

# Decomposing the Returns on European Debt

Antje Berndt and Iulian Obreja

Carnegie Mellon University  
University of Colorado at Boulder

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## Motivation (1/2)

- Standard asset pricing paradigm:  
Markets are integrated and common variation only arises from exposure to macroeconomic risk
- However, episodes of weak integration between European equity and debt markets do exist:
  - In 2002, almost a quarter of all European high-yield bonds defaulted. Aggregate European credit spreads increased by almost 50% for the first quarter of 2002, while the MSCI Euro stock index remained flat for the same time period.
  - From June to August 2004, aggregate European credit spreads increased by more than 60%, while European stocks climbed rather steadily, rising by more than 10%.

## Motivation (2/2)

- Episodes of weak integration not necessarily at odds with standard APT:
  - Most sources of systematic risk are proxied for with zero-cost portfolios which tend to have lognormal returns.
  - But corporate bond returns are sensitive to extreme events (defaults), hence are likely to have a nonlognormal component.
- Why would common variation arise from the nonlognormal component of corporate bond returns?
  - Extreme events (defaults) are rare and investors learn continuously about their likelihood.
  - If an adverse credit market event occurs it might reveal that extreme events are more frequent than previously thought. In this case, bond investors would rationally adjust their of default event across firms.
  - This systemic response leads to common variation in bond returns.

## Example (1/2)

- Let A and B denote two zero-coupon zero-recovery bonds with a maturity of 1yr.
- Suppose there are 3 equally possible states:  $s_1$ ,  $s_2$  and  $s_3$
- Payoffs as of today:
  - Bond A pays 1 unit of account in states  $s_1$  and  $s_2$  and 0 in state  $s_3$ .
  - Bond B pays 1 unit of account for sure.
- Suppose that 1 week from today, new information reveals that  $s_1$  is actually a default state.
- Payoffs, 1 week from today:
  - Bond A pays 1 unit of account in state  $s_2$  and 0 in states  $s_1$  and  $s_3$ .
  - Bond B pays 1 unit of account in states  $s_2$  and  $s_3$  and 0 in state  $s_1$ .

## Example (2/2)

- Suppose the weekly interest rates is  $r$ .
- Return on bond A:
  - Today:  $P_0^A = \frac{2}{3}e^{-50r}$ .
  - 1 week later:  $P_1^A = \frac{1}{3}e^{-49r}$
  - Weekly return:  $r_1^A = \log \frac{P_1^A}{P_0^A} = r + \log \frac{1}{2}$
- Return on bond B:
  - Today:  $P_0^B = e^{-50r}$ .
  - 1 week later:  $P_1^B = \frac{2}{3}e^{-49r}$
  - Weekly return:  $r_1^B = r + \log \frac{2}{3}$
- Excess returns:
  - Bond A:  $r_1^A - r = \log \frac{1}{2} < 0$
  - Bond B:  $r_1^B - r = \log \frac{2}{3} < 0$
  - Comparison:  $|r_1^A - r| > |r_1^B - r|$

# Contribution

- Propose model where common variation in defaultable bond returns can be unrelated to systematic risk.
- Identify a latent **credit market factor (CMF)** which has the potential of capturing the systemic revisions in the distributions of default events across firms.
- Verify that *CMF* induces common variation in corporate bond returns, above and beyond the macroeconomic risk factors identified by our model.
- Investigate whether the common variation in bond returns captured by *CMF* can be attributed to the systemic revisions in the distributions of the default event across firms or not.

## Summary of results (1/2)

- *CMF* captures on between 30% and 54% of the CDS-implied risk-adjusted excess returns of zero-coupon zero-recovery defaultable bonds.
- Evidence from a wide range of corporate portfolios supports the hypothesis that *CMF* captures common variation in bond returns unrelated to macroeconomic risk.
- Consistent with our theoretical results, innovations in the *CMF* induce larger responses in those bond portfolios whose payoffs are more sensitive to extreme events.
- *CMF* is unlikely to be associated with the lack of liquidity in corporate debt markets or tax asymmetries.

## Summary of results (2/2)

- To the extent that the *CMF* captures common variation in bond returns due to other reasons (e.g. missing macroeconomic risk factors), such common variation is not likely to be induced by characteristics which differentiate between debt and equity markets.
- Therefore, *CMF* should induce common variation in the equity returns as well.
- Using a large cross-section for equity portfolios, we verify that this is not the case.

# Data (1/3)

## CDS Data

- Daily 5-year CDS quotes on Euro-denominated senior unsecured debt. Data is provided by CMA Thomson via Datastream. We use weekly data from January 2003 to November 2006.
- We focus exclusively on firms with liquid CDS markets.
- Cleaned sample contains 55 firms from 11 European countries and 16 different industries.
- A typical firm in our sample has 150 valid weekly observations.

## Data (2/3)

### Corporate Bond Portfolios

- Merrill Lynch nonfinancial corporate bond portfolios sorted on rating (3) and time-to-maturity (4)
- Merrill Lynch AAA (4), AA (3), A (4), and BBB (3) corporate bond portfolios sorted on time-to-maturity
- Lehman Brothers Euro-aggregate industrial corporate bond portfolios sorted on rating (5), time-to-maturity (5) and sector (16)

### Equity Portfolios

- Country-specific equity portfolios pre-sorted by sector or industry and by size:  
Finland (75), France (113), Germany (112), Netherlands (76), Sweden (69), UK (75)

## Data (3/3)

### Interest Rate Data

- Euro term structure, inferred from the Euro zero curves relative to Euribor.

### Systematic Risk Factors Data

- Our model implies 2 sources of systematic risk: market and term spread
  - Market: proxied by (MSCI/FTSE) country-specific and overall European equity market factors
  - Term: proxied by zero-cost portfolio of long 30-years zero yield and short one-month zero yield

## Pricing Assets with Nonlognormal Returns (1/3)

- We derive an expected return-beta representation for assets with non-lognormal returns in the context of Campbell's (1993) ICAPM.
- Suppose investors have non-additive preferences:

$$U_t = \left\{ (1 - \beta) C_t^{\frac{1-\gamma}{\theta}} + \beta \left( E_t \left[ U_{t+1}^{1-\gamma} \right] \right)^{\frac{1}{\theta}} \right\}^{\frac{\theta}{1-\gamma}},$$

- Euler equation as derived by Epstein and Zin (1989):

$$1 = E_t \left[ \left\{ \beta \left( \frac{C_{t+1}}{C_t} \right)^{-\frac{1}{\sigma}} \right\}^{\theta} \left\{ \frac{1}{R_{t+1}^m} \right\}^{1-\theta} R_{t+1}^i \right],$$

## Pricing Assets with Nonlognormal Returns (2/3)

- If asset returns and consumption growth are jointly conditionally homoscedastic and lognormally distributed, we can substitute out consumption:

$$E_t r_{t+1}^i - r_{t+1}^f = -\frac{1}{2} V_{ii} + \gamma V_{im} + (1 - \gamma) V_{ib}.$$

$V_{im}$ : covariance of asset log return  $r^i$  with market,  
 $V_{ib}$ : covariance of asset with riskless console bond.

- Expected return-beta representation for assets with **lognormal** returns:

$$E r_t^{j,e} + \frac{1}{2} V_{jj} = \beta_{im} \left[ E r_t^{m,e} + \frac{1}{2} V_{mm} \right] + \beta_{ib}^\perp \left[ E r_t^{b,\perp,e} + \frac{1}{2} V_{bb}^\perp \right],$$

where  $r_{t+1}^{b,\perp} = r_{t+1}^b - \beta_t^{b,m} r_{t+1}^m$ .

## Pricing Assets with Nonlognormal Returns (3/3)

- Now consider an asset with **nonlognormal** returns. Decompose the instantaneous asset return  $r_t^D$  into

$$r_t^D = r_t^{D,c} + r_t^{D,n}.$$

$r_t^{D,c}$ : projection of  $r_t^D$  on the 2 macroeconomic factors

- Generalized expected return-beta representation:

$$\begin{aligned} E r_t^{D,e} + \frac{1}{2} V_{DD}^c &= \beta_{Dm} \left[ E r_t^{m,e} + \frac{1}{2} V_{mm} \right] \\ &+ \beta_{Db}^\perp \left[ E r_t^{b,\perp,e} + \frac{1}{2} V_{bb}^\perp \right] + E \Delta z_t, \end{aligned}$$

where  $\Delta z_t = E_t r_{t+1}^{D,n} - \log E_t e^{r_{t+1}^{D,n}}$ .

- The returns model associated with this representation is:

$$r_t^{D,e} = \alpha + \beta_{Dm} r_t^{m,e} + \beta_{Db}^\perp r_t^{b,\perp,e} + \Delta z_t^D + \epsilon_t^D.$$

# Identifying the Common Variation in the Nonlognormal Component of Returns

- Based on Berndt et al (2005), for each firm we estimate a time-series model of CDS-inferred risk-neutral default intensities.
- Given risk-neutral intensities, we can compute model-implied returns  $r_t^i$  on zero-coupon zero-recovery bonds with various maturities.
- We then identify the residuals of the risk-adjusted excess returns on zero-coupon zero-recovery bonds as

$$r_t^{i,e} = \alpha^i + \beta_{im} r_t^{m,e} + \beta_{ib}^{\perp} r_t^{b,\perp,e} + \epsilon_t^i,$$

- Finally, we construct the **credit market factor (CMF)**:

$$\hat{f}_s = \frac{1}{N} \sum_{i=1}^N \hat{\alpha}^i + \hat{\epsilon}_s^i.$$

**Table:** Country-by-country estimation of risk-neutral default intensities using Black-Karasinski model

	$\kappa^Q$	$\sigma^Q$	$\rho^Q$	mean( $\theta^Q$ )	$\tilde{\kappa}^Q$	mean( $\tilde{\kappa}^Q \tilde{\theta}^Q$ )	firms
Denmark	0.154	0.444	–	3.624	–0.123	–0.220	1
Finland	0.290	0.410	0.309	3.870	0.003	0.242	5
France	1.363	1.455	0.683	2.959	0.158	0.402	13
Germany	1.764	1.274	0.591	2.962	0.224	0.722	10
Greece	4.533	1.043	–	3.182	0.186	0.768	1
Italy	1.086	1.872	0.767	3.257	0.306	0.611	2
Netherlands	3.339	0.938	0.902	2.848	–0.206	–0.854	4
Norway	2.640	0.257	–	2.758	–0.159	–0.214	1
Spain	2.512	0.510	0.287	3.070	0.015	0.325	2
Sweden	0.673	1.098	0.220	3.246	0.289	1.401	5
UK	1.143	0.849	0.357	3.530	0.182	0.903	11

**Table:** Summary Statistics for the Construction of the *CMF*

$\alpha$	$\beta_{EMKT}$	$\beta_{CMKT}$	$\beta_{TERM}$	<i>Perc(C)</i>	<i>Upd.R<sup>2</sup></i>
0.0000 (3.3160)	-0.0005 (-0.0101)	0.0001 (0.0077)	0.1607 (2.6410)	35.28	404.04
-0.0006 (-4.3896)	0.0045 (0.7568)	0.0028 (0.1908)	1.1120 (3.7908)	29.83	405.40
-0.0010 (-4.8849)	0.0064 (0.6559)	0.0031 (0.1730)	1.9146 (4.1127)	39.16	460.73
-0.0014 (-5.1307)	0.0073 (0.5875)	0.0030 (0.1595)	2.6169 (4.2915)	45.85	497.29
-0.0018 (-5.2826)	0.0080 (0.5376)	0.0027 (0.1498)	3.2480 (4.4050)	50.50	521.64
-0.0021 (-5.3858)	0.0086 (0.4992)	0.0024 (0.1426)	3.8203 (4.4827)	53.84	538.83

# Common Variation in Corporate Bond Returns

- We test whether *CMF* induces common variation in corporate bond returns.
- **Firm-by-firm regressions:**

$$r_{t+1}^{i,e} = \alpha^i + \beta_{EMKT}^i r_{t+1}^{EMKT,e} + \beta_{TERM}^i r_{t+1}^{TERM} + \beta_{CMF}^i CMF_{t+1} + \varepsilon_{t+1}^i$$

- **Pooled regressions:**

$$r_{t+1}^{i,e} = \alpha + \beta_{EMKT} r_{t+1}^{EMKT,e} + \beta_{TERM} r_{t+1}^{TERM} + \beta_{CMF} CMF_{t+1} + \varepsilon_{t+1}^i$$

**Table:** Merrill Lynch nonfinancial corporate bond portfolios sorted on rating (AAA, A, BBB)

$\alpha$	$\beta_{EMKT}$	$\beta_{TERM}$	$\beta_{CMF}$	adj $R^2$	$E[R]$
0.0005 (0.5557)	-0.0595 (-4.3825)	0.3449 (0.1998)	0.2627 (0.9530)	0.1995	0.0006
0.0003 (0.2899)	-0.0449 (-3.2363)	1.3751 (0.6576)	0.3485 (1.1975)	0.0999	0.0007
0.0003 (0.2616)	-0.0182 (-1.1118)	2.0377 (1.0694)	0.4504 (1.6468)	0.0458	0.0009

**Table:** AAA Merrill Lynch corporate bond portfolios sorted on maturity (1-3yrs, 3-5yrs, 5-7yrs, 10+yrs)

$\alpha$	$\beta_{EMKT}$	$\beta_{TERM}$	$\beta_{CMF}$	adj $R^2$	$E[R]$
0.0001 (0.1321)	-0.0228 (-4.9212)	0.6924 (0.9058)	0.1827 (1.7263)	0.1864	0.0005
0.0003 (0.3379)	-0.0561 (-4.6869)	0.8716 (0.4915)	0.3009 (1.1967)	0.1882	0.0005
0.0007 (0.4863)	-0.0759 (-4.3608)	0.6578 (0.2709)	0.3428 (0.9914)	0.1754	0.0007
0.0012 (0.5301)	-0.1068 (-4.0024)	-0.1108 (-0.0278)	0.2672 (0.4943)	0.1413	0.0010

**Table:** A Merrill Lynch corporate bond portfolios sorted on maturity (1-3yrs, 3-5yrs, 5-7yrs, 10+yrs)

$\alpha$	$\beta_{EMKT}$	$\beta_{TERM}$	$\beta_{CMF}$	$R^2$	$E[R]$
0.0002 (0.2502)	-0.0333 (-3.9213)	1.1517 (0.8837)	0.2764 (1.4436)	0.1416	0.0006
0.0007 (0.5141)	-0.0638 (-3.7003)	1.1890 (0.5009)	0.4313 (1.1918)	0.1398	0.0008
0.0010 (0.5703)	-0.0683 (-3.1622)	1.0885 (0.3642)	0.4733 (1.1045)	0.1068	0.0010
0.0015 (0.6192)	-0.0607 (-2.2942)	1.6356 (0.4022)	0.7687 (1.3974)	0.0577	0.0012

**Table:** BBB Merrill Lynch corporate bond portfolios sorted on maturity (1-5yrs, 5-7yrs, 7-10yrs)

$\alpha$	$\beta_{EMKT}$	$\beta_{TERM}$	$\beta_{CMF}$	$R^2$	$E[R]$
0.0001 (0.1794)	-0.0107 (-1.1048)	1.7770 (1.4401)	0.3616 (1.9255)	0.0546	0.0008
0.0004 (0.2502)	-0.0341 (-1.5129)	2.4134 (1.0277)	0.5214 (1.3538)	0.0568	0.0009
0.0008 (0.4681)	-0.0236 (-0.9869)	2.5044 (0.8136)	0.6602 (1.5680)	0.0359	0.0012

**Table:** Merrill Lynch nonfinancial corporate bond portfolios sorted on maturity (1-3yrs, 3-5yrs, 5-7yrs, 10+yrs)

$\alpha$	$\beta_{EMKT}$	$\beta_{TERM}$	$\beta_{CMF}$	adj $R^2$	$E[R]$
0.0000 (0.01947)	-0.0145 (-2.1089)	1.2130 (1.5237)	0.2207 (1.8600)	0.0909	0.0006
0.0002 (0.1957)	-0.0328 (-2.8268)	1.8151 (1.0831)	0.3889 (1.6571)	0.0994	0.0007
0.0004 (0.3192)	-0.0493 (-2.5540)	1.7211 (0.7296)	0.4422 (1.2075)	0.0927	0.0008
0.0014 (0.5520)	-0.0597 (-1.6539)	2.1434 (0.5077)	0.7049 (1.2781)	0.0474	0.0015

**Table:** Lehman Brothers Euro-aggregate industrial corporate bond portfolios sorted on rating (AAA, AA, A, BAA, HY)

$\alpha$	$\beta_{EMKT}$	$\beta_{TERM}$	$\beta_{CMF}$	$R^2$	$E[R]$
-0.0007 (-0.7199)	-0.0550 (-3.8647)	0.7849 (0.4435)	0.1591 (0.5781)	0.1627	-0.0003
-0.0002 (-0.1897)	-0.0605 (-4.2683)	0.1914 (0.0889)	0.2726 (0.8825)	0.1377	-0.0003
-0.0003 (-0.2315)	-0.0496 (-3.0092)	0.4817 (0.2214)	0.2871 (1.0274)	0.0914	-0.0002
-0.0004 (-0.3551)	-0.0370 (-2.7172)	1.3619 (0.6662)	0.4976 (1.6431)	0.0708	-0.0003
0.0015 (0.5592)	0.0554 ( 1.9091)	3.1904 (0.9239)	1.3851 (1.7404)	0.0618	0.0011

**Table:** The Lehman Brothers Euro-aggregate corporate bond portfolios sorted on maturity (1-3yrs, 3-5yrs, 5-7yrs, 10+yrs)

$\alpha$	$\beta_{EMKT}$	$\beta_{TERM}$	$\beta_{CMF}$	adj $R^2$	$E[R]$
-0.0006 (-1.1988)	-0.0188 (-3.4722)	1.0872 (1.1677)	0.2645 (2.1299)	0.1186	-0.0001
-0.0003 (-0.3513)	-0.0385 (-3.4332)	0.8861 (0.5141)	0.3908 (1.6555)	0.1066	-0.0002
-0.0008 (-0.5271)	-0.0693 (-3.6313)	2.1092 (0.8244)	0.3910 (1.0410)	0.1417	-0.0002
0.0000 (0.0072)	-0.0763 (-3.2838)	0.0900 (0.0279)	0.4878 (1.1081)	0.1089	-0.0005
0.0012 (0.3786)	-0.1013 (-2.9269)	2.6832 (0.5325)	1.1192 (1.5013)	0.0794	0.0007

**Table:** Lehman Brothers Euro-aggregate corporate bond portfolios sorted on sector (16 portfolios)

$\alpha$	$\beta_{EMKT}$	$\beta_{TERM}$	$\beta_{CMF}$	$R^2$	$E[R]$
Cross-Sectional Averages of the Estimates					
-0.0004	-0.0416	1.1984	0.4301	0.0703	-0.0002
Cross-Sectional Standard Deviations of the Estimates					
0.0004	0.0159	0.8203	0.2036	0.0337	0.0001
Cross-Sectional Averages of the $t$ -Statistics					
(-0.3498)	(-3.3661)	(0.4835)	(1.5052)		
Cross-Sectional Standard Deviations of the $t$ -Statistics					
(0.2960)	(1.1992)	(0.2949)	(0.5092)		

**Table:** Pooled regressions for Merrill Lynch corporate bond portfolios

$\alpha$	$\beta_{EMKT}$	$\beta_{TERM}$	$\beta_{CMF}$	adj $R^2$	$E[R]$
Merrill Lynch sorted on rating					
0.0004 (0.6173)	-0.0409 (-4.4799)	1.2526 (1.1253)	0.3539 (2.1702)	0.0963	0.0003
Merrill Lynch sorted on rating/maturity					
0.0006 (1.5949)	-0.0539 (-9.2750)	1.1575 (1.6852)	0.4014 (4.0677)	0.0917	0.0003
Merrill Lynch sorted on maturity					
0.0005 (0.6617)	-0.0391 (-3.2384)	1.7231 (1.3380)	0.4392 (2.3995)	0.0535	0.0004

**Table:** Pooled regressions for Lehman Brothers corporate bond portfolios

$\alpha$	$\beta_{EMKT}$	$\beta_{TERM}$	$\beta_{CMF}$	adj $R^2$	$E[R]$
Lehman Brothers sorted on rating					
-0.0000 (-0.0502)	-0.0293 (-3.0176)	1.2021 (1.0575)	0.5203 (2.7349)	0.0329	-0.0005
Lehman Brothers sorted on maturity					
-0.0001 (-0.1112)	-0.0609 (-5.3811)	1.3711 (1.0059)	0.5306 (2.7049)	0.0767	-0.0005
Lehman Brothers sorted on sectors					
-0.0004 (-1.1990)	-0.0416 (-9.5535)	1.1984 (2.0372)	0.4301 (4.7138)	0.0706	-0.0007

Table: Pooled regressions for equity portfolios

$\alpha$	$\beta_{EMKT}$	$\beta_{TERM}$	$\beta_{CMKT}$	$\beta_{CMF}$	adj $R^2$	$E[R]$
Finland						
-0.0008 (-0.8230)	0.2686 (11.908)	5.4926 (2.9977)	0.2005 (14.839)	-0.5073 (-2.3018)	0.1643 $n = 75$	0.0031
France						
0.0026 (3.9095)	0.0945 (1.9018)	-3.6029 (-3.0799)	0.6705 (12.803)	-0.0862 (-0.5036)	0.3437 $n = 113$	0.0022
Germany						
0.0018 (2.4525)	0.0799 (1.6718)	-1.3920 (-1.0053)	0.6187 (16.535)	0.0080 (0.0403)	0.3352 $n = 112$	0.0023

Table: Pooled regressions for equity portfolios (cont'd)

$\alpha$	$\beta_{EMKT}$	$\beta_{TERM}$	$\beta_{CMKT}$	$\beta_{CMF}$	adj $R^2$	$E[R]$
Netherlands						
0.0023 (2.6127)	0.3318 (9.1078)	-2.4220 (-1.5138)	0.3678 (10.7255)	0.2469 (1.0287)	0.2984 $n = 76$	0.0019
Sweden						
0.0017 (2.2894)	0.0631 (2.3808)	-2.6421 (-1.8971)	0.6434 (32.703)	-0.3013 (-1.7799)	0.4751 $n = 69$	0.0028
UK						
0.0021 (2.7902)	-0.0095 (-0.5649)	-1.9132 (-1.4125)	0.6924 (30.818)	0.2251 (1.2429)	0.2987 $n = 75$	0.0018

# Conclusion

- This paper studies the sources of common time-series variation in the returns of European corporate bonds
- Building on Campbell's ICAPM, we show that common variation in defaultable bond returns arise:
  - From exposure to macroeconomic risk factors
  - If investors revise in a systemic fashion the distributions of default event across firms
- Using European bond and equity data we provide evidence in support of this theory
- Our results seem to suggest that the sources of common variation for a particular securities market do not necessarily have to be associated with macroeconomic risk.
- This point has been made previously by Daniel and Titman (1997) for equity markets. We expand the focus of this point to the credit and corporate bond markets.