A Revisit to the Equity-Credit Market Integration Anomaly

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Outline

Stylized facts (based on the corp. bond market)

- Yield spreads = Model spreads + non-credit component
  - if models first calibrated to default rates and equity risk premia (sometimes referred to as the "credit spread puzzle")
  - Huang and Huang (2012)
- Yield spread changes = Explained portion + Unexplained part
  - Credit risk variables suggested by theory explain only about 25% of the variations in ΔCS_t^i
  - Unexplained portion mainly due to "local supply/demand shocks that are independent of both credit-risk factors and standard proxies for liquidity" (the abstract)
  - by Collin-Dufresne, Goldstein, and Martin (2001, CDGM)
- Corporate bond returns
  - The Merton model *hedge ratios* are quite consistent with those observed from market data (the benchmark $R^2 \approx 50\%$)
  - Schaefer and Strebulaev (2008)

Related Studies (A Short List)

- Evidence from the corporate bond market:
  - Jones, Mason, and Rosenfeld (1984), Lyden and Saraniti (2000), Eom, Helwege, and Huang (2004), Ericsson and Reneby (2004), Schaefer and Strebulaev (2004), Arora, Bohn, and Zhu (2005), Ericsson, Reneby, and Wang (2005), Cremers, Driessen, and Maenhout (2008), Bao and Pan (2012)
  - Elton, Gruber, Agrawal, and Mann (2001); Avramov, Jostova, and Philipov (2007); Cremers, Driessen, Maenhout, and Weinbaum (2008)
- Evidence from the CDS market
  - Ericsson, Jacobs, and Oviedo (2009), Zhang, Zhou, and Zhu (2009), Huang and Zhou (2008), Bai and Wu (2012), Kapadia and Pu (2012)

Related Studies (II)

A growing literature on corporate bond liquidity:

- Driessen (2005), Longstaff, Mithal, and Neis (2005), Chen, Lesmond, and Wei (2007), Mahanti, Nashikkar, Subrahmanyam, Chacko, and Mallik (2008), Han and Zhou (2008), Das and Hanouna (2009), Rossi (2009), Bao, Pan, and Wang (2011), Dick-Nielsen, Feldhütter, and Lando (2011), Feldhütter (2011), Friewald, Jankowitsch, and Subrahmanyam (2011), Helwege, Huang, and Wang (2011), Jankowitsch, Nashikkar, and Subrahmanyam (2011), and Lin, Wang, and Wu (2011)

What We Do

- Research Q: Can we reconcile these two findings of CDGM (2001) and Schaefer and Strebulaev (2008)?
  - This difference considered to be an "equity-credit integration anomaly"
- Consider three possible sources of the "anomaly"
  - Corporate bond data used
  - Different dependent variables used in regressions
  - Different degrees of nonlinearity involved in regressions
- Focus on magnitudes of regression coefficients, not just the R^2
- Do simulation studies using a variety of structural models as the data generating process
- Conduct empirical studies

Three possible sources of the “anomaly”

- Data:
  - Lehman bond data over 1988-1997 (Collin-Dufresne, Goldstein and Marin 2001)
  - Merrill Lynch bond data over 1996.12-2003.12 (Schaefer and Strebulaev 2008)
  - TRACE data used to analyze both spreads and returns (this study)
- Different dependent variables used
  - Yield spread changes (CDGM)
  - Bond returns (Schaefer-Strebulaev)
- Different degrees of nonlinearity involved
  - Linear regressions with model suggested variables (CDGM)
  - Linear regressions with model hedge ratios (Schaefer-Strebulaev)

Regression Models (I)

- One set of models used in both the simulation and empirical analysis:

$$
\begin{aligned}
r_{i,t}^{T} &= \alpha_r + \beta_{i,rf}^{r} rf_t^{T_0} + \beta_{i,E}^{r} r_{i,t}^{E}, & (1)\\
\Delta CS_{i,t}^{T} &= \alpha_S + \beta_{i,T}^{CS} \Delta TY_t^{T_0} + \beta_{i,I}^{CS} \Delta I_{i,t}; & (2)\\
\Delta CS_{i,t}^{T} &= \alpha_S + \beta_{i,T}^{CS} \Delta TY_t^{T_0} + \beta_{i,E}^{CS} r_{i,t}^{E}. & (3)
\end{aligned}
$$

where

- CS_t^i: the credit spread; $TY_t^{T_0}$: the Treasury yield;
- $\Delta CS_t^i = CS_t^i - CS_{t-1}^i$;
- $r_{i,t}^{T}$, $r_{i,t}^{E}$, and $rf_t^{T_0}$ are the excess returns of the corporate bond, stock, and the T-bond, respectively.

Reg Models (II): Incorporating Model-Implied Sensitivities

- Another set of models used in the analysis:

$$
\begin{aligned}
rx_{i,t}^{T} &= \alpha_r + \beta_{i,rf}^{r} rf_t^{T_0} + \beta_{i,E}^{r} h_E^r rx_{i,t}^{E}, && (4)\\
\Delta CS_{i,t}^{T} &= \alpha_{CS} + \beta_{i,T}^{CS} \Delta TY_t^{10} + \beta_{i,l}^{CS} h_{\ell}^{CS} \Delta \ell_{i,t}; && (5)\\
\Delta CS_{i,t}^{T} &= \alpha_{CS} + \beta_{i,T}^{CS} \Delta TY_t^{10} + \beta_{i,E}^{CS} h_E^{CS} r_{i,t}^{E}, && (6)
\end{aligned}
$$

where

- $\ell_{i,t} = \frac{FP_t^{T}}{A_t}$;
- $h_E^r, h_\ell^{CS}, h_E^{CS}$ denote the sensitivities of the bond return to equity, the spread to leverage, and the spread to equity, respectively

Data-Generating Processes Considered

- Merton (1974) and its three direct extensions
  - The Shimko, Tejima, and Van Deventer (1993) Model
    - = Merton (1974) + Vasicek (1977)
    - the focus of the simulation exercise
  - The Merton (1976) jump-diffusion Model
  - A Stochastic Asset Volatility Model
    - Merton (1974) + Square-root asset volatility process
- First-Passage Time Models
  - Black-Cox (1976)
  - Longstaff-Schwartz (1995)

Results using Merton (1974) as DGP [Table 1]

	Regressions of changes in the credit spread $\Delta CS^{\tau}_{i,t}$					
	AAA	AA	A	BBB	BB	B
$\Delta l_{i,t}$	1.67	3.66	5.06	6.24	8.86	13.04
	(41.07)	(50.96)	(54.06)	(56.64)	(56.27)	(58.21)
$\bar{R}^2$	0.75	0.83	0.82	0.81	0.77	0.73
$r^E_{i,t}$	-0.24	-0.74	-1.08	-1.30	-1.67	-2.22
	(-25.46)	(-43.74)	(-58.52)	(-66.96)	(-86.48)	(-108.62)
$\bar{R}^2$	0.57	0.74	0.82	0.85	0.90	0.92
$h^{CS}_l \Delta l_{i,t}$	1.00	1.00	1.00	1.00	1.00	1.00
	(5.29)	(12.61)	(14.05)	(14.10)	(11.26)	(-1.20)
$\bar{R}^2$	0.98	0.99	0.99	1.00	1.00	1.00
$h^{CS}_E r_{i,t}$	0.99	0.99	0.99	1.00	1.00	1.00
	(-16.96)	(-9.39)	(-4.56)	(-0.66)	(5.15)	(13.14)
$\bar{R}^2$	0.99	0.99	1.00	1.00	1.00	1.00

Using Shimko et al. (1993) as DGP (Panel A of Table 2)

Results from one-factor regression models:

LHS		AAA	AA	A	BBB	BB	B
$\Delta CS_{i,t}^{\tau}$	ΔTY_t^{10}	-2.16	-7.98	-13.16	-15.91	-21.49	-27.19
		(-16.77)	(-28.42)	(-34.16)	(-37.67)	(-44.12)	(-54.01)
	$\bar{R}^2$	0.07	0.13	0.18	0.19	0.21	0.21
$rx_{i,t}^{\tau}$	rf_t^{10}	76.70	70.55	65.25	62.63	57.21	52.10
		(738.26)	(361.02)	(245.18)	(216.57)	(173.01)	(153.34)
	$\bar{R}^2$	0.96	0.93	0.88	0.85	0.76	0.61
$\Delta Y_{i,t}^{\tau}$	ΔTY_t^{τ}	97.79	91.99	86.73	84.05	78.39	72.69
		(741.77)	(326.43)	(223.25)	(198.55)	(160.05)	(143.02)
	$\bar{R}^2$	0.99	0.94	0.89	0.86	0.78	0.66
$rx_{i,t}^{\tau}$	$xr_{i,t}^{E}$	10.66	8.58	7.34	9.30	11.98	19.17
		(42.07)	(41.95)	(39.32)	(55.42)	(79.30)	(135.11)
	$\bar{R}^2$	0.02	0.02	0.02	0.04	0.09	0.26

Shimko et al. (1993) as DGP (Panel B of Table 2)

One-fac reg. using the Merton (1974) Model Implied Sensitivity:

LHS		AAA	AA	A	BBB	BB	B
$\Delta CS^T_{i,t}$	$h^{CS}_l \Delta l_{i,t}$	1.18	1.28	1.28	1.25	1.13	1.08
		(4.17)	(7.94)	(8.17)	(8.30)	(5.01)	(3.50)
	$\bar{R}^2$	0.60	0.69	0.71	0.73	0.75	0.79
	$h^{CS}_E r^E_{i,t}$	0.92	1.03	1.01	1.01	0.92	0.93
		(-2.65)	(1.07)	(0.44)	(0.40)	(-3.98)	(-3.51)
	$\bar{R}^2$	0.32	0.44	0.49	0.51	0.54	0.60
$rx^T_{i,t}$	$h^r_E xr^E_{i,t}$	1.68	1.16	1.06	1.08	1.01	1.00
		(7.11)	(4.88)	(2.35)	(3.13)	(0.27)	(0.04)
	$\bar{R}^2$	0.02	0.04	0.06	0.11	0.15	0.29

Shimko et al. as DGP: 2-fac Reg (Panel C of Table 2)

LHS		AAA	AA	A	BBB	BB	B
$\Delta CS_{i,t}^{T}$	ΔTY_t^{10}	0.93	0.06	-1.63	-2.77	-5.79	-8.97
		(9.02)	(0.31)	(-5.91)	(-9.44)	(-16.99)	(-25.33)
	$\Delta l_{i,t}$	2.67	4.08	4.81	5.40	6.60	9.14
		(68.41)	(81.65)	(74.93)	(72.12)	(62.28)	(56.19)
	$\bar{R}^2$	0.64	0.74	0.74	0.75	0.73	0.74
	ΔTY_t^{10}	-1.93	-6.24	-9.28	-11.33	-15.26	-21.77
		(-23.07)	(-46.30)	(-54.67)	(-58.78)	(-64.22)	(-72.26)
	$r_{i,t}^{E}$	-0.25	-0.62	-0.86	-1.00	-1.25	-1.65
		(-22.51)	(-35.99)	(-45.60)	(-49.46)	(-58.13)	(-66.91)
	$\bar{R}^2$	0.35	0.51	0.59	0.63	0.69	0.77
$rx_{i,t}^{T}$	rf_t^{10}	76.98	71.97	68.34	66.15	61.93	55.79
		(791.72)	(551.82)	(442.00)	(385.67)	(304.57)	(219.49)
	$xr_{i,t}^{E}$	2.78	7.42	10.36	12.12	15.09	19.73
		(23.87)	(44.59)	(59.42)	(67.69)	(85.34)	(105.22)
	$\bar{R}^2$	0.97	0.97	0.96	0.95	0.94	0.92

Shimko et al. (1993) as DGP (Panel D of Table 2)

One-fac reg. using the Merton (1974) Predicted Spreads or Returns:

	AAA	AA	A	BBB	BB	B
	Regressions of changes in the credit spread $\Delta CS_{i,t}^{\tau}$					
$\Delta\widehat{CS}_{i,t}^{\tau}$	0.05	0.58	0.87	1.00	1.12	1.11
	(3.50)	(33.49)	(61.71)	(94.31)	(174.85)	(350.09)
$\bar{R}^2$	0.20	0.38	0.54	0.65	0.81	0.93
	Regressions of excess bond returns $rx_{i,t}^{\tau}$					
$\widehat{rx}_{i,t}^{\tau}$	0.46	0.44	0.43	0.43	0.43	0.46
	(277.29)	(200.17)	(163.67)	(146.01)	(120.43)	(100.87)
$\bar{R}^2$	0.92	0.87	0.83	0.81	0.77	0.74

Main Data Used

- Corporate bond data
  - TRACE database
  - Sample period: July 2002 - Dec. 2010
  - Senior unsecured bonds without imbedded options (non-financial firms)
  - Transactions size $\geq \$100,000$
  - Time-to-maturity $\geq$ 4 years
  - At least 25 monthly observations
- The final sample consists of
  - 255 from 108 issuers (11,489 bond-months)
- Treasury CMT; CRSP; COMPUSTAT

Bivariate Regressions (Table 7)

Panel A: $\Delta CS_{i,t}^{T} = \alpha_{CS} + \beta_{i,T}^{CS} \Delta TY_t^{10} + \beta_{i,I}^{CS} \Delta I_{i,t}$

	All	AAA	AA	A	BBB	BB	B
Intercept	0.00	-0.00	-0.01	-0.00	-0.01	-0.01	0.08
	(0.93)	(-0.92)	(-1.80)	(-0.48)	(-0.83)	(-0.60)	(2.79)
ΔTY_t^{10}	-0.61	-0.20	-0.25	-0.34	-0.64	-1.03	-1.18
	(-15.20)	(-6.28)	(-3.52)	(-16.15)	(-8.17)	(-6.28)	(-9.22)
$\Delta I_{i,t}$	6.35	4.76	2.74	2.58	4.13	5.46	14.53
	(6.79)	(2.27)	(1.91)	(4.26)	(2.54)	(2.00)	(3.37)
$\bar{R}^2$	0.19	0.11	0.09	0.14	0.22	0.23	0.28
N	255	12	14	85	82	22	24

Bivariate Regressions (Table 7) - II

Panel B: $\Delta CS^{\tau}_{i,t} = \alpha_{CS} + \beta^{CS}_{i,T} \Delta TY^{10}_t + \beta^{CS}_{i,E} r^E_{i,t}$

	All	AAA	AA	A	BBB	BB	B
Intercept	0.01	0.00	-0.01	0.00	0.00	0.01	0.07
	(2.27)	(0.49)	(-1.12)	(0.66)	(0.15)	(0.39)	(2.81)
ΔTY^{10}_t	-0.60	-0.20	-0.26	-0.34	-0.64	-1.01	-1.15
	(-15.24)	(-6.40)	(-3.65)	(-15.85)	(-8.20)	(-5.83)	(-9.18)
$r^E_{i,t}$	-1.21	-0.60	-0.48	-0.57	-1.07	-2.01	-2.60
	(-8.23)	(-3.22)	(-1.86)	(-5.64)	(-3.24)	(-3.13)	(-5.46)
$\bar{R}^2$	0.20	0.10	0.10	0.14	0.22	0.25	0.34
N	255	12	14	85	82	22	24

Bivariate Regressions (Table 7) - III

Panel C: $rx^{\tau}_{i,t} = \alpha_r + \beta^r_{i,rf} rf^{\tau_0}_t + \beta^r_{i,E} rx^E_{i,t}$

	All	AAA	AA	A	BBB	BB	B
Intercept	-0.04	-0.03	-0.03	0.03	-0.03	0.03	-0.06
	(-1.31)	(-0.76)	(-0.87)	(2.16)	(-0.83)	(0.35)	(-0.46)
rf^{10}_t	34.97	64.69	60.63	51.42	32.58	-23.58	-6.53
	(9.77)	(8.55)	(10.62)	(19.74)	(4.64)	(-0.86)	(-0.69)
$xr^E_{i,t}$	9.01	3.33	2.75	3.30	9.56	16.79	16.31
	(8.91)	(1.78)	(2.56)	(4.38)	(6.83)	(3.76)	(3.38)
$\bar{R}^2$	0.29	0.43	0.42	0.30	0.20	0.18	0.21
N	255	12	14	85	82	22	24

2-fac Regs w/ Merton Implied Sensitivities (Table 8)

Panel A: $\Delta CS^{T}_{i,t} = \alpha_{CS} + \beta^{CS}_{i,T}\Delta TY^{10}_{t} + \beta^{CS}_{i,l} h^{CS}_{\ell} \Delta\ell_{i,t}$

	All	AAA	AA	A	BBB	BB	B
Intercept	0.01	-0.00	-0.01	-0.00	-0.01	-0.01	0.10
	(1.51)	(-0.55)	(-1.71)	(-0.19)	(-0.81)	(-0.41)	(3.76)
ΔTY^{10}_{t}	-0.58	-0.23	-0.26	-0.34	-0.60	-0.95	-1.32
	(-13.96)	(-6.36)	(-3.37)	(-15.57)	(-7.92)	(-5.55)	(-7.97)
$h^{CS}_{\ell}\Delta\ell_{i,t}$	1.08	0.83	0.29	1.10	1.37	1.13	2.34
	(0.45)	(-0.25)	(-1.52)	(0.20)	(0.99)	(0.17)	(1.75)
$\bar{R}^2$	0.22	0.11	0.10	0.17	0.23	0.23	0.34
N	255	12	14	85	82	22	24

2-fac Regs w/ Merton Implied Sensitivities (Table 8) - II

Panel C: $\Delta CS_{i,t}^{T} = \alpha_{CS} + \beta_{i,T}^{CS} \Delta TY_t^{10} + \beta_{i,E}^{CS} h_E^{CS} r_{i,t}^{E}$

	All	AAA	AA	A	BBB	BB	B
Intercept	0.01	0.00	-0.00	0.00	-0.00	-0.00	0.07
	(2.44)	(1.38)	(-0.81)	(0.15)	(-0.18)	(-0.12)	(3.66)
ΔTY_t^{10}	-0.58	-0.22	-0.27	-0.35	-0.62	-0.97	-1.14
	(-14.07)	(-6.16)	(-3.65)	(-15.80)	(-8.36)	(-5.11)	(-6.24)
$h_E^{CS} r_{i,t}^{E}$	1.03	0.58	0.84	1.22	0.79	0.88	1.55
	(0.10)	(-0.42)	(-0.79)	(1.14)	(-1.01)	(-0.54)	(1.60)
$\bar{R}^2$	0.22	0.11	0.10	0.16	0.25	0.27	0.34
N	255	12	14	85	82	22	24

2-fac Regs w/ Merton Implied Sensitivities (Table 8) - III

Panel E: $rx_{i,t}^{\tau} = \alpha_r + \beta_{i,rf}^{r} rf_t^{\tau_0} + \beta_{i,E}^{r} h_E^r rx_{i,t}^{E}$

	All	AAA	AA	A	BBB	BB	B
Intercept	-0.03	-0.02	-0.04	0.03	-0.02	0.04	-0.09
	(-1.34)	(-0.65)	(-1.32)	(1.73)	(-0.77)	(0.42)	(-0.73)
rf_t^{10}	38.29	63.91	74.28	57.51	35.25	-23.51	-19.84
	(7.74)	(7.46)	(8.82)	(15.87)	(5.22)	(-0.83)	(-1.55)
$h_E^r xr_{i,t}^E$	1.06	1.23	0.61	1.09	0.73	1.35	0.58
	(0.11)	(0.21)	(-0.90)	(0.61)	(-0.41)	(0.51)	(-1.72)
$\bar{R}^2$	0.31	0.41	0.38	0.35	0.23	0.24	0.17
N	255	12	14	85	82	22	24

Conclusion

- Examine the "equity-credit integration anomaly:"
  - Variables suggested by structural models can explain only a small portions of yield spread *changes* (Collin-Dufresne, Goldstein and Marin 2001)
  - The Merton model *hedge ratios* are quite consistent with those observed from market data (Schaefer and Strebulaev 2008)
- Can largely reconcile these two seemingly conflicting results if
  - taking into account the following aspects
    - Different data
    - Different dependent variables used in regressions
    - Different degrees of nonlinearity involved
  - focusing on magnitudes of reg coefficients, rather than the R^2