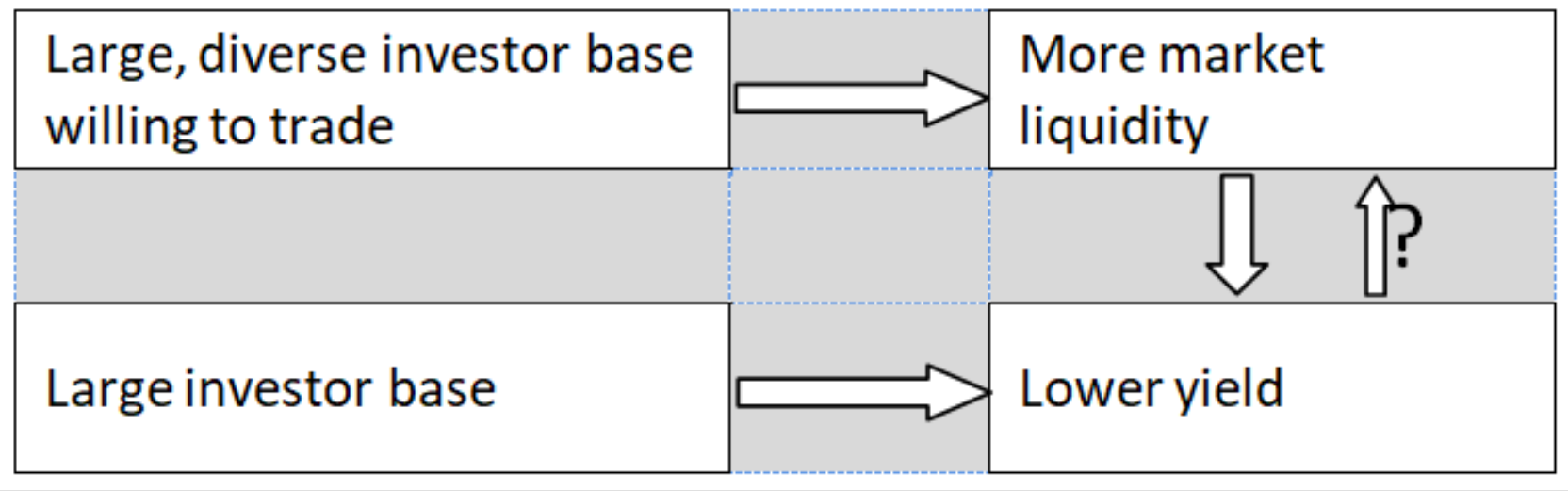
- "Market liquidity" complex
  - Can trade reasonable amount
    - Reasonably quickly
    - Reasonably cheaply
    - With minimal price impact
- Can vary over time
  - Depends on behavior, not asset features
  - Feedback loops

Theory

- Market liquidity offers "convenience yield"
  - Can adjust position quickly and cheaply in response to
    - New information
    - New liquidity need
  - Better price discovery
  - Valuable to both investors and issuers

Theory

- Yield and market liquidity interact



Yields and market liquidity

Empirical

- (Il-)Liquidity measures
  - Price based
    - e.g., bid-ask spread; “flipping” between bid and offer
  - Volume based
    - e.g., turnover; order book

- All price based measures usually perform similarly
  - Bid-ask spread robust
  - Volume based measures are complementary

Empirical

- Yields on assets tend to increase with illiquidity
  - Both in cross-section and over time
    - Especially in stress periods
    - Especially for lower-rated assets
  - Various asset classes
    - Corporate bonds
    - US and European sovereign bonds
    - Similar results for equity

Yields, market liquidity, and the bid-ask spread

Theory

- Bid-ask spread can reflect
  - Operating costs
  - "Cost of carry" of dealer's inventory
  - Dealer market power
    - In providing immediacy
  - Dealer's risk of facing informed trader

Yields, market liquidity, and the bid-ask spread

Theory

- Bid-ask spread negatively related to market liquidity
- "Modest" bid-ask spread is necessary but not sufficient for market liquidity

Yields, market liquidity, and the bid-ask spread

Empirical

- Bid-ask spread on advanced economy bonds depends on
  - Issue volume (-)
  - Duration
    - Remaining maturity (+)
    - Coupon (-)
  - Age (+)
  - Risk (+)
  - Yield to maturity (+)
    - Yield is endogenous
- Yields have similar determinants

Eurobond characteristics

- Medium-term fixed-interest bonds
- Issued in major foreign jurisdiction
  - Typically under New York or English law
- Denominated in major currency
  - Predominantly US$
- Sold OTC
- (Informal) dealers post bids and offers
- Recorded in international central securities depositories
- Largely standardized contracts
  - (enhanced) CACs
  - (modified) pari-passu clauses

Eurobonds: an important asset class

- EMDC sovereign Eurobonds
  - outstanding > $1.5 trillion
  - >80 issuers
  - >50 issues/year
- EMDC non-sovereign Eurobonds > $0.5 trillion
- Some advanced country issuers

Eurobonds: an important asset class

- Conduit for capital flows to and from EMDCs
  - Finance development
- Means of portfolio diversification
  - Special indices, e.g., EMBIG
- Focus of debt restructurings
- Yield premium is taken as signal of creditworthiness

Eurobond market

Relatively

- Homogeneous
  - Currency
  - Term
- Relevant differences
  - Issue size
  - Credit rating
  - Some contractual provisions
- Easy but not highly automated trading

=> Worthwhile and suited to empirical investigation

Empirical

- Eurobond yields affected by
  - Global rates
  - Credit rating
  - Duration
  - Inclusion of an (enhanced) CAC
    - Effects depend on credit rating
  - Jurisdiction of issue
    - Effects depend on credit rating

Yields, market liquidity, and the bid-ask spread

Hypotheses

- Large, diverse, active investor base and thus narrow bid-ask spread related to
  - Issue volume
  - Total country issuance

  } Investors' research worthwhile
  - Consistent issue pattern
  - Yield on alternatives
  - Moderate duration
  - Young age
  - Moderate sovereign risk
  - Coupon

Yields, market liquidity, and the bid-ask spread

Hypotheses

- Large diverse investor base and thus narrow bid-ask spread related to
  - Fixed effects
    - Inclusion in a bond index
    - Jurisdiction of issuance
    - Presence of an (enhance) CAC or (modified) pari-passu clause
    - Market evolution
- Similar influences on yield
- Feedback between yield and b-a spread

Dataset

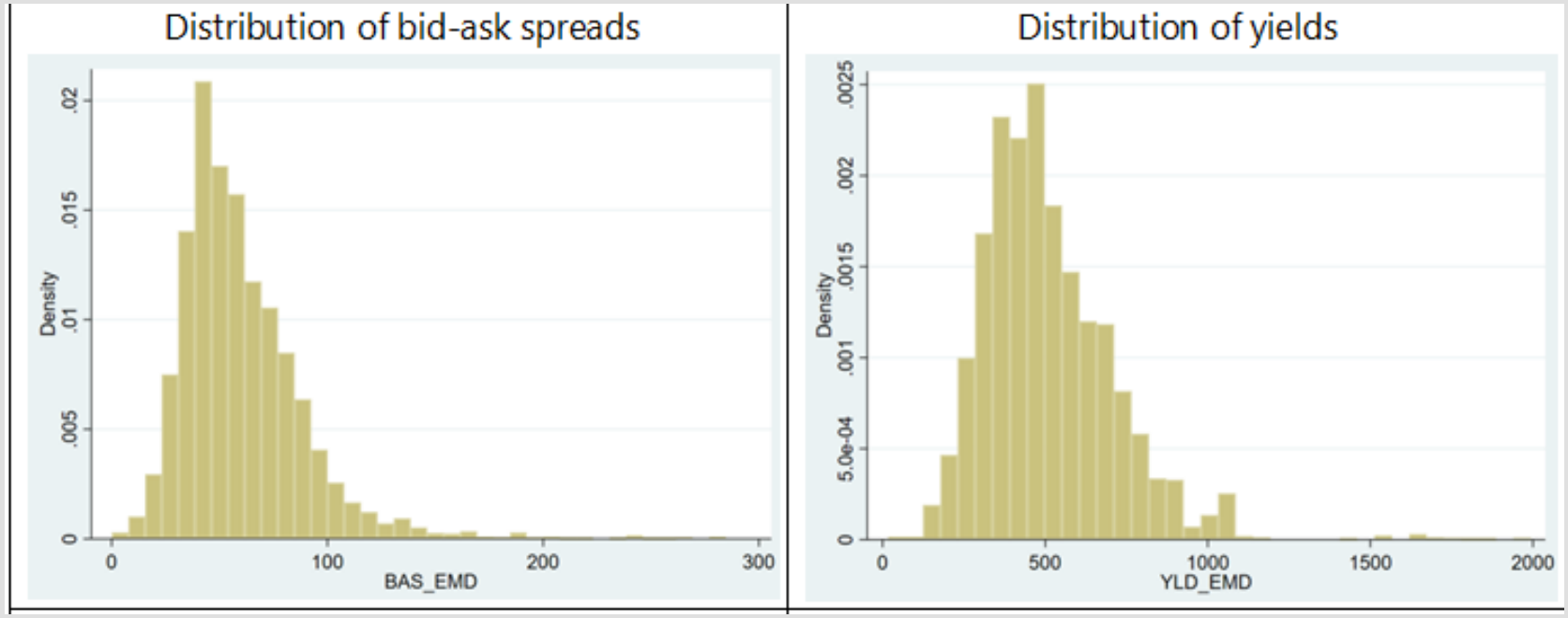
- End-quarter observations (March 2017–March 2019) on Eurobond and country characteristics, e.g.,
  - Yield to maturity (YLD)
  - Bid-ask spread (BAS)
  - Volume outstanding (VOL)
  - Maturity (MAT)
  - Credit rating (CRR)
    - Converted to numeric scale
- Dummies constructed, e.g.,
  - Issuance under New York law (D_NY_LAW)
  - Inclusion of an enhanced CAC (D_E_CAC)

Dataset

- Some variables observed both at time of issue (_ISS) and contemporaneously (_NOW)
  - Former relevant to DMO and initial investors
- Focus on EMDC US$-denominated bonds
  - Total of over 4750 observations
  - Some extreme outliers
    - Mostly associated with debt default and restructuring cases
      - e.g., Venezuela
  - Regressions based on a trimmed sample of about 4300 observations
    - Some explanatory variables missing

Summary features

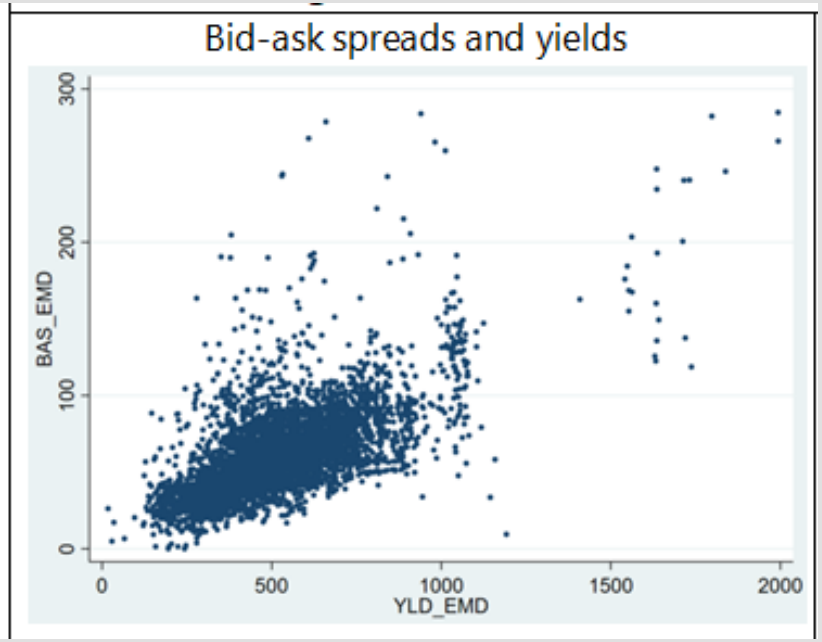
- Asymmetry

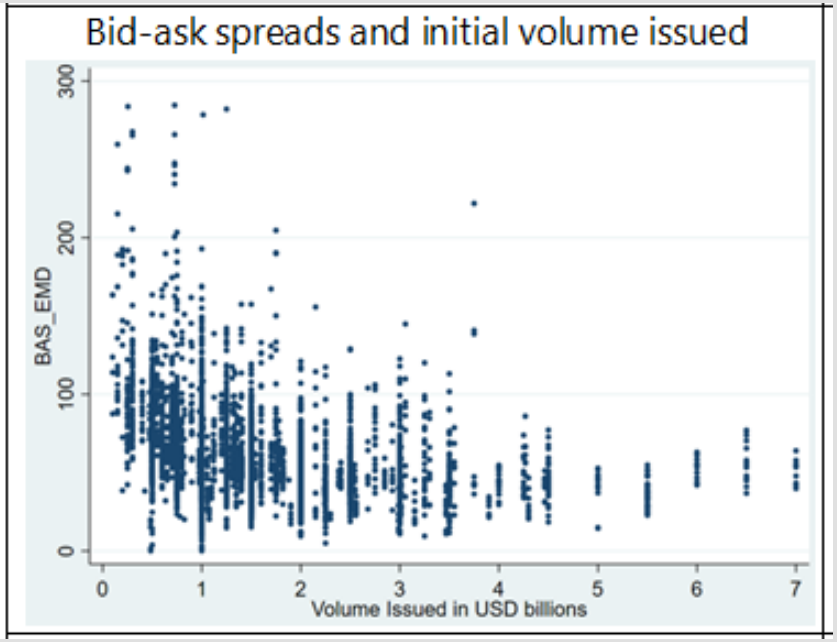


Summary features

- Correlations

- Non-linear relations

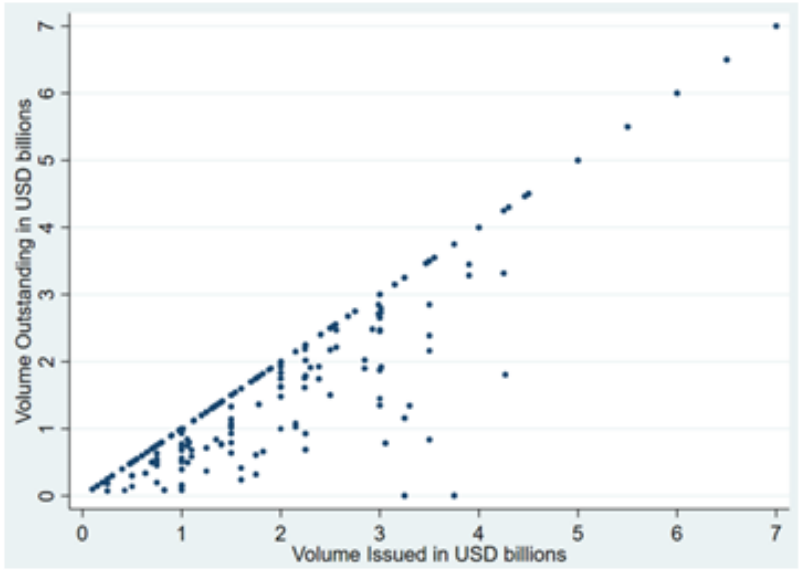




Summary features

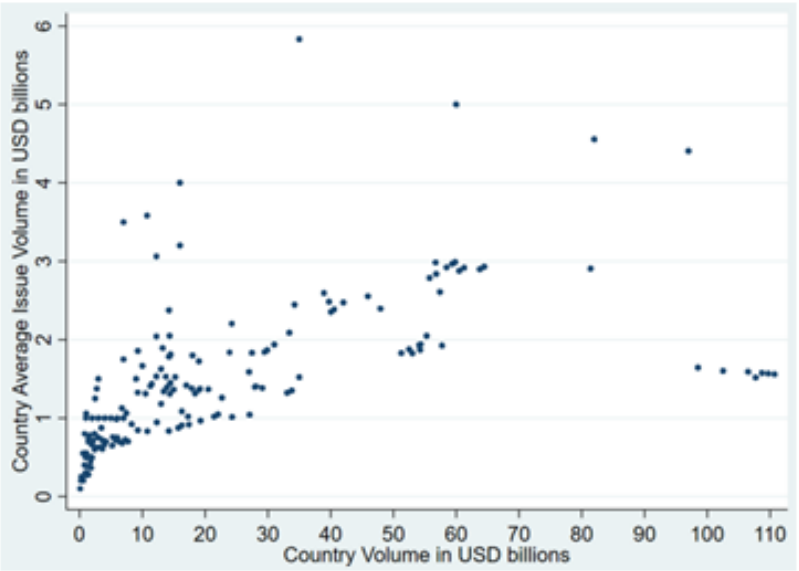
- Collinearity

Volume issued and volume outstanding



Source: See text.

Country volume and average issue size



Specification

- Bid-ask spread or yield on explanatory variables
  - Parameters "incorporate"
    - Direct effect of explanatory variable
    - Feedback between bid-ask spread and yield
  - Variables clearly pre-determined or exogenous
    - Many set at time of issuance
    - Others reflect persistent country characteristics

Specification

- Translog
  - Flexible form
  - Logs for normality
  - Limited cross products
    - Only with when-issued credit risk rating terms
  - Dummies for observation periods
    - Fixed effects capture global state
      - Safe interest rate
      - Risk sentiment

Specification

- Translog

log level

log squared

cross-product with LCRR_ISS

cross-product with LCRR_ISS_SQ

$$LY = \sum_{i}^{I} (\alpha_{1i} LX_i + \alpha_{2i} LX\_SQ_i + \alpha_{3i} LX\_LCRR\_I_i + \alpha_{4i} LX\_LCRR\_I\_SQ_i) + \sum_{j}^{J-1} (\beta_j D\_period\_j) + \sum_{k}^{K-1} (\gamma_k D\_ISSUE\_YR\_k) + CONSTANT$$

period dummies

issue year dummies

Reduced form regressions

- Hard to interpret
  - Tables complex

=> project effect on levels
  - For typical values

    of variables

Table 4: Log bid-ask spread determinants; reduced form regressions

	Full sample			Robust regression		Trimmed sample		Extended sample		First half of sample		Second half of sample	
	coef	se	convenience se	coef	se	coef	se	coef	se	coef	se	coef	se
LVOL_ISS	0.451***	1.435	0.989	6.870***	0.968	3.921***	1.050	4.696***	0.623	6.521***	1.996	9.607***	1.261
LVOL_ISS_SQ	0.008	0.018	0.017	0.062***	0.016	-0.021	0.016	-0.022*	0.010	0.005	0.025	0.016	0.019
LVOL_ISS_LCRR	-5.021***	1.136	0.803	-4.677***	0.716	-3.363***	0.681	-3.657***	0.496	-4.942***	1.566	-7.583***	1.060
LVOL_ISS_LCRR_SQ	0.610***	0.221	0.162	0.861***	0.151	0.627***	0.153	0.706***	0.095	0.687***	0.305	1.457***	0.208
CHG_LVOL	-2.657***	1.875	2.910	-19.262***	2.701	-10.686***	4.020	-10.230***	2.012	-24.132***	4.826	-27.894***	6.157
CHG_LVOL_SQ	0.128**	0.056	0.088	0.771***	0.085	0.302**	0.098	0.161**	0.028	0.194**	0.075	0.035	0.075
CHG_LVOL_LCRR	2.156***	3.036	2.307	16.199***	2.162	15.358***	3.216	7.516**	1.562	19.945***	3.815	22.859***	4.685
CHG_LVOL_LCRR_SQ	-1.462***	0.590	0.454	-3.393***	0.421	-3.103***	0.626	-1.408***	0.102	-4.086***	0.750	-4.672***	0.927
D_VOL_ISS_500	-0.016***	0.007	0.005	-0.110***	0.004	-0.060***	0.003	-0.116***	0.005	-0.196***	0.006	-0.068	0.009
D_VOL_ISS_1000	-0.008***	0.009	0.006	-0.068***	0.007	-0.078***	0.006	-0.036***	0.001	-0.134***	0.005	-0.052*	0.029
D_VOL_ISS_1500	-0.008***	0.003	0.004	-0.060***	0.003	-0.053***	0.002	-0.048***	0.000	-0.082*	0.018	-0.057**	0.019
D_VOL_ISS_2000	-0.004	0.004	0.005	-0.009	0.004	0.008	0.002	0.002	0.000	0.020	0.020	0.010	0.019
D_VOL_ISS_3000	-0.010	0.023	0.020	-0.015	0.019	0.030	0.021	0.025*	0.010	0.004	0.032	-0.013	0.032
LCTY_VOL	-0.028	0.508	0.410	-0.067	0.400	-0.145	0.360	-0.171	0.235	0.614	0.791	-1.261***	0.459
LCTY_VOL_SQ	0.008	0.008	0.003	0.008	0.003	0.009*	0.003	0.004	0.002	-0.009*	0.005	0.013**	0.005
LCTY_VOL_LGRR	-0.064	0.402	0.352	-0.077	0.327	0.200	0.314	0.126	0.205	0.734	0.635	0.903**	0.376
LCTY_VOL_LGRR_SQ	0.036	0.079	0.071	0.037	0.066	-0.035	0.062	-0.023	0.040	0.205*	0.125	-0.186**	0.076
DAVG_LVOL	-1.630**	1.401	1.167	-1.053***	1.065	-1.259***	1.111	-1.136**	0.678	-2.814*	1.919	-6.860***	1.364
DAVG_LVOL_SQ	0.019	0.017	0.016	-0.006	0.015	0.020	0.014	-0.007	0.009	0.052	0.023	0.001	0.026
DAVG_LVOL_LCRR	2.587**	1.097	0.927	3.180***	0.850	2.710**	0.877	3.415**	0.516	2.233	1.498	5.614***	1.118
DAVG_LVOL_LCRR_SQ	-0.577**	0.213	0.186	-0.624***	0.171	-0.563***	0.171	-0.657***	0.101	-0.416	0.290	-1.121***	0.222
LMAT_NOM_DYC	-0.235	2.235	2.073	-0.178	1.925	-1.756	2.264	-1.201*	1.176	1.550	3.168	-16.149**	11.906
LMAT_NOM_DYC_SQ	0.089	0.158	0.129	0.087	0.120	0.160	0.162	0.258**	0.098	0.264	0.236	2.972**	1.218
LMAT_NDYC_LCRR	-0.221	1.150	1.230	-0.176	1.142	0.136	1.061	0.872	0.675	0.955	1.898	2.496	4.873
LMAT_NDYC_LCRR_SQ	-0.025	0.226	0.267	0.013	0.239	-0.130	0.217	-0.162	0.134	0.169	0.379	-0.492	0.974
LMAT_NOM	0.478	0.465	0.509	-0.110	0.473	1.068**	0.416	0.661**	0.267	0.494	0.666	0.253	0.623
LMAT_NOM_SQ	-0.058***	0.012	0.011	-0.057***	0.010	-0.063***	0.009	-0.036	0.006	-0.051***	0.018	-0.074***	0.015
LMAT_NOM_LCRR	0.015	0.168	0.416	0.466	0.386	-0.513	0.561	-0.657**	0.217	0.055	0.556	0.281	0.519
LMAT_NOM_LCRR_SQ	-0.005	0.035	0.083	-0.098	0.077	0.101	0.068	0.140**	0.043	0.025	0.111	-0.062	0.103
CHG_LMAT	-0.700	0.675	0.866	0.178	0.612	-1.660**	0.684	-1.102***	0.516	0.629	1.321	0.063	1.065
CHG_LMAT_SQ	0.073**	0.021	0.019	0.004***	0.018	0.060**	0.018	0.061***	0.012	0.071**	0.033	0.004***	0.027
CHG_LMAT_LCRR	0.031	0.710	0.726	-0.701	0.674	1.032	0.685	2.426**	0.415	-1.121	1.071	-0.512	0.854
CHG_LMAT_LCRR_SQ	0.026	0.141	0.145	0.195	0.135	-0.169	0.138	-0.479**	0.082	0.285	0.215	0.140	0.170
LCRR_ISS	-5.612	6.258	6.557	-14.667**	6.068	-11.410*	6.149	-1.923	3.647	-10.060	10.549	-22.730	27.850
LCRR_ISS_SQ	1.535	1.245	1.320	3.160**	1.225	2.524**	1.229	0.706	0.726	1.726	2.095	4.562	5.527
CHG_LCRR	-0.118	0.458	0.436	0.435	0.405	0.969**	0.413	-1.645***	0.261	-1.572***	0.615	1.752**	0.752
CHG_LCRR_SQ	-0.141	0.105	0.091	-0.267***	0.084	-0.310***	0.088	0.122*	0.052	0.260*	0.130	-0.357**	0.159
LCRR_RT	0.068	1.191	0.870	-5.711***	0.808	-3.958***	1.112	2.736**	0.495	0.979	1.565	0.668	1.814
LCRR_RT_SQ	-0.129**	0.043	0.037	-0.167***	0.035	-0.063	0.062	-0.200***	0.025	-0.258***	0.056	-0.360***	0.063
LCRR_RT_LCRR	1.090	0.898	0.726	4.753***	0.674	3.111***	0.829	-1.003**	0.417	0.823	1.248	0.735	1.261
LCRR_RT_LCRR_SQ	-0.263	0.135	0.119	-0.868***	0.110	-0.572***	0.151	0.061	0.068	0.004	0.251	-0.222	0.214
D_BMBG	0.165	0.145	0.105	0.151	0.139	0.230	0.160	0.309*	0.201	0.710	0.637	-0.145	0.356
D_BMBG_LCRR	-0.066	0.161	0.410	-0.111	0.381	-0.035	0.122	0.671**	0.206	0.359	0.532	0.226	0.453
D_BMBG_LCRR_SQ	-0.017	0.032	0.082	-0.002	0.077	-0.007	0.024	-0.108***	0.042	0.019	0.107	-0.101	0.091
D_NW_LAW	1.624**	0.579	0.567	2.052***	0.527	0.735	0.452	2.019**	0.306	1.216	0.643	2.721**	0.864
D_NW_LAW_LCRR	-1.219**	0.471	0.466	-1.570***	0.433	-0.618	0.362	-1.608***	0.249	-0.695	0.686	-2.168**	0.767
D_NW_LAW_LCRR_SQ	0.210**	0.095	0.095	0.262***	0.088	0.121	0.079	0.134**	0.050	0.129	0.136	0.414***	0.114
D_Q_CAC	-0.696	0.737	0.787	-2.902***	0.711	-1.610**	0.799	0.268	0.456	0.562	0.959	-0.548	1.057
D_Q_CAC_LGRR	0.602	0.596	0.612	2.368***	0.566	1.387**	0.691	-0.060	0.162	0.433	0.778	0.533	0.854
D_Q_CAC_LGRR_SQ	-0.123	0.118	0.130	-0.470***	0.121	-0.310***	0.127	-0.002	0.072	0.072	0.156	-0.122	0.171
D_E_CAC	-5.063***	0.670	0.852	-7.600***	0.791	-6.958***	0.861	-2.656***	0.492	-10.615***	1.256	-5.751***	1.009
D_E_CAC_LCRR	4.062***	0.711	0.702	6.069***	0.651	4.807***	0.866	2.062***	0.198	3.675***	1.021	4.503***	0.864
D_E_CAC_LCRR_SQ	-0.803***	0.143	0.143	-1.199***	0.133	-0.923***	0.159	-0.425**	0.080	-0.752***	0.207	-0.884***	0.161
Hidden:													
Obs. period dummies													
Issue year dummies													
Country dummies													
CONS	10.141	9.052	8.964	26.273***	8.303	20.610**	9.052	10.781*	5.440	9.369	14.548	123.685**	51.625
Number of observations	4,314			4,314		3,206		4,198		2,230		2,086	
Adjusted R2	0.686			0.722		0.610		0.680		0.686		0.705	

Source: Sentrue
Note: ***p<0.01; **p<0.05; *p<0.1

Specification

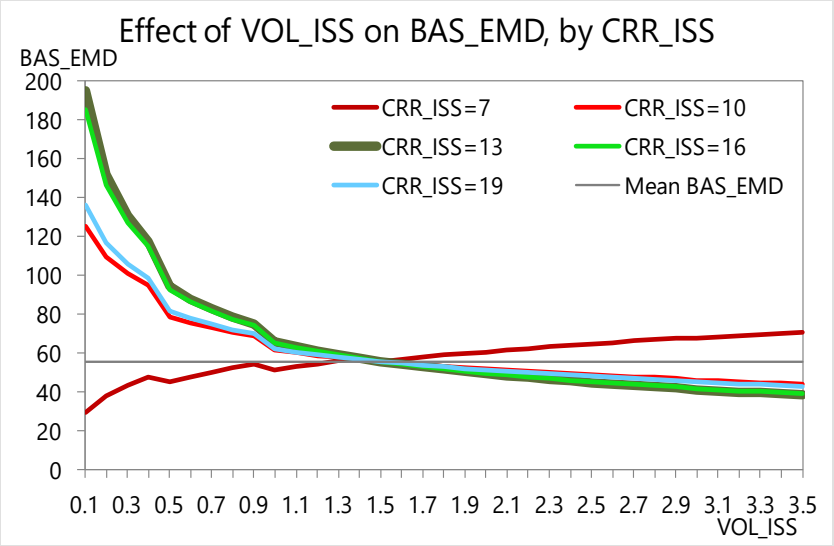
- Collinearity problem
  - Examples
    - Log level and log squared terms
    - Log level and cross-product with CRR
    - CAC and pari-passu dummies
  - Hence
    - Use of differences as RHS variables
      - e.g., issue-period log-level and change to current period
    - No specification search
    - Wald (F) tests for groups of parameter estimates
    - Only CAC dummies
      - no pari-passu dummies

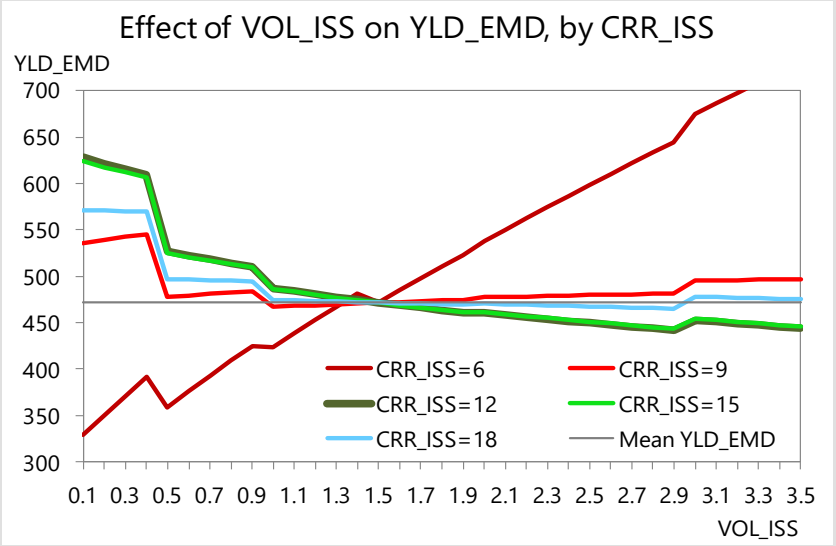
Influence of bond and country characteristics

- Good explanatory power
  - $R^2 > 0.66$
- Interpretable results
  - Mostly consistent with hypotheses
- Many highly significant individual parameter estimates
- Many highly significant groups of parameter estimates

Influence of bond and country characteristics

- Issue size

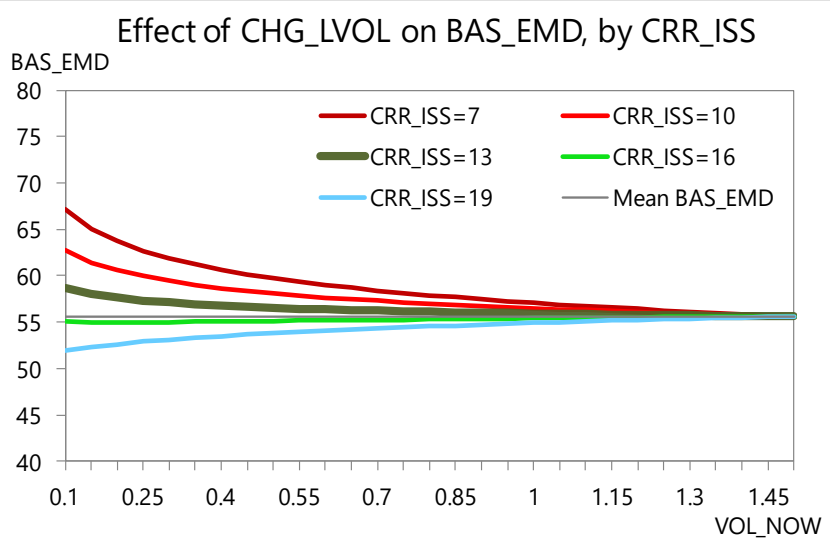


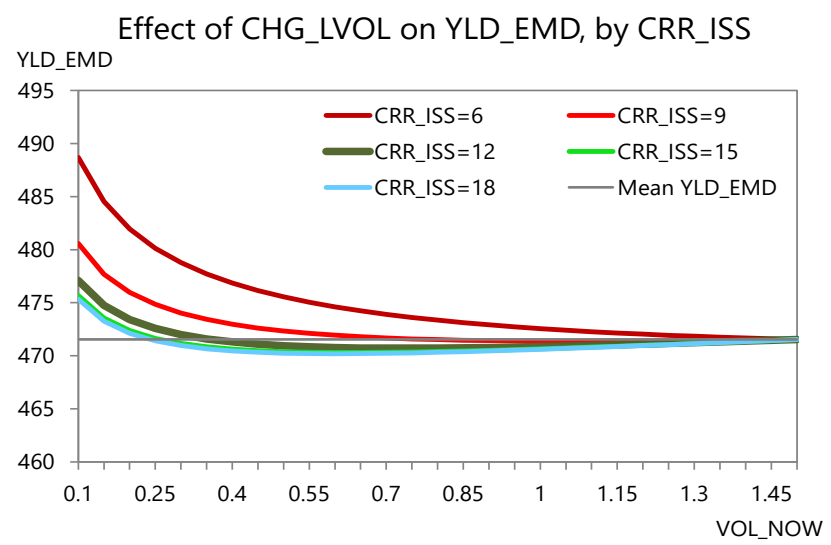


- Large effects
- Threshold effects and non-linearities

Influence of bond and country characteristics

- Change in volume

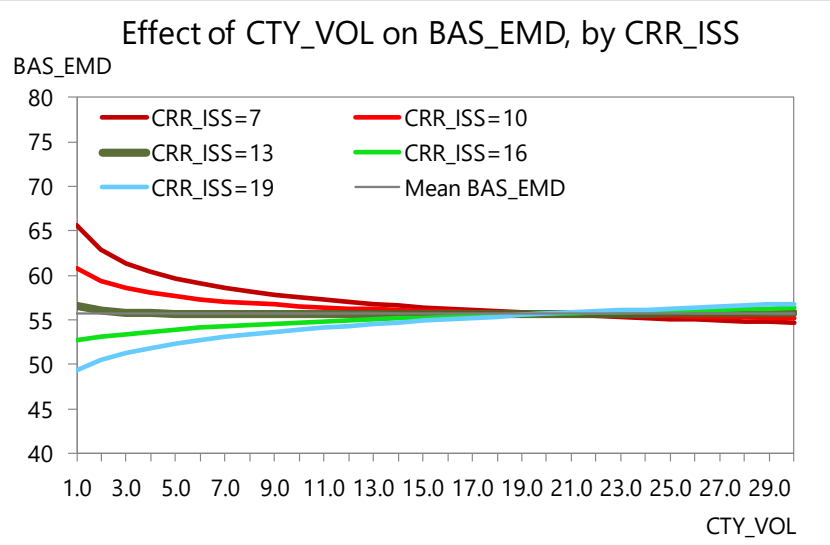


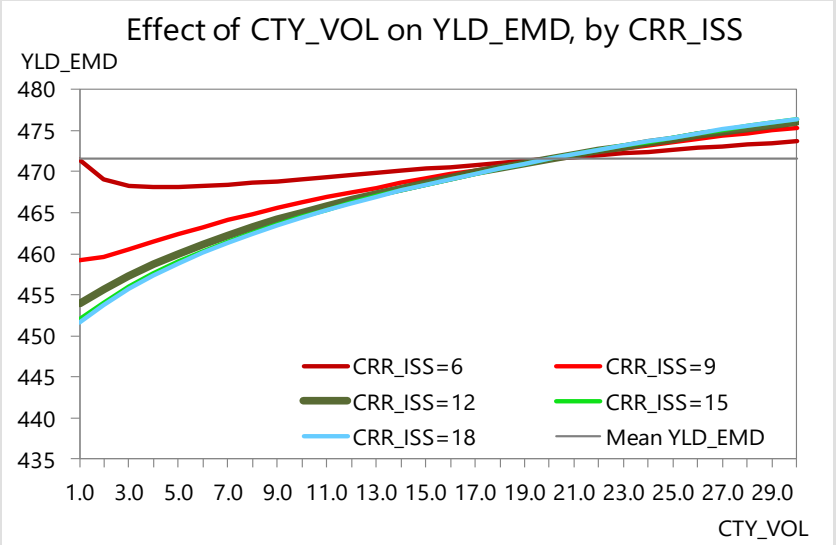


- Large liability management operations eventually reduce liquidity and increase yield

Influence of bond and country characteristics

- Country volume

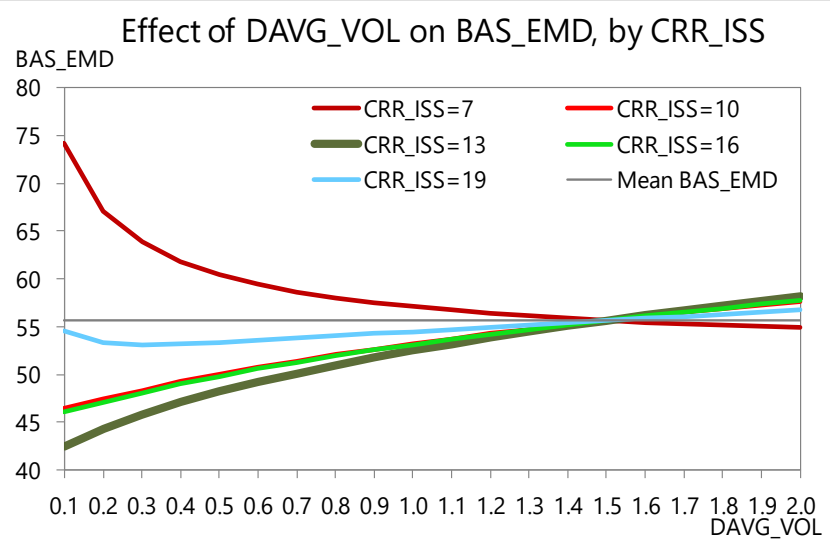


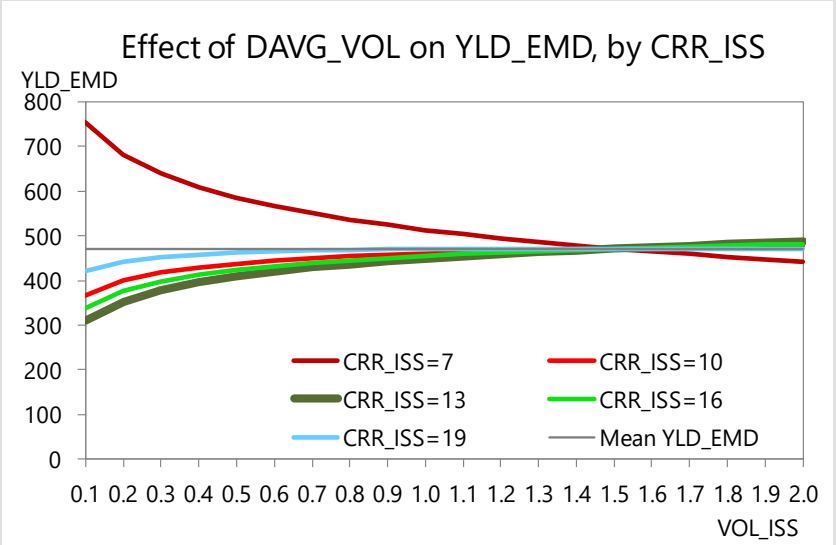


- Relatively modest
  - Extra results: larger country volume reduces b-a-s for small issuers

Influence of bond and country characteristics

- Deviation from country average

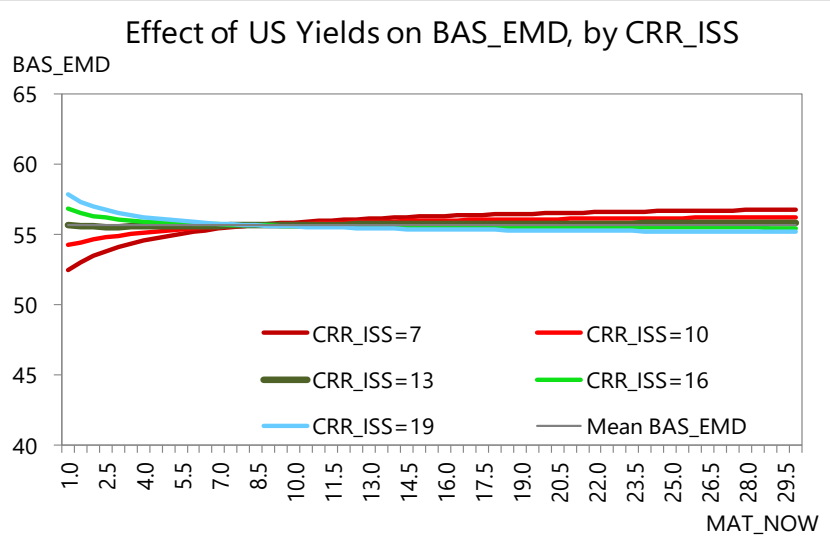


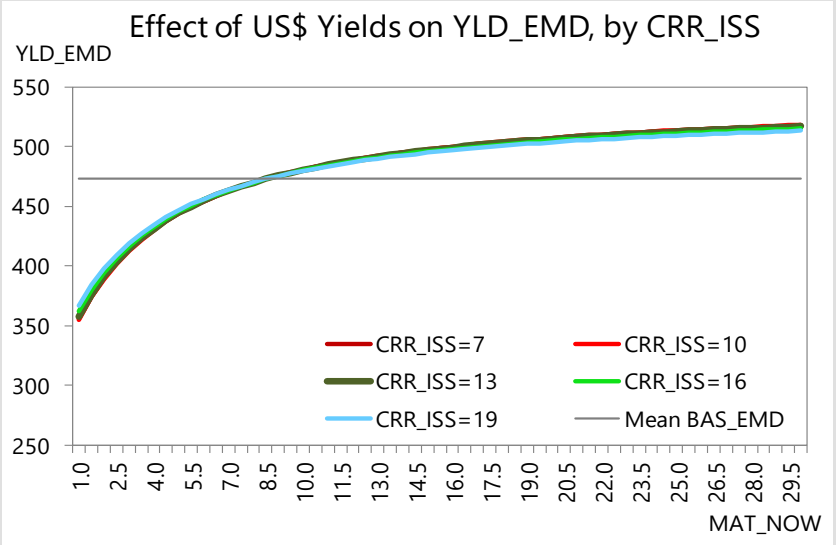


- Relatively modest

Influence of bond and country characteristics

- US yields

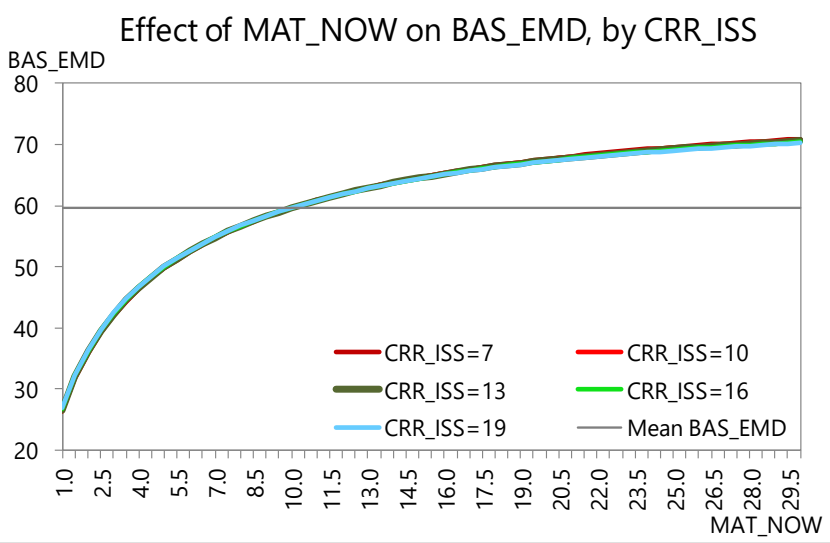


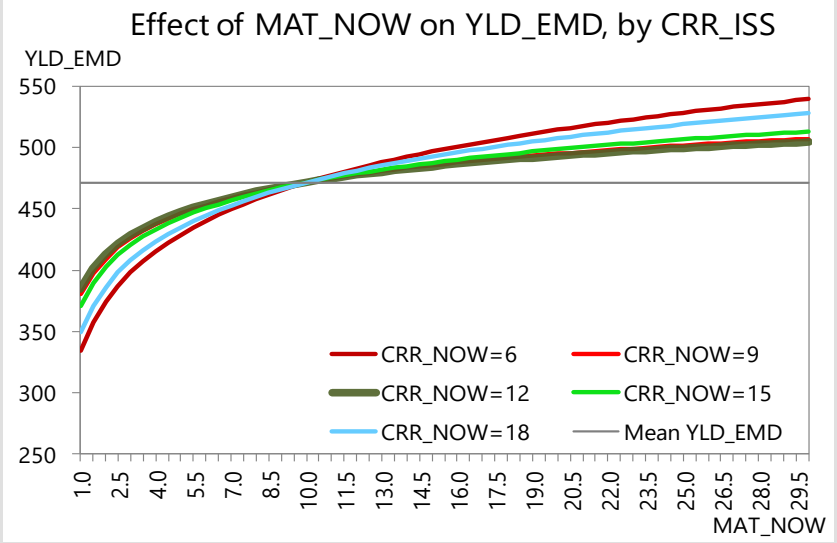


- Insignificant for bid-ask spread

Influence of bond and country characteristics

- Current maturity

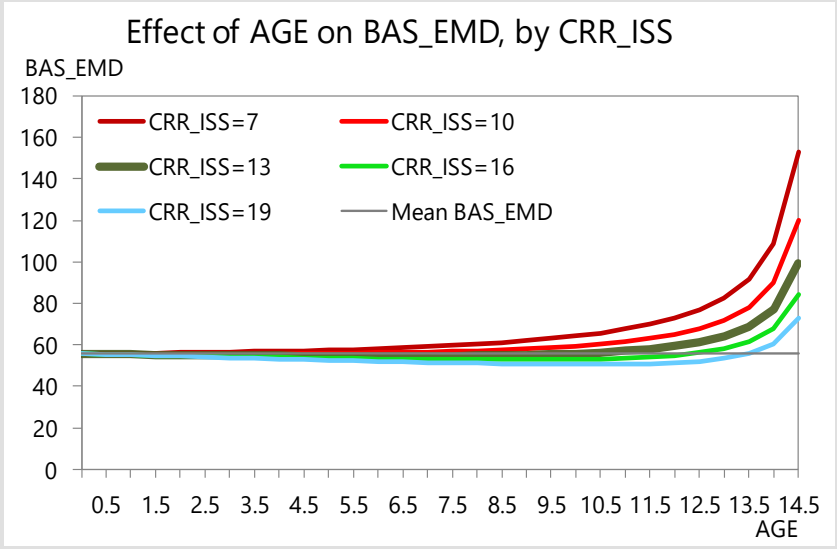


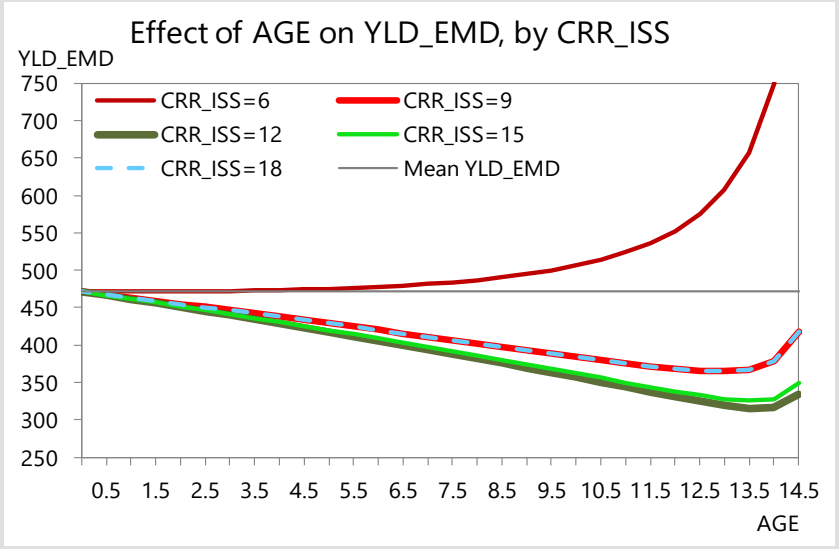


- Strong effect, independent of rating

Influence of bond and country characteristics

- Seasoning

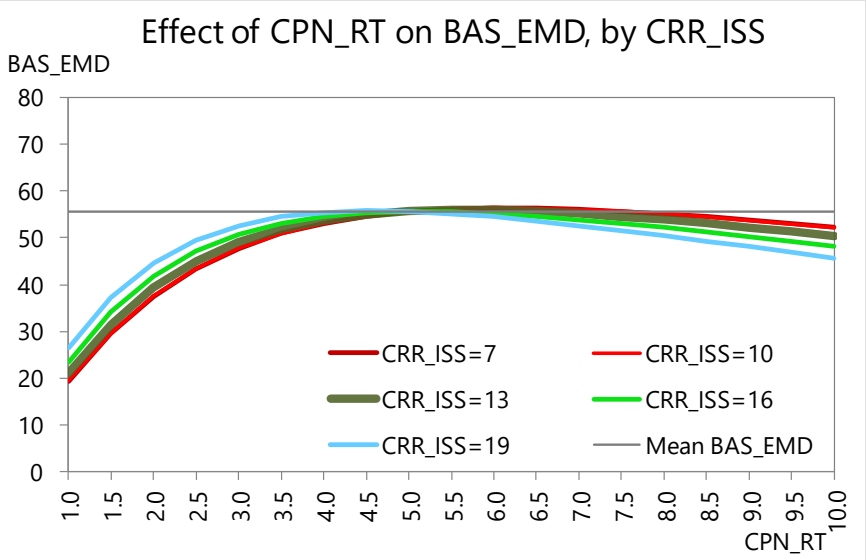


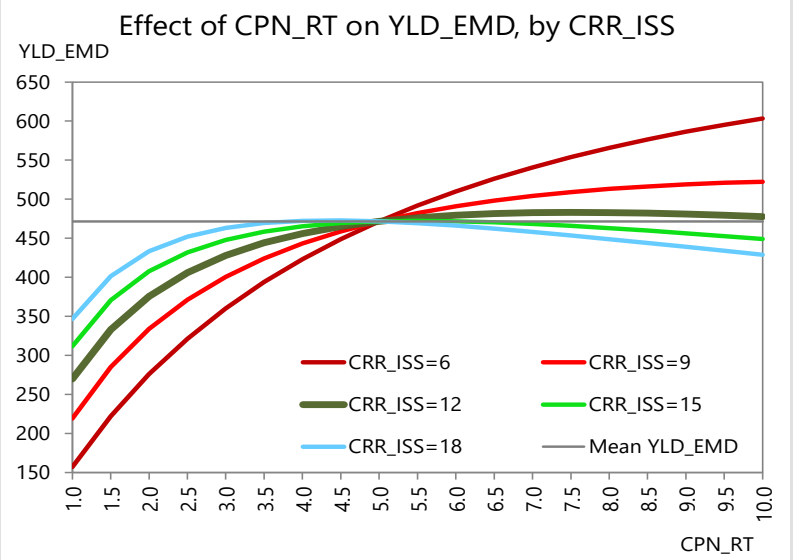


- Age matters shortly before maturity

Influence of bond and country characteristics

- Coupon rate

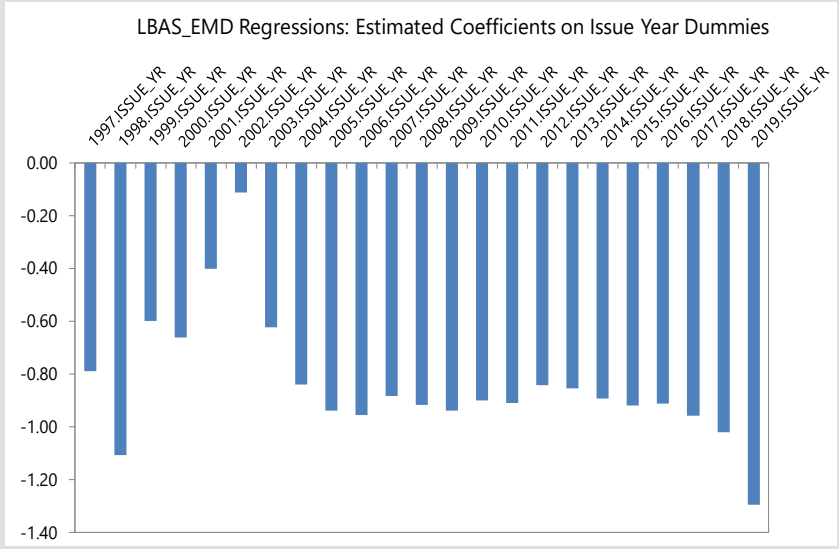


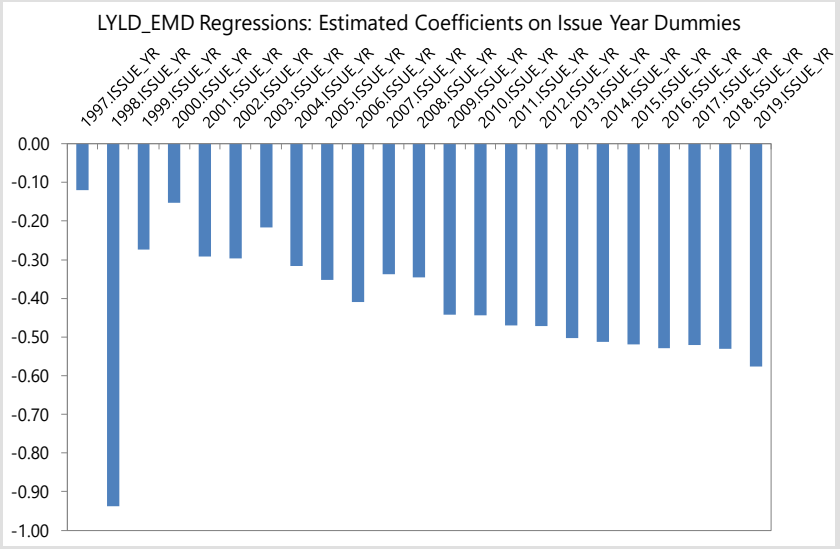


- May signal credit risk rather than affect duration
  - Matters mainly for low-rated issuers

Influence of bond and country characteristics

- Issue year

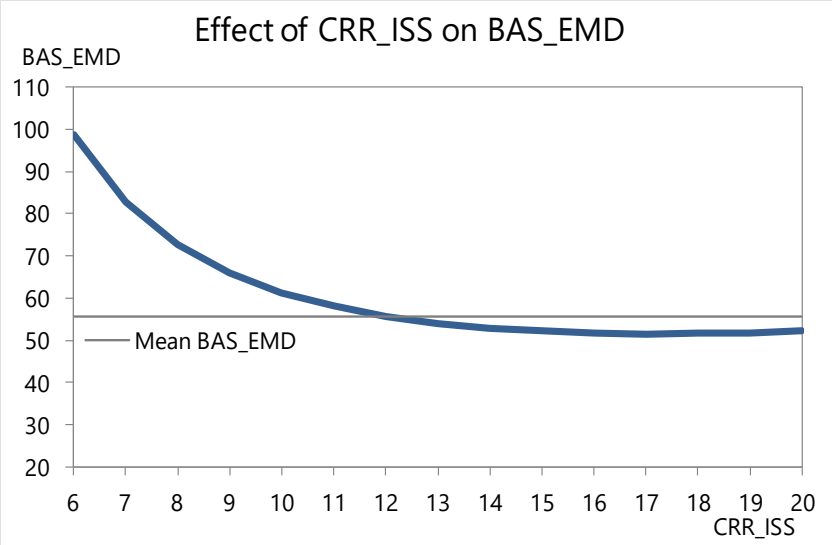


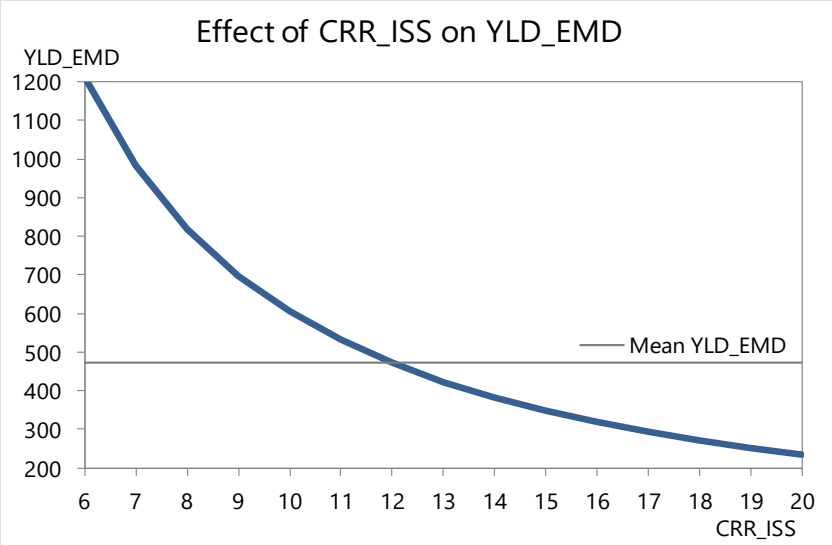


- Market has matured
  - Fewer unusual years later in sample

Influence of bond and country characteristics

- Credit rating when issued

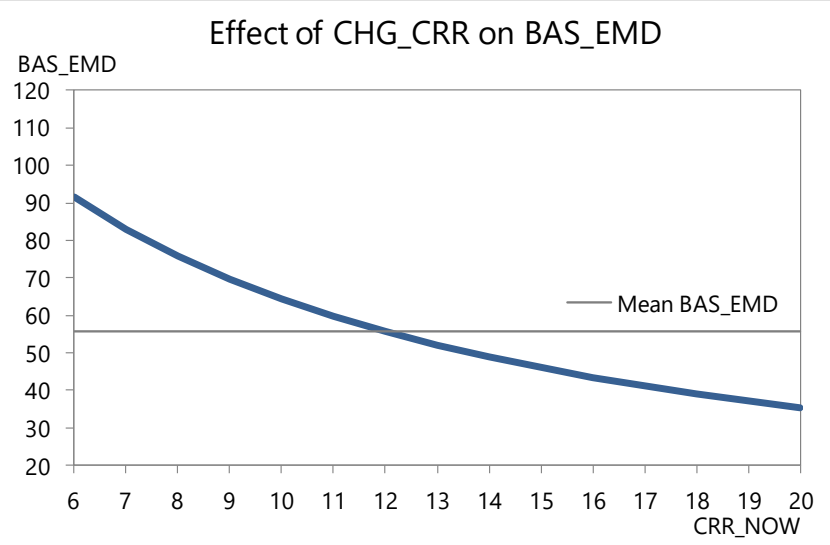


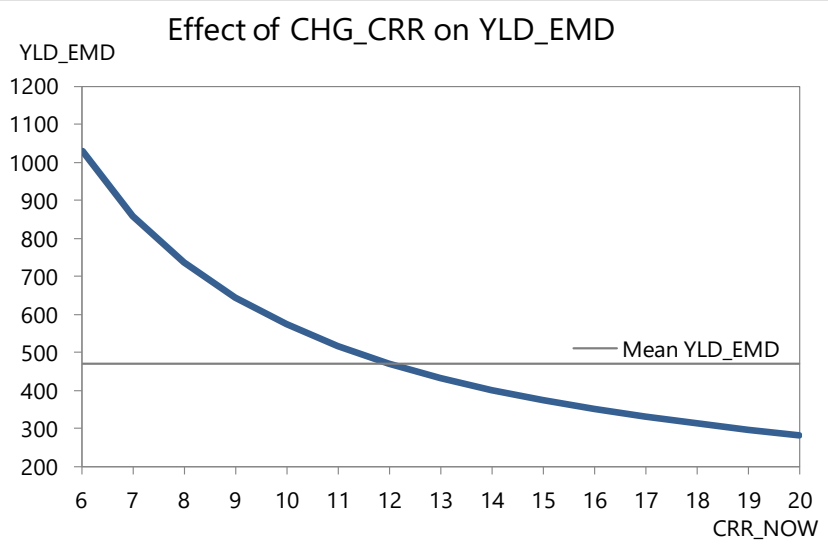


- Effect persistent
  - Effect on b-a-s of low-rated issuers only

Influence of bond and country characteristics

- Change in credit rating

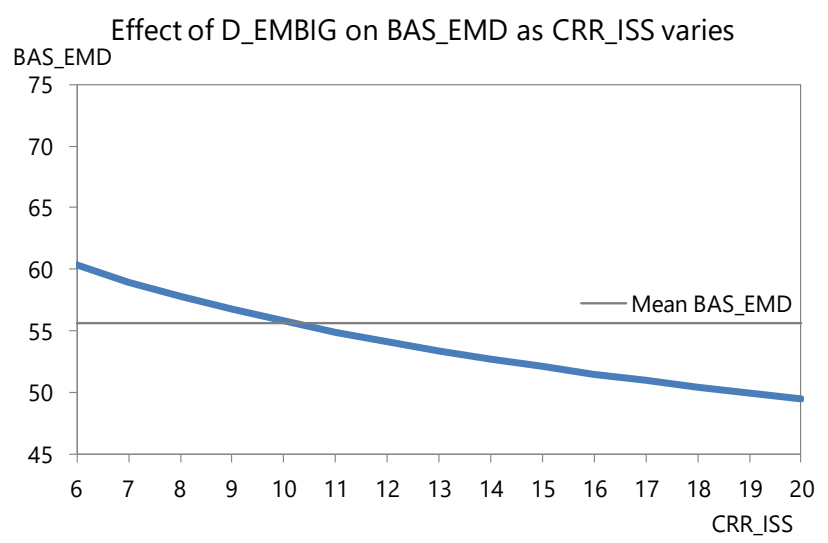


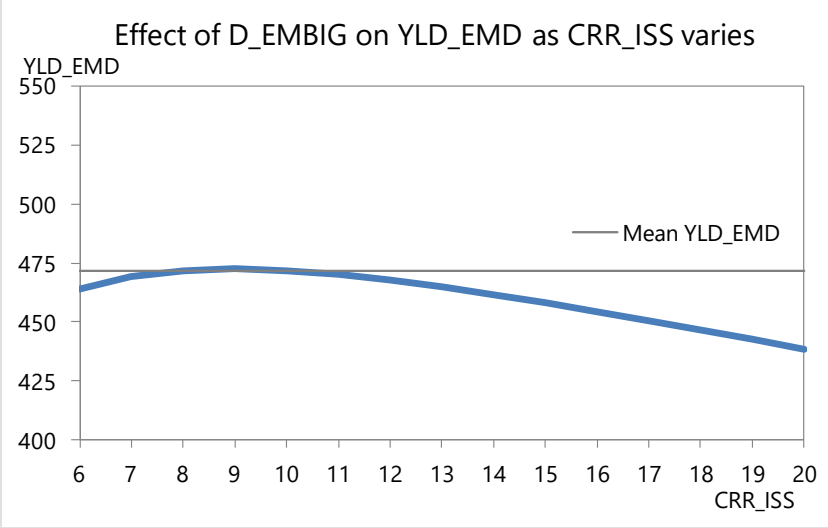


- Current credit rating also matters

Influence of bond and country characteristics

- EMBIG inclusion

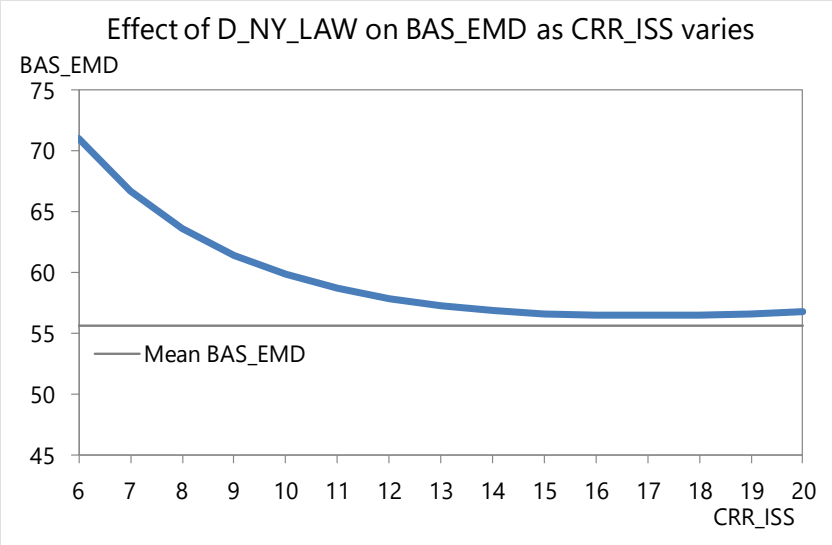


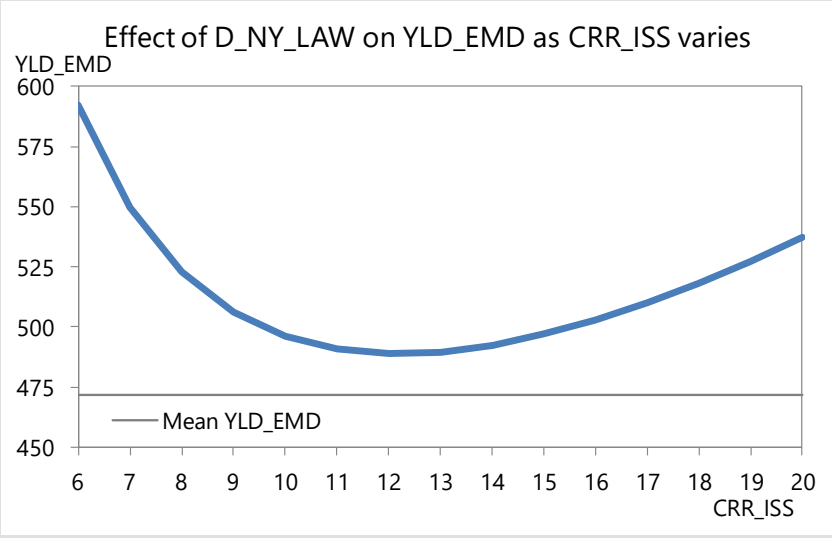


- Modest effect

Influence of bond and country characteristics

- Jurisdiction

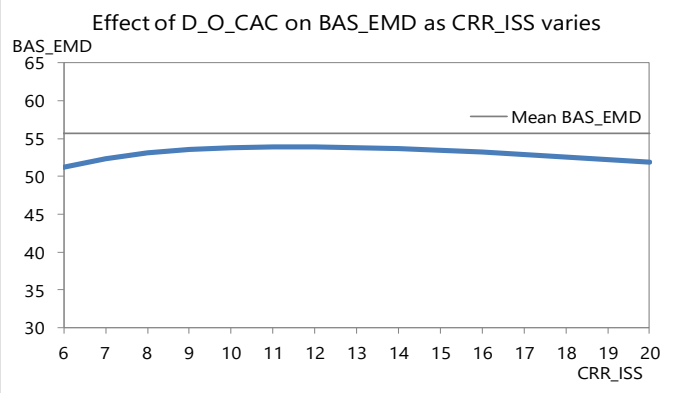


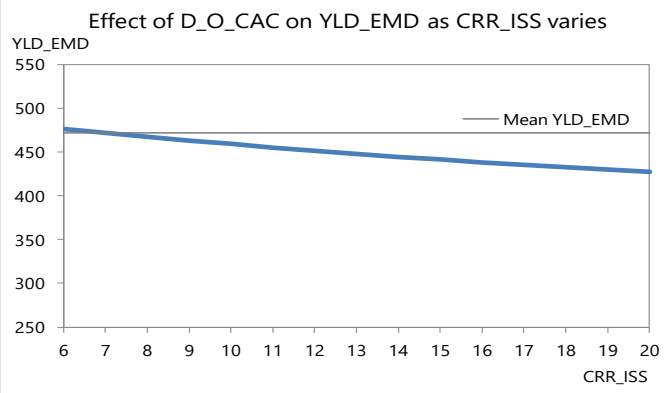


- Effect mainly for low-rated issuers
  - Possibly: fear restructuring under NY law more costly for some investors

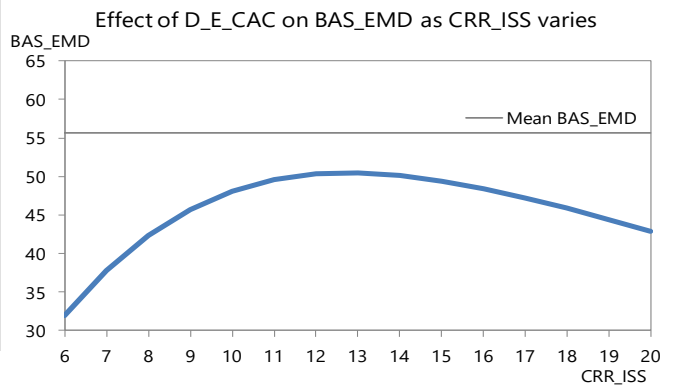
Influence of bond and country characteristics

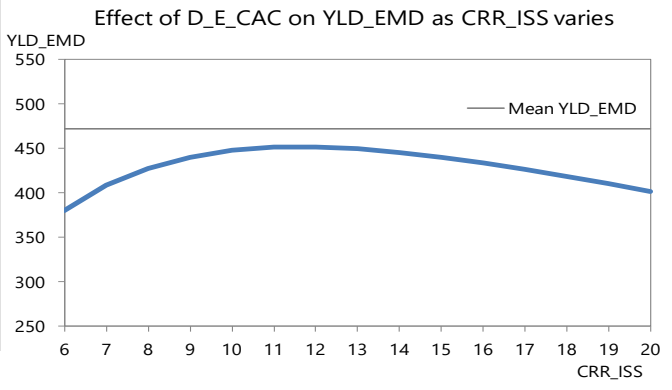
- Original CAC





- Enhanced CAC





Influence of bond and country characteristics

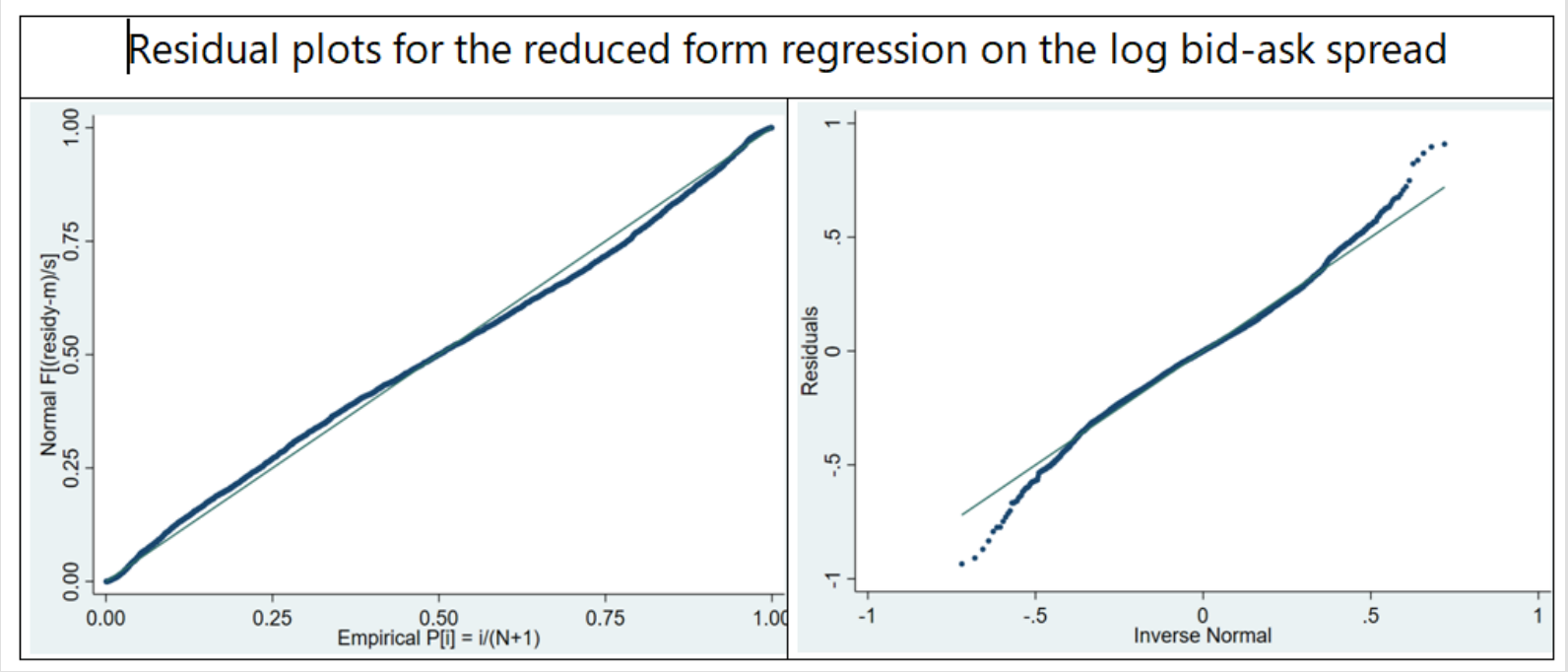
Robustness

- Across samples
- Across estimation technique
- Inclusion of country dummies

- Exception: highly rated bonds
  - But still have good R^2

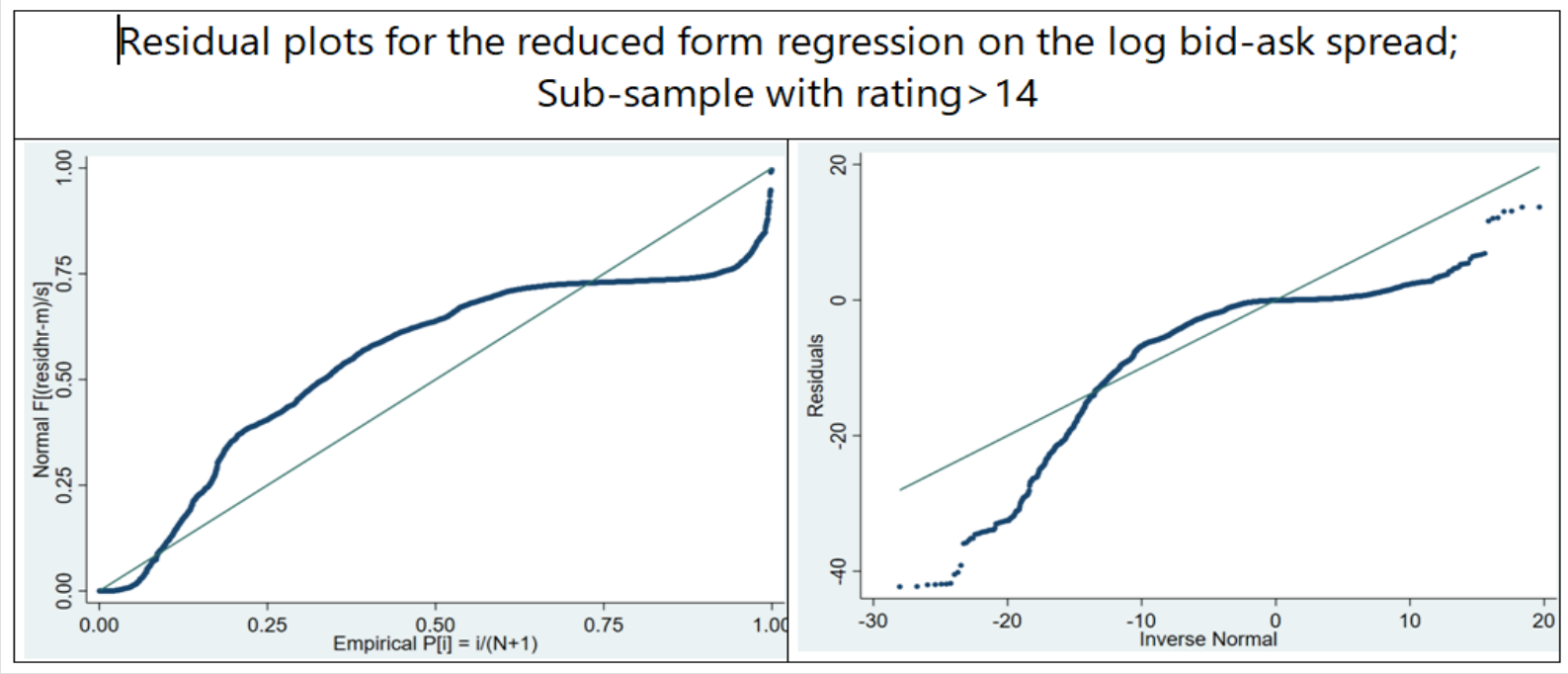
Influence of bond and country characteristics

- Error diagnostics:
  - Probit plots suggest normality with slight heteroskedasticity



Influence of bond and country characteristics

- Error diagnostics
  - Exception: highly rated bonds



Reduced form regressions

Using only variables known at time of issue

- Relevant for DMOs

- Drop
  - All fixed effects
  - Current volume, US$ T-bond yields, and rating
- Adequate predictive power
  - $R^2 > 0.50$
- Most effects persist
  - Some stronger
    - e.g., issue volume

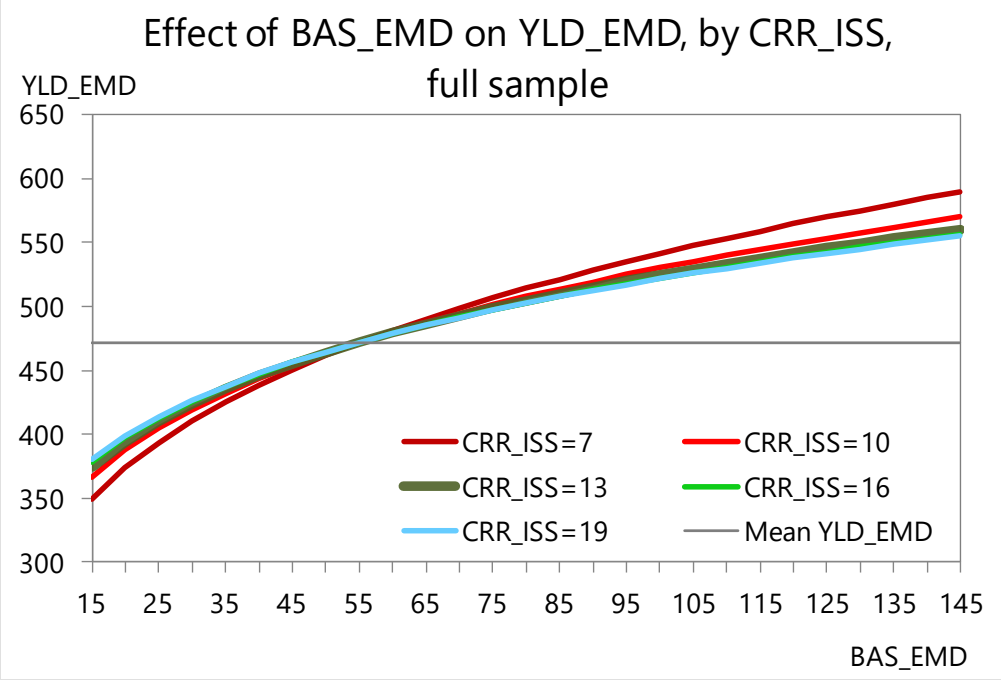
Effect of liquidity on yields

- Want to understand how yields and liquidity interact
  - Beyond common explanatory variables
- No reliable instruments in sample
  - Over-identification or exogeneity tests failed
  - Statistically acceptable candidates are economically unintuitive
  - Not robust

=>Residuals on residuals regression

Effect of liquidity on yields

- Understand interaction after controlling for all explanatory variables
  - Residuals on residuals regression



Effect of liquidity on yields

- Residuals on residuals regression
  - Typically: 10 bps. reduction in b-a spread reduces yield by 20 bps.
    - Even after controlling for all other effects
    - Not very sensitive to credit risk

	Full sample			
	coef.	s.e.	coef.	s.e.
R_LBAS	0.681	0.723	0.185***	0.011
R_LBAS_SQ	0.105***	0.036	0.103***	0.036
R_LBAS_LCRR	-0.343	0.581	...	
R_LBAS_LCRR_SQ	0.057	0.116	...	
CONS	-0.004**	0.002	-0.004**	0.002
Number of observations	4,314		4,314	
Adjusted R2	0.107		0.106	
F tests				
R_LBAS=0; R_LBAS_SQ=0; R_LBAS_LCRR=0; R_LBAS_LCRR_SQ=0	F(4, 4309)	85.67***	...	...
R_LBAS=0; R_LBAS_SQ=0	F(2, 4309)	4.65***	F(2, 4311)	152.64***
R_LBAS_LCRR=0; R_LBAS_LCRR_SQ=0	F(2, 4309)	1.23	...	...

Take-aways

- Instrument design has economically significant effects on yields and bid-asks spreads
  - Initial issue volume
  - Current volume
  - Initial maturity
  - Current maturity
  - Coupon rate
  - Jurisdiction
  - Enhanced CAC

Take-aways

- Effects are long lasting
  - Investor base established at issuance endures
- Effects are non-linear
- Effects vary with credit risk
  - Bond-idiosyncratic features matter less for high investment-grade bonds
- Liquidity risk is priced in Eurobond yields
  - Affects interpretation of yield spreads

Take-aways

- Hence
  - Theories largely corroborated
  - Investors can trade off yield against liquidity
  - Careful debt management rewarded
- Approach could be applied elsewhere
  - e.g., functioning of EMDC local currency bond markets