# Financial Intermediaries and the Cross-Section of Asset Returns

Adrian, Etula, and Muir

The Journal of Finance (2014)

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# Motivation

**SDF = V'(W) prices all assets across different states**

- SDF based on a representative household
- Assumptions: everyone participates in all markets, no transaction cost, agents can compute dynamic portfolios strategies, optimize continuously, know return moments
- Frictions...

# Financial Intermediary Asset Pricing

- Intermediaries fit classic assumptions
- **SDF based on $V'(W)$ of rep intermediary**
  - Assumptions: everyone participates in all markets, no transaction cost, agents can compute dynamic portfolios strategies, optimize continuously, know return moments
  - Leverage of broker-dealers measures $V'(W)$ of intermediary consistent w/ theory of intermediaries and asset prices

# Intermediary Asset Pricing

**De-leveraging = bad times for intermediary, high marginal value of wealth**

- Brunnermeier & Pedersen (2009)
  - Intermediaries face future funding/leverage constraint
  - $E_t[R_{t+1}] - R_f = -cov(\phi_{t+1}, R_{t+1})$, where $\phi$ = multiplier on funding/leverage constraint "Funding liquidity risk"
  - $SDF_t - \phi_t - f(Lev_t)$: high $\phi \Rightarrow$ low Leverage
  - Leverage measures marginal value of wealth

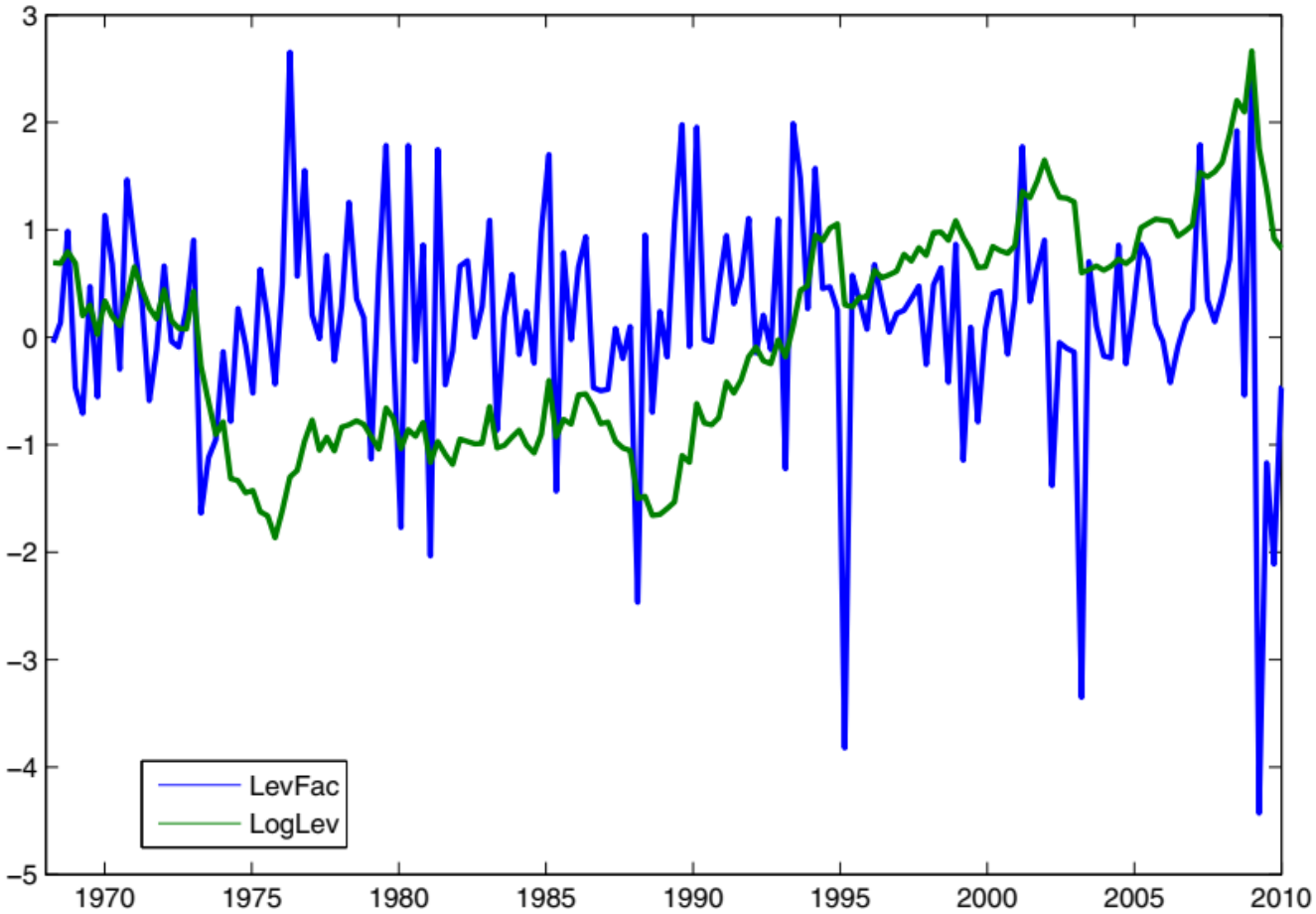
# Data (Q1/1968 - Q4/2009)

Flow of Funds (Quarterly)

- Total assets, Total liabilities of U.S. broker-dealers
- Lev = (Total Assets)/(Total assets - Total liabilities)

Leverage factor: $\Delta ln(Lev)$ = changes in log leverage (seasonally adjusted)

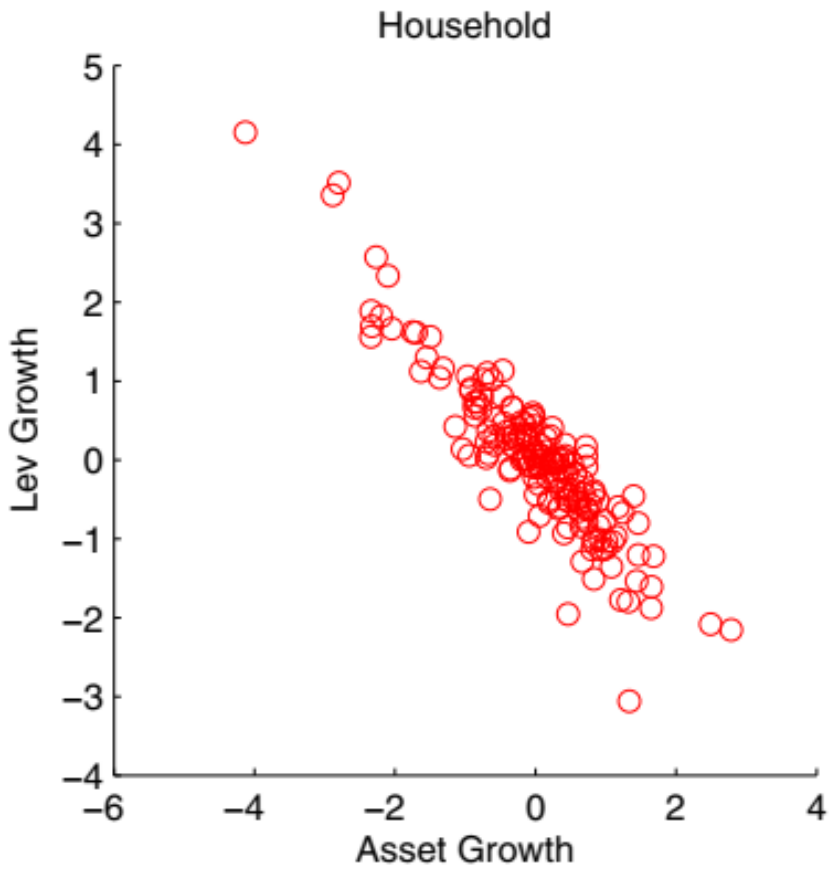
# Broker-Dealer Leverage  Leverage Factor



# Correlation of Leverage Factor with Aggregate Variables

| | Correlation of Broker-Dealer Leverage Factor with: | | | |
|---|---|---|---|---|
| | Log Broker-Dealer Asset Growth | Market Volatility | Baa-Aaa Spread | Financials Stock Return |
| $\rho$ | 0.73 | −0.37 | −0.16 | 0.18 |
| $p$-value | 0.00 | 0.00 | 0.03 | 0.02 |

# Procyclical Leverage of Dealers




# Asset Pricing Test

**Cross-Section of Expected Returns:**

- **Time-series** regression ($\beta_{i,lev}$ exposure to risk):

$$R^e_{i,t} = c_i + \beta'_{i,lev} Lev_t + \epsilon^i, t \quad t = 1, ..., T \quad i = 1, ..., N \tag{1}$$

- **Cross-sectional** regression ($\lambda_{lev}$ price of risk):

$$E[R^e_i] = \alpha + \beta'_{i,lev} \lambda_{lev} + \xi_i \tag{2}$$

- **Theory**: $\lambda_{lev} > 0, \quad \alpha = 0, \quad R^2 \quad high, \quad MAPE = \frac{1}{N} \sum |\xi_i|$ low
- Report the results from the **cross-sectional** regression

# 25 Size and Book/Market, 10 Momentum, 6 Treasury Portfolios

Panel A: Prices of Risk

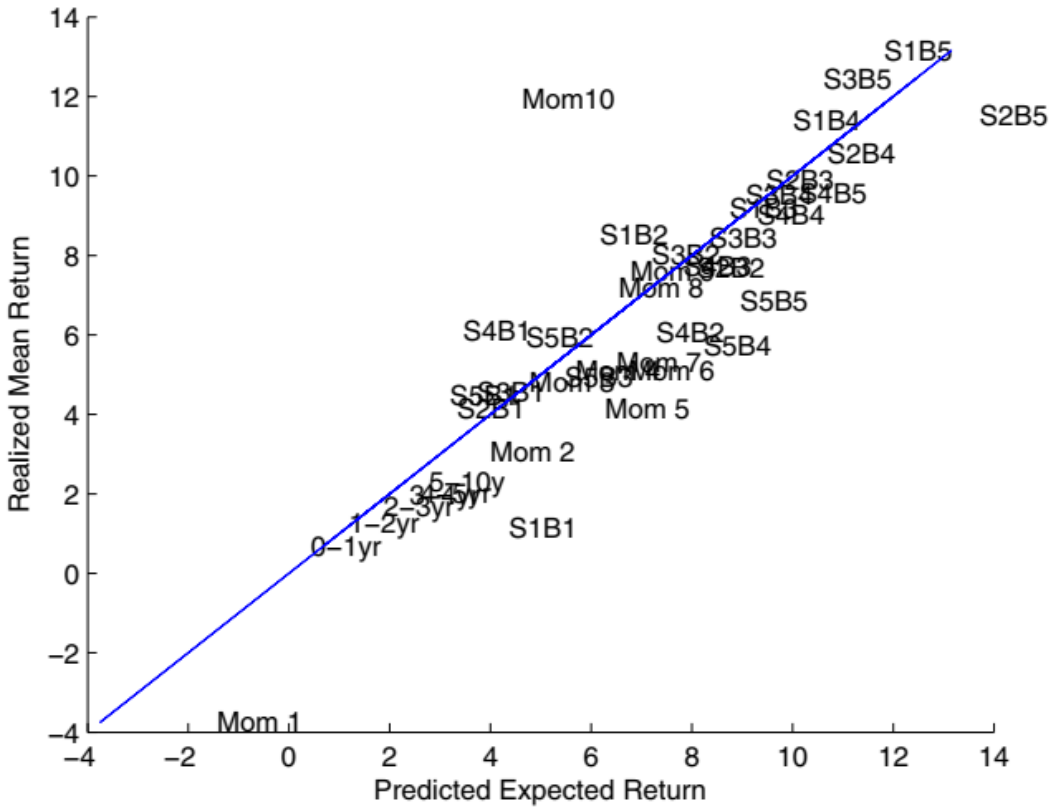
| | CAPM | FF | FF, Mom | FF, Mom, PC1 | LevFac | LevMkt |
|---|---|---|---|---|---|---|
| Intercept | 3.39 | 3.16 | 1.06 | 0.66 | 0.12 | −0.19 |
| *t*-FM | 3.55 | 4.09 | 1.51 | 1.14 | 0.06 | −0.21 |
| *t*-Shanken | 3.54 | 4.03 | 1.34 | 1.01 | 0.04 | −0.14 |
| LevFac | | | | | 62.21 | 60.97 |
| *t*-FM | | | | | 4.62 | 5.29 |
| *t*-Shanken | | | | | 3.12 | 3.65 |
| Mkt | 3.06 | 2.30 | 4.54 | 4.89 | | 5.46 |
| *t*-FM | 0.99 | 0.80 | 1.59 | 1.71 | | 1.75 |
| *t*-Shanken | 0.99 | 0.80 | 1.58 | 1.70 | | 1.55 |
| SMB | | 1.76 | 1.57 | 1.63 | | |
| *t*-FM | | 0.93 | 0.83 | 0.87 | | |
| *t*-Shanken | | 0.93 | 0.82 | 0.86 | | |
| HML | | 3.33 | 4.37 | 4.34 | | |
| *t*-FM | | 1.45 | 1.90 | 1.89 | | |
| *t*-Shanken | | 1.45 | 1.86 | 1.85 | | |
| MOM | | | 7.82 | 7.75 | | |
| *t*-FM | | | 2.94 | 2.91 | | |
| *t*-Shanken | | | 2.92 | 2.89 | | |
| PC1 | | | | 14.99 | | |
| *t*-FM | | | | 1.03 | | |
| t-Shanken | | | | 0.93 | | |

# 25 Size and Book/Market, 10 Momentum, 6 Treasury Portfolios

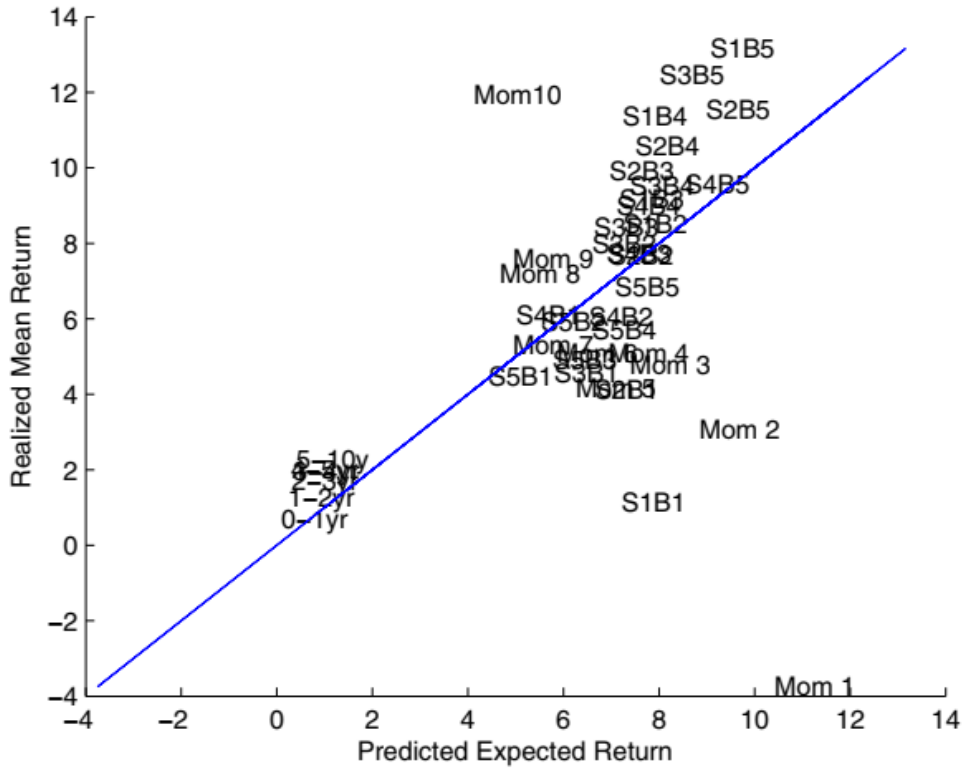
Panel B: Test Diagnostics

| MAPE | $E[R^e]$ | CAPM | FF | FF, Mom | FF, Mom, PC1 | LevFac | LevMkt |
|---|---|---|---|---|---|---|---|
| Size B/M | 7.86 | 2.62 | 1.81 | 1.05 | 1.01 | 1.16 | 1.11 |
| MOM | 5.80 | 3.05 | 3.75 | 1.47 | 1.48 | 1.79 | 1.85 |
| Bond | 1.65 | 1.83 | 1.59 | 0.17 | 0.17 | 0.37 | 0.26 |
| Intercept | | 3.39 | 3.16 | 1.06 | 0.66 | 0.12 | 0.12 |
| Total | 6.45 | 6.00 | 5.41 | 2.08 | 1.66 | 1.31 | 1.36 |
| Adj$R^2$ | | 0.10 | 0.16 | 0.81 | 0.81 | 0.77 | 0.78 |
| C.I.Adj$R^2$ | | [0.02, 0.30] | [0.02, 0.36] | [0.74, 0.88] | [0.72, 0.88] | [0.82, 1] | [0.76, 1] |
| $T^2(\chi^2_{N-K})$ | | 174.48 | 167.46 | 111.45 | 110.19 | 67.87 | 68.86 |
| $p$-value | | 0.0% | 0.0% | 0.0% | 0.0% | 0.3% | 0.0% |

# Single leverage factor



# Five-factors benchmark model



# Equity Portfolio

Panel A: Prices of Risk

| | 25 Size and Book-to-Market Portfolios | | | | 25 Size and Momentum Portfolios | | | |
|---|---|---|---|---|---|---|---|---|
| | CAPM | FF | LevFac | LevMkt | CAPM | FF, Mom | LevFac | LevMkt |
| Intercept | 12.11 | 15.58 | 1.00 | 0.27 | 3.51 | 11.72 | 0.31 | −5.47 |
| $t$-FM | 2.99 | 3.84 | 0.25 | 0.06 | 3.41 | 1.72 | 0.07 | −0.96 |
| $t$-Shanken | 2.97 | 3.57 | 0.18 | 0.04 | 3.37 | 1.60 | 0.04 | −0.53 |
| LevFac | | | 55.78 | 56.80 | | | 69.66 | 81.82 |
| $t$-FM | | | 3.30 | 3.27 | | | 3.66 | 4.25 |
| $t$-Shanken | | | 2.34 | 2.29 | | | 2.28 | 2.38 |
| Mkt | −3.81 | −10.19 | | 5.20 | −5.88 | −4.76 | | 10.62 |
| $t$-FM | −0.80 | −2.09 | | 0.95 | −1.17 | −0.64 | | 1.69 |
| $t$-Shanken | −0.79 | −1.98 | | 0.70 | −1.16 | −0.60 | | 1.00 |
| SMB | | 1.85 | | | | 2.39 | | |
| $t$-FM | | 0.98 | | | | 1.12 | | |
| $t$-Shanken | | 0.97 | | | | 1.10 | | |
| HML | | 5.76 | | | | −4.01 | | |
| $t$-FM | | 2.42 | | | | −1.00 | | |
| $t$-Shanken | | 2.38 | | | | −0.95 | | |
| MOM | | | | | | 8.40 | | |
| $t$-FM | | | | | | 3.19 | | |
| $t$-Shanken | | | | | | 3.18 | | |

Panel B: Test Diagnostics

| | 25 Size and Book-to-Market Portfolios | | | | 25 Size and Momentum Portfolios | | | |
|---|---|---|---|---|---|---|---|---|
| MAPE: | CAPM | FF | LevFac | LevMkt | CAPM | FF, Mom | LevFac | LevMkt |
| Intercept | 12.11 | 15.58 | 1.00 | 0.27 | 3.51 | 11.72 | 0.31 | −5.47 |
| Total | 14.41 | 16.69 | 2.09 | 1.34 | 6.48 | 12.83 | 2.47 | 7.57 |
| MAX | 5.71 | 4.33 | 3.72 | 3.95 | 9.99 | 4.54 | 7.01 | 6.06 |
| Adj$R^2$ | 0.03 | 0.68 | 0.74 | 0.75 | 0.05 | 0.84 | 0.51 | 0.56 |
| C.I.Adj$R^2$ | [0, 0.28] | [0.48, 0.82] | [0.70, 1] | [0.64, 1] | [0, 0.30] | [0.72, 0.90] | [0.40, 1] | [0.38, 1] |
| $T^2(\chi^2_{N-K})$ | 71.99 | 55.38 | 34.98 | 33.37 | 75.83 | 50.70 | 23.88 | 18.90 |
| $p$-value | 0.0% | 0.0% | 5.2% | 5.7% | 0.0% | 0.0% | 41.1% | 65.1% |

# Treasury Bonds

| Panel A: Pricing Errors | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $E[R^e]$ | CAPM | FF | FF, Mom | PC1 | LevFac | Lev NRE | LevMkt |
| 0–1 yr | 0.70 | 0.65 | 0.61 | 0.58 | 0.36 | 0.33 | 0.27 | 0.31 |
| 1–2 yr | 1.28 | 1.16 | 1.08 | 0.84 | 0.31 | 0.28 | 0.10 | −0.18 |
| 2–3 yr | 1.70 | 1.54 | 1.47 | 1.04 | 0.22 | 0.12 | −0.15 | 0.21 |
| 3–4 yr | 1.95 | 1.77 | 1.73 | 1.13 | 0.11 | −0.05 | −0.40 | 0.10 |
| 4–5 yr | 2.00 | 1.84 | 1.85 | 1.03 | −0.13 | −0.19 | −0.58 | −0.01 |
| 5–10 yr | 2.29 | 2.01 | 2.11 | 0.96 | −0.27 | −0.03 | −0.44 | −0.02 |

| Panel B: Prices of Risk | | | | |
|---|---|---|---|---|
| | PC1 | LevFac | Lev NRE | LevMkt |
| LevFac | | 52.90 | 62.21 | 40.14 |
| $t$-FM | | 2.28 | NA | 2.05 |
| $t$-Shanken | | 1.65 | NA | 1.57 |
| PC1 | 31.52 | | | 18.88 |
| $t$-FM | 2.27 | | | 1.95 |
| $t$-Shanken | 2.14 | | | 1.50 |

| Panel C: Test Diagnostics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MAPE: | $E[R^e]$ | CAPM | FF | FF, Mom | PC1 | LevFac | Lev NRE | LevMkt |
| Total | 1.65 | 1.50 | 1.47 | 0.93 | 0.23 | 0.17 | 0.32 | 0.14 |
| MAX | 2.29 | 2.01 | 2.11 | 1.13 | 0.36 | 0.33 | 0.58 | 0.31 |
| Adj$R^2$ | | | | | 0.78 | 0.85 | | 0.89 |
| C.I.Adj$R^2$ | | | | | [0.28, 0.90] | [0.48, 1] | | [0.48, 1] |
| $T^2(\chi^2_{N-K})$ | | | | | 17.96 | 9.10 | | 9.92 |
| $p$-value | | | | | 0.3% | 10.5% | | 4.1% |

# Robustness Checks

- Skeptical view: Lewellen, Nagel, Shanken (2010)
- Analyze individual cross sections
- Time-series regressions
- Excluding crisis / starting date
- Leverage mimicking portfolios (LMP)
- Leverage beta sorts for all CRSP stocks

# Leverage Mimicking Portfolio (LMP)

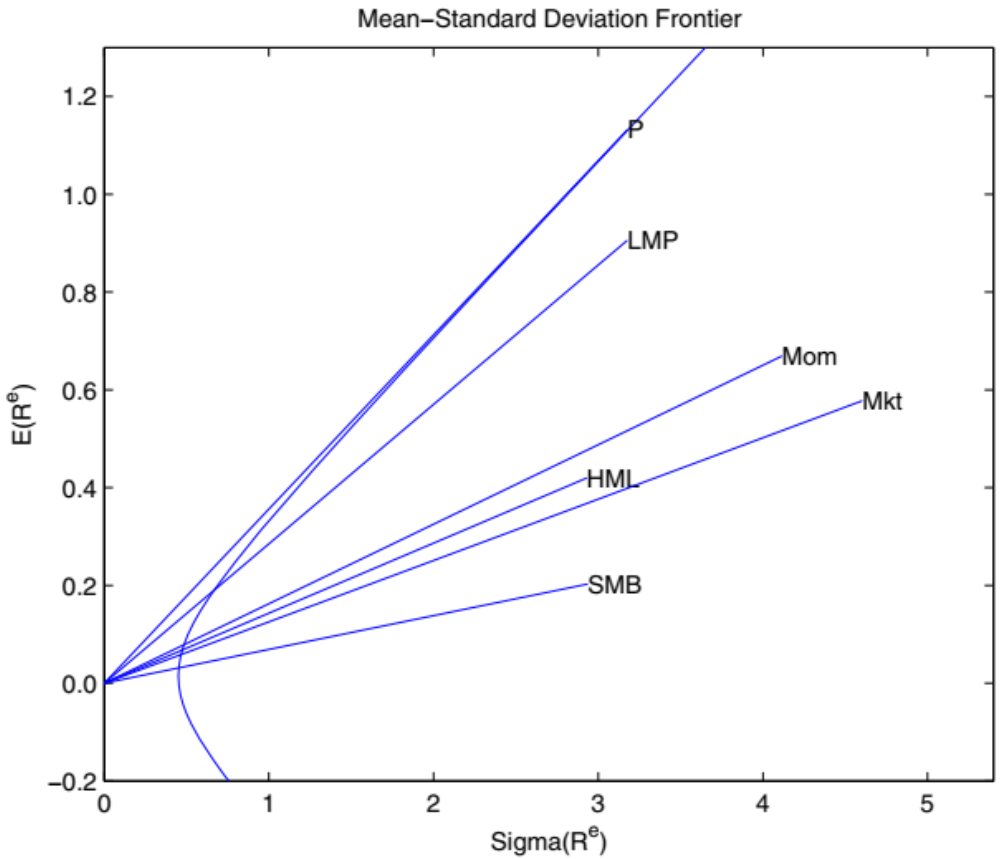
**Project leverage factor onto 6 FF Bchmrks + Mom, constant weights**

- Re-do analysis using time series alphas, monthly data, back to 1930's
- LMP is nearly mean-variance efficient

| | Annualized Sharpe |
|---|---|
| Market | 0.46 |
| SMB | 0.18 |
| HML | 0.50 |
| Mom | 0.70 |
| LMP | 0.99 |
| Max Sharpe | 1.20 |

# Mean-Variance Analysis

P=max(Sharpe(**a**mkt+**b**smb+**c**hml+**d**mom))



# LMP: Comparing Models

| Panel A: Time-Series Alphas | | | | |
|---|---|---|---|---|
| MAPE | Mean | LMP | FF, MOM | FF |
| SBM | 7.86 | 1.15 | 1.04 | 1.57 |
| MOM | 5.80 | 1.66 | 1.46 | 4.36 |
| Bond | 3.04 | 0.59 | 0.93 | 1.47 |
| Total | 6.33 | 1.19 | 1.13 | 2.24 |
| Model Fit | | LMP | FF, MOM | FF |
| GRS | | 2.57 | 2.28 | 4.48 |
| $p$-value | | 0 | 0 | 0 |

| Panel B: Cross-Sectional Results across Time Periods | | | | |
|---|---|---|---|---|
| Time Period | | LMP | FF, MOM | FF |
| 1968 to 2009, | Intercept | −0.32 | 1.06 | 3.12 |
| Quarterly | Adj$R^2$ | 0.78 | 0.81 | 0.16 |
| 1936 to 2009, | Intercept | −3.00 | 14.74 | 27.97 |
| Monthly | Adj$R^2$ | 0.63 | 0.81 | 0.52 |

# Betting Against Beta and Funding Constraints

- Sort by mkt betas, scale to have unit beta (Frazzini Pedersen)
- Spread measures leverage constraints
- High correlation btw leverage factor and BAB factor
- Cross-sectional $R^2$=73%

Panel A: Time-Series Regressions: $R^e_{i,t} = c_i + \beta_{Lev,i} LevFac_t + \epsilon_{i,t}$

| | $E[R^e]$ | Sharpe | $\beta_{Lev}$(x $10^{-2}$) | $t$-stat | $R^2$ |
|---|---|---|---|---|---|
| BAB1 | 10.98 | 0.46 | 19.45 | 2.93 | 4.90% |
| BAB2 | 8.94 | 0.40 | 21.71 | 3.50 | 6.88% |
| BAB3 | 7.29 | 0.36 | 16.41 | 2.91 | 4.84% |
| BAB4 | 6.87 | 0.35 | 11.33 | 2.01 | 2.38% |
| BAB5 | 6.68 | 0.34 | 11.67 | 2.11 | 2.60% |
| BAB6 | 4.67 | 0.25 | 12.91 | 2.41 | 3.38% |
| BAB7 | 5.68 | 0.30 | 10.19 | 1.89 | 2.10% |
| BAB8 | 4.68 | 0.25 | 8.90 | 1.67 | 1.66% |
| BAB9 | 4.29 | 0.22 | 3.97 | 0.72 | 0.31% |
| BAB10 | 3.99 | 0.20 | 3.51 | 0.62 | 0.23% |
| 1 – 10 | 6.99 | 0.36 | 15.94 | 2.90 | 4.82% |

# Conclusion

**A single factor, broker-dealer leverage, can explain a large set of asset returns**

- *Single* factor competes with leading 4 factors equity pricing model and bond pricing model
- *Economically* meaningful: measures "intermediary SDF"

# Thank you!

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