Financial Distress
and the Cross Section of Equity Returns

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Motivation

Empirical regularities in the cross section of equity returns
- Size effect
- Value premium
- Momentum

Empirical evidence on the role of financial distress in the cross section
- Griffin and Lemmon (2002) (value premium stronger in distressed firms)
- Vassalou and Xing (2004) (size and value premium stronger for high default probability firms)
- Avramov et al (2006) (momentum profits stronger with low credit rating)

Lack of a unified framework to understand these “anomalies”
Objectives

- Develop a theoretical framework to simultaneously account for major cross-sectional features of equity returns (value premium and momentum) and their interaction with financial distress.

- Show how financial distress can enhance anomalies

- Derive unique empirical predictions based on the expected payoff to equity-holders in financial distress

- Test predictions with Moody’s KMV EDF data
Background

1. **Real options/neoclassical** models of firms’ assets:
   [e.g., Berk, Green and Naik (1999), Gomes, Kogan and Zhang (2003), Carlson, Fisher and Giammarino (2004), Sagi and Seasholes (2006), ...]
   - **Size** effect related to growth opportunities w.r.t. assets-in-place
   - **B/M** effect related to the risk of assets-in-place
   - **Momentum** driven by growth options

2. Limitations of ignoring financial leverage:
   - Inability to explain the effect of distress on the cross section
   - Anomalies are significant for equity, not asset, returns [Hecht (2000)]
   - Unusually high risk premia required in some calibrations
Features of Our Approach

1. Introduces financial leverage in a real option model of equity value

2. Models the outcome of financial distress (e.g., potential APR violations)

3. Generates momentum in stock returns without relying on predictability in the underlying process (e.g. mean reversion)
   - Momentum arises endogenously in high-default-risk firms

4. Provides a unified framework based on fundamental asset pricing principles
Model

- **Partial equilibrium**, continuous-time model

- Two types of firms: **growth** and **mature**

- Firms have both **operating** \((c)\) and **financial** \((l)\) leverage

- Default may result in possible **violation of APR**

- **Unique** source of risk: price of the good produced

\[
dP = \mu P dt + \sigma P dW
\]

- Constant **risk premium** \(\lambda\) associated with \(P\).
Beta and Momentum Measures

Let $E(P)$ denote **equity value**:

1. **Beta** – sensitivity of equity return to the state variable $P$

\[
\beta = \frac{\frac{\partial E(P)}{\partial P}}{\frac{P}{E(P)}}.
\]

2. **Autocorrelation** – sensitivity of expected return to realized return

\[
\text{AutoCorr} = \frac{\text{cov}[\Delta \lambda \beta, \Delta \ln(E)]}{\text{var}[\Delta \ln(E)]} = \lambda \frac{\partial \beta / \beta}{\partial P / P}.
\]
**Equity Value of a Mature Firm**

\[
E^m(P_t) = \mathbb{E} \left[ \int_0^{\tau_L} \left( (\xi(P_{t+s} - c) - l) e^{-r s} - \xi_c \right) ds + \eta X^m(P^m) e^{-r \tau_L} \right]
\]

- \(\xi\): *scale* of operation.
- \(\tau_L\): *default* stopping time: \(\tau_L = \inf \{ t : P_t = P^m \}\)
- \(P^m\): *endogenous* default boundary
- \(X^m(P^m)\): *residual* value to shareholders (e.g., \(\xi_c/r\): “book” value of assets)
- \(\eta\): fraction of book value of assets captured by shareholders in default (*expected violation of APR*).
Beta of a Mature Firm

\[
\beta = 1 + \left( \frac{(\xi c - l)/r}{E^m} \right) \left( \frac{\xi c + l}{\xi c - l} \right) \left( 1 - \pi \frac{(1 + \eta)\xi c + l}{\xi c + l} \right)
\]

- \( \pi \): risk-neutral probability of default
- \( \frac{(\xi c - l)/r}{E^m} \): “book-to-market” equity (BME)
- The BME effect captures \textbf{all} the cross sectional variation in beta (no growth), i.e. risk of \textit{assets in place} (as in BGN and CFG)
- \textbf{Amplifying} effect of leverage
Expected Return vs Default Probability

No violations of APR ($\eta = 0$)

Violations of APR ($\eta = 5\%$)

Expected Return

Beta

Default probability deciles

Default probability deciles
Momentum vs Default Probability for Mature Firms

The *momentum measure* for mature firms is

\[ \text{AutoCorr} = \lambda \left[ 1 - \beta - \pi \left( \frac{\gamma_1}{\beta E^m} \right) \left( \frac{l + \xi c (1 + \eta)}{r} \right) \right], \quad \gamma_1 < 0. \]

1. If \( \eta = 0 \) or low default prob. \( \Rightarrow \) AutoCorr < 0, no momentum.

2. If \( \eta > 0 \) and high default prob. \( \Rightarrow \) AutoCorr > 0, momentum.

- **Violation of APR** crucial for momentum.

- Mean reversion and growth options *not necessary* for generating momentum.
Intuition for Momentum

Expected return vs. Default probability deciles

- Positive realized return
- Lower expected return
- Negative realized return
- Higher expected return

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Momentum Profits and Default Probability

- Simulate \textit{cross-section} and \textit{time-series} of \textit{realized returns}
- Construct Jegadeesh-Titman (1993) \textit{winner–loser} portfolios

No violations of APR ($\eta = 0$)

Violations of APR ($\eta = 5\%$)
Equity Value of a Growth Firm

\[ E^g(P_t) = \mathbb{E} \left[ \int_0^{\tau_L \wedge \tau_G} \frac{P_{t+s} - c - l}{P_t} e^{-rs} ds \right] \]

\[ + (E^m(P) - I) \mathbb{E} \left[ e^{-r\tau_G} \mathbb{I}_{\{\tau_G < \tau_L\}} \right] + \eta X^g(P^g) \mathbb{E} \left[ e^{-r\tau_L} \mathbb{I}_{\{\tau_L < \tau_G\}} \right] \]

- \( \tau_L \): stopping time for default. \( \tau_L = \inf \{ t : P_t = P^g \} \)
- \( \tau_G \): stopping time for growth. \( \tau_G = \inf \{ t : P_t = \bar{P} \} \)
- \( P^g \): endogenous default boundary. \( \bar{P} \): endogenous growth threshold
- \( X^g(P^g) \): residual value to shareholders (e.g., \( c/r \): “book” value of assets)
- \( E^m(P) \): equity value of mature firm at \( \bar{P} \)
- \( I \): investment cost (borne by shareholders)
- \( \eta \): violation of APR
Value Premium and Default Probability

- **Empirically**, value premium = \( \text{return}(\text{high BM}) - \text{return}(\text{low BM}) \)

- **In our model**, value premium = ExpRtn(mature) - ExpRtn(growth)

No violations of APR (\( \eta = 0 \))

Violations of APR (\( \eta = 5\% \))
Testable Implications from the Model

► **Prediction 1.** Value premium vs. Default probability:

- **Positively** related if default probability is **low** (high priced stocks).
- **Negatively** related if default probability is **high** (low priced stocks).

► **Prediction 2.** Momentum profits higher if:

- Default probability **high**, and
- High likelihood of **APR violations** upon financial distress.
Empirical Analysis – Data

▶ Moody’s KMV EDF: Expected Default Frequency™
  - Inspired by the Black-Scholes-Merton Model (Kealhofer (2003))
  - Time period: January 1969–December 2003
  - Number of observations: 1,430,713 firm-month
  - No financial firms

▶ CRSP
  - Equity Returns

▶ COMPUSTAT
  - Accounting variables
## Value Premium and Default Probability

### Full Sample

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<th>High - Low</th>
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Financial Distress and the Cross Section of Equity Returns
## Value Premium and Default Probability

### Stocks with price \( \geq \$5 \)

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Empirical Proxies for APR Violations ($\eta$)

From Garlappi, Shu and Yan (2006):

1. Asset size. High asset size $\Rightarrow$ APR more likely

2. R&D expenditures/assets. High R&D $\Rightarrow$ APR less likely

3. Herfindahl Index of sales. High Hfdl index $\Rightarrow$ APR more likely
Momentum and Default Probability

Methodology:

- Independently sort stocks into:
  1. terciles of EDF
  2. terciles of $\eta$ proxy
  3. and quintiles of losers/winners (past 6 month)

- Record equal-weight return over future 6-month period

- Report results in top EDF tercile.
## Momentum and Default Probability

### Asset Value

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### SalesHfdl

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Conclusions

▶ Propose a new perspective for cross-sectional anomalies.

▶ Expected outcome of financial distress affects the link between default probability and:

1. Beta/Expected returns
2. Value premium
3. Momentum

▶ A simple risk-based explanation for major cross-sectional features in returns

  • Financial distress risk is reflected in beta and manifested in value premium and momentum
  • A structural understanding, and no new risk factor necessary