A unified model of Distress Risk Puzzles
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Discussion

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- Motivation
- The paper
- Inspecting the mechanism
- Comments
- Conclusion

Distressed stocks earn low average returns

- Campbell, Hilscher, Szilagyi (2008) sort stocks into deciles based on estimated **Probability of Default (PD)**:
  - High PD stocks earn low returns.
  - High PD stocks have high market beta and FF-size and value exposures.

→ Contradicts FF 1996 hypothesis that small and value firms earn high premium because they are distressed!

	Excess ret.	CAPM alpha	Three-factor alpha	Four-factor alpha	MKT	SMB	HML
Low	0.608**	0.166	0.433***	0.096	0.879***	0.109**	−0.462***
	(2.01)	(0.99)	(2.86)	(0.72)	(23.63)	(2.17)	(8.05)
2	0.569**	0.095	0.090	0.022	0.898***	0.110***	−0.141***
	(2.55)	(1.51)	(1.42)	(0.36)	(54.84)	(4.66)	(−2.72)
3	0.534**	0.092	0.034	0.043	1.033***	0.116***	−0.071***
	(2.51)	(1.48)	(0.55)	(0.69)	(60.30)	(4.66)	(−2.75)
4	0.553*	−0.059	−0.168**	−0.075	1.170***	0.249***	0.069**
	(1.92)	(−0.70)	(−2.06)	(−0.96)	(54.03)	(7.90)	(2.13)
5	0.496	−0.175	−0.279***	−0.167*	1.252***	0.367***	−0.021
	(1.54)	(−1.64)	(−2.73)	(−1.69)	(45.85)	(9.24)	(−0.84)
6	0.385*	−0.112	−0.157	0.056	1.254***	0.389***	0.013
	(1.70)	(−0.79)	(−1.19)	(0.47)	(36.52)	(9.37)	(0.32)
7	0.408*	−0.089	−0.224*	−0.043	1.245***	0.458***	0.031
	(1.68)	(−0.65)	(−1.77)	(−0.37)	(41.65)	(10.52)	(0.68)
8	0.308	−0.371***	−0.476***	−0.280***	1.171***	0.358***	0.027
	(0.92)	(−2.73)	(−3.99)	(−2.61)	(36.10)	(7.57)	(0.55)
9	0.200	−0.596**	−0.653***	−0.375***	1.425***	0.920***	0.053
	(0.44)	(−2.17)	(−2.67)	(−2.85)	(23.64)	(12.44)	(0.58)
High	−0.576	−1.216***	−1.509***	−0.736***	1.511***	0.923***	0.430***
	(1.19)	(3.87)	(5.29)	(3.24)	(21.63)	(9.82)	(3.99)
High–Low	−1.184**	−1.382***	−1.942***	−0.832***	0.632***	0.814***	0.892***
	(2.34)	(2.96)	(4.68)	(2.64)	(5.69)	(10.96)	(6.25)

source: Anginer and Yildizhan (2018) replicate CLS with extended sample 1981-2010

High Credit risk-premium stocks earn high returns

- Stocks with high **credit risk-premium (CRP)** estimated from CDS (Friewald, Wagner Zechner (2014)) or from bonds (Anginer and Yildizhan (2018)):
  - earn high returns
  - have high FF-factor exposures

	Excess return	CAPM alpha	Three-factor alpha	Four-factor alpha	MKT	SMB	HML
Low	0.463*	−0.074	−0.021	0.01	0.890***	−0.319***	0.020
	(1.65)	(0.52)	(0.17)	(0.08)	(27.51)	(9.29)	(0.47)
2	0.489**	0.048	0.026	−0.000	0.971***	−0.287***	0.017
	(2.19)	(0.45)	(0.24)	(−0.20)	(41.48)	(−8.35)	(0.48)
3	0.552**	−0.033	0.006	0.001	0.909***	−0.131***	0.050
	(2.31)	(−0.25)	(0.05)	(0.99)	(37.17)	(−3.66)	(1.35)
4	0.568**	−0.053	−0.116	0.000	0.978***	−0.105***	0.046
	(2.29)	(−0.39)	(−0.86)	(0.28)	(36.24)	(−2.66)	(1.12)
5	0.574**	0.095	0.020	−0.001	1.022***	−0.066*	0.190***
	(2.29)	(0.68)	(0.14)	(−0.75)	(39.59)	(−1.73)	(4.84)
6	0.608***	0.069	0.092	0.002	1.032***	0.004	0.281***
	(2.66)	(0.47)	(0.62)	(1.56)	(35.49)	(0.09)	(6.36)
7	0.619*	0.063	0.004	−0.000	1.114***	0.157***	0.419***
	(1.73)	(0.54)	(0.04)	(−0.21)	(35.73)	(3.43)	(8.86)
8	0.621**	−0.012	−0.053	0.002	1.217***	0.192***	0.324***
	(2.21)	(−0.10)	(−0.46)	(1.12)	(31.57)	(5.15)	(5.54)
9	0.795**	0.054	0.015	−0.000	1.239***	0.231***	0.575***
	(2.45)	(0.49)	(0.14)	(−0.15)	(29.70)	(5.00)	(8.39)
High	0.984***	0.325	−0.193	0.005	1.28***	0.157***	0.715***
	(2.58)	(1.33)	(0.93)	(0.02)	(22.83)	(2.63)	(9.62)
High–low	0.521**	0.399	−0.172	−0.005	0.391***	0.476***	0.695***
	(1.98)	(1.50)	(0.75)	(0.02)	(6.32)	(7.25)	(8.49)

source: Anginer and Yildizhan (2018)

The paper's objective

- High-low PD long-short portfolio earns negative return (even controlling for FF factors).
- High-low CRP long-short portfolio earns positive return (but not controlling for FF factors as shown in AY 2018).

Q? Inefficiency or Risk-based explanation?

- This paper proposes a risk-based explanation based on structural default risk model to explain these "seemingly inconsistent distress puzzles".
- The mechanism is based on firms' **endogenous choice of leverage to avoid a distress region** where cash-flows (and therefore asset value) grow slower and have more systematic risk.

Structural model: the setup

- Assets in place generate cash

$$\frac{dX_t}{X_t} = \mu_{s_t,w_t} dt + \beta_{s_t,w_t} \sigma^m_{s_t} dZ^m_t + \sigma^i_{s_t} dZ^i_t$$

  - $w_t = \mathbf{1}_{\{X_t \leq X_s\}}$ is distress indicator: when $X_t < X_s$ then $\mu_{s_t,1} < \mu_{s_t,0}$ and $\beta_{s_t,1} > \beta_{s_t,0}$.
  - s_t is exogenous Markov chain that drives risk-free rate and market price of risk.
  - State price density is: $\frac{dm_t}{m_t} = -r_{s_t} dt - \theta_{s_t} dZ^m_t + (e^{\kappa_{s_t}} - 1) dM_t$
- Firm issues perpetual callable consol bond and chooses optimal coupon to balance tax shield versus bankruptcy costs.
- At upper threshold (X_u) it is optimal to call the bond at par and lever up,
- At lower threshold (X_d) it is optimal to default ($\sim$ Goldstein, Ju, Leland (2001)).
- New feature: **distress region**
  - when $X_s > X_t > X_d$ drift decreases and beta increases.
  - At X_s, firm sells a fraction ζ of its assets to retire a fraction of its debt at par.
- Authors solve the model in closed-form (derive debt and equity value, optimal coupon and leverage, default and refinancing barriers).

Structural model: Main results

- Simulate 100 panels of 4000 firms over 150 years starting from identical initial conditions but discarding the first 100 years.
- On the 50-year panel of heterogeneous firms they replicate the sorting procedure of CLS and of FWZ.

Panel A. Sorted on Failure Probability						
	L(ow)	2	3	4	H(igh)	H–L
r^{ex} (%)	10.38	4.26	0.42	−3.26	−7.27	−17.66
(t)	(5.71)	(2.08)	(0.21)	(−1.33)	(−2.56)	(−15.62)
α (%)	5.97	−0.73	−4.91	−8.99	−13.97	−19.94
(t)	(34.33)	(−4.70)	(−22.62)	(−29.25)	(−27.62)	(−32.01)
β	0.89	1.01	1.08	1.16	1.37	0.48
(t)	(112.63)	(207.34)	(129.53)	(79.06)	(39.14)	(10.80)
$Adj.R^2$	0.98	1.00	0.99	0.97	0.94	0.54

Panel B. Sorted on Implied Risk Premium						
	L(ow)	2	3	4	H(igh)	H–L
r^{ex} (%)	−4.59	−0.13	3.47	7.08	11.97	16.57
(t)	(−2.14)	(−0.04)	(1.65)	(3.41)	(6.14)	(27.94)
α (%)	−9.61	−5.29	−1.65	2.08	7.32	16.93
(t)	(−24.41)	(−23.62)	(−9.19)	(12.69)	(30.99)	(29.68)
β	1.02	1.04	1.04	1.01	0.94	−0.07
(t)	(59.27)	(103.34)	(141.61)	(157.61)	(84.23)	(−2.80)
$Adj.R^2$	0.95	0.98	0.99	0.99	0.97	0.05

Interpretation in the structural Merton model of defaultable bond

- Firm value $\frac{dV_t}{V_t} = (r + \theta_{\mathbf{v}}\sigma_{\mathbf{v}})dt + \sigma_v dZ_t$ and face value of debt D due at T.
- The $PD = P(V_T < D) = N\Big(- \frac{\log \frac{\mathbf{V_0}}{\mathbf{D}} + (r + \theta_{\mathbf{v}}\sigma_{\mathbf{v}} - \frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}}\Big)$
- Risky Bond is risk-free bond minus a Black-Scholes put: $B_t = De^{-r(T-t)} - P(V_t, t)$
- Stock price is Black-scholes Call: $S_t = C(V_t, t)$
- The stock volatility $\sigma_S = \sigma_v \frac{V}{S} N\Big(\frac{\log \frac{V_t}{D} + (r + \frac{1}{2}\sigma_v^2)(T-t)}{\sigma_v\sqrt{T-t}}\Big)$
- Absence of arbitrage $\rightarrow$ all firm's contingent claims have same **Sharpe ratio**:

$$\frac{\frac{1}{dt}\mathrm{E}[\frac{dB}{B}] - r}{\sigma_B} = \frac{\frac{1}{dt}\mathrm{E}[\frac{dS}{S}] - r}{\sigma_S} = \theta_{\mathbf{v}}$$

$\rightarrow$ Consistent with the findings that high CRP implies high expected equity returns.

$\rightarrow$ Low expected stock return if either asset value has low systematic risk (i.e., low θ_v) or if stock volatility (σ_S) is low (i.e., leverage is low).

- Merton model explains "distress puzzle" if firms with high PD (i.e, high leverage or high asset volatility) have low systematic risk (θ_v).
- With endogenous capital structure: firms with high systematic risk choose low leverage ex ante to avoid distress. Thus firms with high leverage (PD) have low systematic risk which lowers their expected returns.

Generating negative expected excess returns

- You write p. 33: *The key mechanism of our model is the negative covariance between levered equity beta and market risk premium in highly distressed firms.*

$$\mathbb{E}r^{ex}_{s_t,D} = \mathbb{E}\beta^{E}_{s_t,D}\mathbb{E}\lambda^{m}_{s_t}dt + \underbrace{\mathbf{cov}(\beta^{E}_{s_t,D}, \lambda^{m}_{s_t})dt}_{\leq 0}, \qquad (17)$$

where $\beta^{E}_{s_t,D}$ is the equity beta, $\lambda^{m}_{s_t}$ is the expected market risk premium, and $\mathbf{cov}(\beta^{E}_{s_t,D}, \lambda^{m}_{s_t})$ is the covariance between the equity beta and market risk premium. We have demonstrated in our first result that in distressed firms, the levered equity beta and the market risk premium covary negatively, i.e., $\mathbf{cov}(\beta^{E}_{s_t,D}, \lambda^{m}_{s_t}) < 0$. Therefore, the negative covariance results in a reduction in the unconditional expected equity return for the portfolio of distressed firms. When the negative covariance dominates the first component, our model generates negative stock returns for distressed firms. Our paper is the first that provides a risk-based story for the negative returns of distressed firms via the negative covariance.

- However, by definition $\mathrm{E}[r^{ex}] = \mathrm{E}[\beta]\mathrm{E}[\lambda^m] + cov(\beta, \lambda^m) = \mathrm{E}[\beta\lambda^m]$
- Thus if $\lambda^m > 0$ *a.s* then $\beta > 0$ *a.s.* $\Rightarrow \mathrm{E}[r^{ex}] > 0$.
- Thus for $\mathrm{E}[r^{ex}] < 0$, the model must generate **negative conditional betas** for highly levered firms. Why? In which states?
- One remark:
  - You define excess returns relative to the risk-free rate, so $\mathrm{E}[r^{ex}] < 0$ requires $\beta < 0$.
  - CLS define r^{ex} relative to the market, so $\mathrm{E}[r^{ex}] < 0$ only requires $\beta < 1$

Asset value, asset sales, and the scaling property?

- You define asset value as :

$$A_{t,w_t} \equiv A(X_t, w_t) = \mathbb{E}^Q \left[\int_t^\infty X_\tau e^{-r\tau} d\tau \right] = \frac{X_t}{r - \mu_{w_t}}. \quad (3)$$

- This is the asset value **only** if the distress state $w_t = \mathbf{1}_{\{X_< X_s\}}$ never changes (or for zero leverage firms).
- For a firm with leverage, the asset value would be lower, reflecting the lower drift incurred when $X_t < X_s$.
- This has implications for the deleveraging at $X_t = X_s$ where you assume fraction of this "zero-debt asset value" of equation (3) is sold off.

→ How to guarantee that the actual assets are large enough to do so?

→ Note that this asset value jumps at the deleveraging barrier X_s.

→ How to guarantee that the scaling property that you assume for the solution at the upper and lower restructuring barrier actually holds at the optimum?

- More generally, what should be the right price for asset sales:
  - If you sell to an unlevered firm then price would be higher (as in (3)) ?
  - if you sell to a more levered firm it should be lower?

More Comments

- It seems like the default probabilities computed in proposition 3 conditional on the distressed state ignore the possibility that the firm could exit the distress state prior to defaulting? Why?
- In the general model the optimal coupon is assumed to only depend on the Markov state s_t and not on the current value of the cash-flow process X_t. Is that a result or an assumption?
- In your empirical experiment you sort firms every year into distress probabilities and plot annual averages. In the empirical papers, the sorting is done at a monthly horizon. Would results look identical with monthly sorting/returns?
- Would be nice to study the properties of the conditional equity betas generated by the model: volatility, sign. . .

Concluding comments

- Develop structural model to provide risk-based explanation for a surprising robust stylized fact: 'The distress puzzle'
- Still only a preliminary paper and partial explanation:
  - Need to give more details about the model 'assumptions': asset value definition, scaling property, default probability calculations. . .
  - Need to look into the model mechanism (time variation in conditional betas < 0)?
  - lots (> 25!) typos
  - Organizaton of paper: Good and bad macro-economic states used in section 2.6.1 before they get defined in section 3.
- Several alternative theoretical papers also propose risk-based mechanisms that explain the distress puzzle by making the distressed firms essentially less risky to explain why rational agents would like to hold these firms (Garlappi and Yan (2011), George and Hwang (2010))

→ would be nice to better discuss these alternatives and propose test to discriminate between these three (or more?) risk-based explanations.