The Market State, Mispricing and Asset Pricing Anomalies

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Asset Pricing Anomalies

- **What is an asset pricing anomaly?**
  Return spread between High and Low (H-L) portfolios sorted on a given firm characteristic

- **Example: Size Anomaly**
  The return of a zero-cost portfolio which is long a portfolio of small firms and short a portfolio of large firms (SMB).

- **Why Return Anomalies Matter**
  Exposure to anomalies can help explain variation in expected returns. Crucial in asset pricing models since Fama-French (1993).

14 Asset Pricing Anomalies

- market beta (BETA)
- stock volatility (VOL)
- correlation with the market (COR)
- idiosyncratic volatility (IVOL)
- firm size (ME)
- book-to-market (BM)
- operating profitability (OP)
- asset growth (INV)
- momentum (MOM) - last 12 months
- short-term reversal (STR) - last month
- MAX return over the last month
- M1 max return over the last year
- illiquidity (ILLIQ)
- Value-at-Risk at 1 percent (VaR1)

Aggregate Mispricing Measure

- We aggregate across anomalies using the mispricing measure of Stambaugh, Yu and Yuan (2015).
- The mispricing measure represents a firm's average percentile ranking across 11 firm characteristics.
- Provides an aggregate view on which firms are more overpriced or underpriced in the cross section.
- Mispricing measure is:
  - high for overpriced firms (high prices, low expected returns)
  - and low for underpriced firms (low prices, high expected returns).

This Paper

- Examine the role of the **market state** in predicting return anomalies.
- Find that the size, sign and significance of anomaly returns depend crucially on the preceding market state.
- Individual anomaly returns are stronger and more significant following the negative market state!
- Aggregate mispricing occurs exclusively following the negative market state!
- The arbitrage asymmetry model of Stambaugh et al. (2015) helps us identify which firms are affected by the market state.
- Overpriced firms which are difficult to arbitrage are to blame!

This Paper

Two complementary mechanisms for most overpriced firms:

- **The Loosening of Arbitrage Capital:** capital frictions among **short investors** create a negative price feedback effect.
  - This is supported by short interest data.
- **The Disposition Effect:** behavioural biases among **long investors** create price underreaction, generating negative return momentum.
  - This is supported by liquidity and mutual fund flow data.

Data and Sample Period

- Monthly returns on all U.S. firms traded on the NYSE/NASDAQ/AMEX.
- The sample period ranges from August 1965 to January 2017 (T = 618).
- 2382 firms on average, ranging 878 firms to 3828 firms.
- Total monthly observations: N = 1,438,831.

Motivating The Market State

Consider a simple AR(1) process (with and without additional controls):

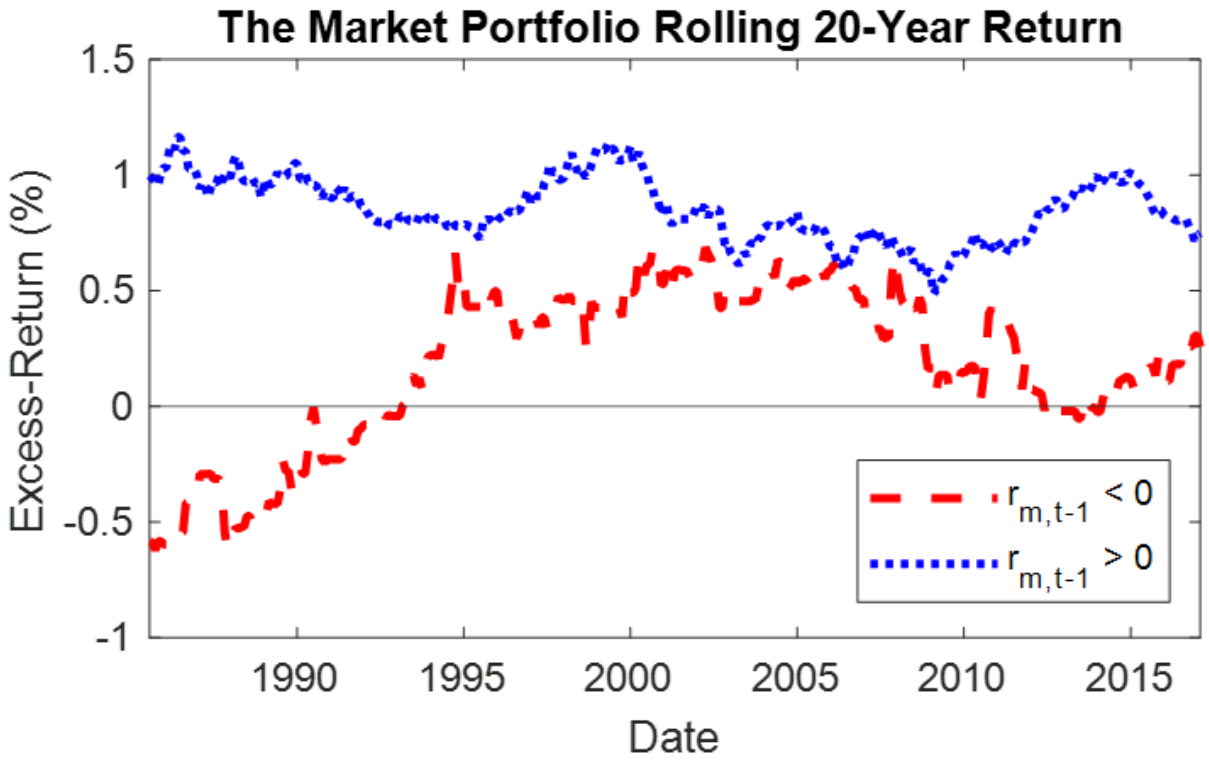
$$r_{m,t} = \beta_0 + \beta_1 r_{m,t-1} + \epsilon_t$$

	Coefficient	SE	t-stat	p-value
β_0	0.005***	0.002	2.426	0.015
β_1	0.075**	0.036	2.095	0.036

- Systematic Risk Compensation: $\beta_0 > 0 \Rightarrow E[r_m] > 0$
- Short Run Persistence: $\beta_1 \neq 0$

The Effect of The Market State on The Market

- $\beta_1 > 0$ implies that $E[r_{m,t}|r_{m,t-1} > 0] > E[r_{m,t}|r_{m,t-1} < 0]$

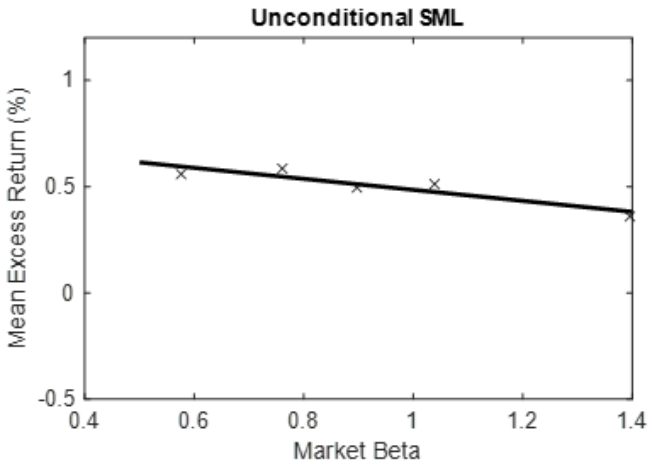


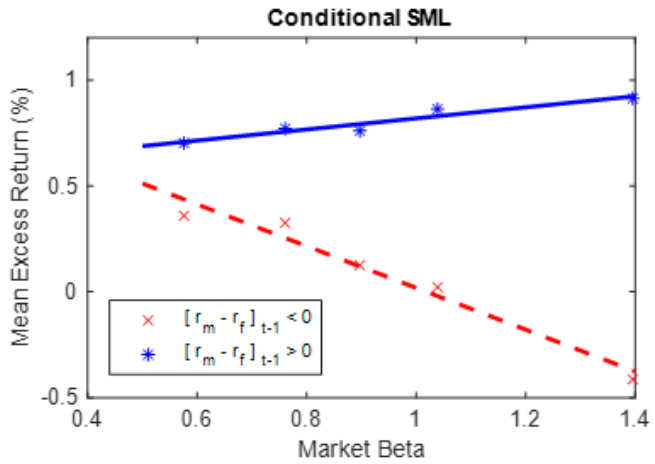
- When $r_{m,t-1} > 0$, $r_{m,t}$ averages 0.83% (10% annualized)
- When $r_{m,t-1} < 0$, $r_{m,t}$ averages 0.05% (0.6% annualized)

The Effect of The Market State on The CAPM

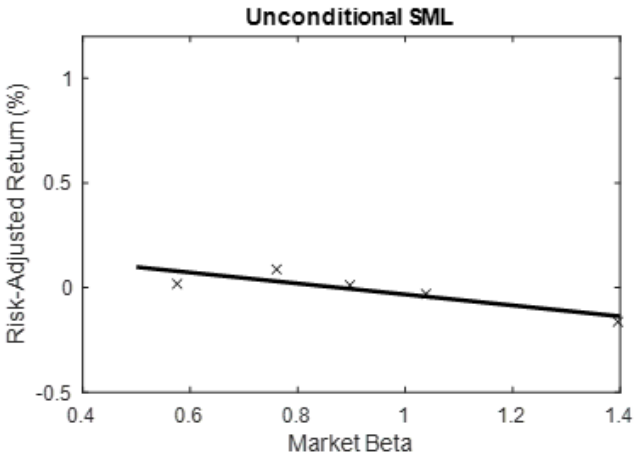
$$r_{i,t} = \alpha_i + \beta_i r_{m,t} + \epsilon_{i,t}$$

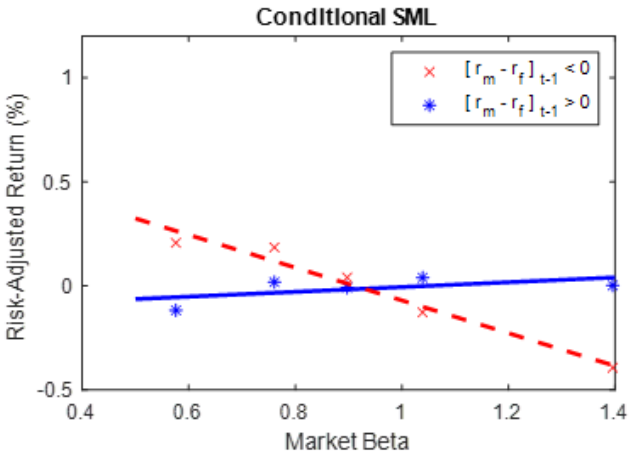
Panel A: **Excess Returns** and Unconditional Betas





Panel B: **Risk-Adjusted Returns** and Unconditional Betas





The Effect of The Market State on Anomaly Returns

Panel A: Excess Returns (%) **After Market Price Appreciation**

$$[r_m - r_f]_{t-1} > 0$$

	BETA	ME	BM	OP	INV	MOM	MAX
High	0.91	0.66	1.20	0.91	0.86	1.18	1.05
4	0.86	1.05	0.89	0.78	0.82	0.83	0.96
3	0.76	1.24	0.84	0.73	0.73	0.68	0.83
2	0.77	1.48	0.87	0.71	0.76	0.76	0.84
Low	0.70	1.76	0.72	0.85	1.07	0.75	0.72
H-L	0.21	-1.09	0.48	0.06	-0.20	0.43	0.33
t(H-L)	(0.77)	(-5.17)	(2.55)	(0.42)	(-1.47)	(1.52)	(1.29)

Panel B: Excess Returns (%) **After Market Price Depreciation**

$$[r_m - r_f]_{t-1} < 0$$

	BETA	ME	BM	OP	INV	MOM	MAX
High	-0.41	0.16	0.19	0.14	-0.15	0.45	-0.39
4	0.02	0.13	0.19	0.15	0.13	0.21	-0.01
3	0.13	0.03	0.20	0.23	0.19	0.08	0.20
2	0.33	-0.08	0.05	0.09	0.26	0.10	0.25
Low	0.36	-0.39	0.09	-0.24	0.25	-0.57	0.31
H-L	-0.77	0.55	0.10	0.38	-0.40	1.03	-0.69
t(H-L)	(-2.33)	(2.28)	(0.43)	(2.16)	(-2.04)	(3.70)	(-2.24)

Summary of Results - Market State and Anomaly Returns

The results are remarkable!

- **For excess returns, the results are always different across market states.**
- None of the anomalies displays a significant high-minus-low (H-L) spread of the same sign in the two subsamples.
- **Either** the anomaly spread is significant in only one of the two market states **or** it is significant in both states **but with a different sign**.
- For six anomalies the spread is significant in both states but flips sign.
- Most anomalies are significant in the negative market state.

Arbitrage Asymmetry Model (Stambaugh et al., JF 2015)

- The Stambaugh, Yu and Yuan (2015) model motivates the use of double-sorted portfolios on the mispricing measure and IVOL
- The combination of high IVOL with high mispricing delivers the strongest results.
- Two Key Concepts
  - **1. Arbitrage risk:** the risk that deters arbitrage. IVOL is a proxy for arbitrage risk.
  - **2. Arbitrage asymmetry:** buying is easier than shorting. Arbitrage is more effective in eliminating underpricing with long positions than overpricing with short positions.
- Result: less capital willing to hold short **most overpriced/highest IVOL firms**, prices are very high, expected returns are extremely low.

Mispricing-IVOL Portfolios **Following** the Market State

Panel A: Risk-Adjusted Returns **After Market Appreciation**, $[r_m - r_f]_{t-1} > 0$

	Most Overpriced	Next 20%	Next 20%	Next 20%	Most Underpriced	Overpriced-Underpriced
Highest IVOL	-0.26	-0.16	-0.12	0.01	0.00	-0.25
(Top 20%)	(-1.51)	(-1.05)	(-0.87)	(0.06)	(-0.01)	(-1.29)
Next 20%	0.10	-0.08	-0.06	-0.05	0.12	-0.01
	(0.77)	(-0.65)	(-0.51)	(-0.40)	(1.03)	(-0.08)
Next 20%	-0.16	-0.23	0.06	0.04	-0.06	-0.10
	(-1.36)	(-2.10)	(0.63)	(0.43)	(-0.56)	(-0.62)
Next 20%	-0.23	-0.10	0.01	0.12	-0.13	-0.10
	(-2.21)	(-0.83)	(0.08)	(1.37)	(-1.31)	(-0.65)
Lowest IVOL	-0.02	-0.08	0.06	0.00	-0.10	0.08
(Bottom 20%)	(-0.15)	(-0.73)	(0.59)	(-0.06)	(-1.11)	(0.53)
Highest IVOL -	-0.24	-0.08	-0.18	0.01	0.10	
Lowest IVOL	(-1.07)	(-0.40)	(-0.93)	(0.08)	(0.51)	

Panel B: Risk-Adjusted Returns **After Market Depreciation**, $[r_m - r_f]_{t-1} < 0$

	Most Overpriced	Next 20%	Next 20%	Next 20%	Most Underpriced	Overpriced-Underpriced
Highest IVOL	-1.46	-0.65	-0.48	-0.46	0.06	-1.52
(Top 20%)	(-7.09)	(-3.53)	(-2.79)	(-2.15)	(0.31)	(-5.49)
Next 20%	-0.24	0.06	0.06	-0.06	0.37	-0.61
	(-1.39)	(0.37)	(0.52)	(-0.45)	(2.52)	(-2.75)
Next 20%	-0.30	0.00	0.22	0.16	0.13	-0.43
	(-1.84)	(0.03)	(1.82)	(1.29)	(0.97)	(-1.97)
Next 20%	-0.10	0.29	-0.04	0.42	0.47	-0.56
	(-0.58)	(2.07)	(-0.38)	(3.26)	(3.60)	(-2.77)
Lowest IVOL	0.06	0.21	0.10	-0.01	0.06	0.00
(Bottom 20%)	(0.41)	(1.53)	(0.72)	(-0.13)	(0.48)	(0.02)
Highest IVOL -	-1.52	-0.86	-0.58	-0.45	0.00	
Lowest IVOL	(-5.30)	(-3.33)	(-2.38)	(-1.86)	(0.00)	

Mispricing-IVOL Portfolios **During** The Market State

Panel A: Risk-Adjusted Returns **During Market Appreciation**, $[r_m - r_f]_t > 0$

	Most Overpriced	Next 20%	Next 20%	Next 20%	Most Underpriced	Overpriced-Underpriced
Highest IVOL (Top 20%)	-0.01	0.31	0.32	0.27	0.34	-0.35
	(-0.05)	(1.95)	(2.40)	(1.68)	(2.08)	(-1.42)
Next 20%	0.53	0.42	0.27	0.26	0.21	0.32
	(4.04)	(3.50)	(2.30)	(2.09)	(1.76)	(1.89)
Next 20%	0.24	-0.03	0.36	0.20	0.06	0.18
	(1.99)	(-0.22)	(3.54)	(1.97)	(0.58)	(1.12)
Next 20%	-0.27	-0.09	-0.03	0.22	-0.08	-0.19
	(-2.34)	(-0.70)	(-0.37)	(2.07)	(-0.73)	(-1.08)
Lowest IVOL (Bottom 20%)	-0.40	-0.53	-0.32	-0.28	-0.47	0.07
	(-3.18)	(-5.16)	(-3.25)	(-2.76)	(-5.04)	(0.44)
Highest IVOL - Lowest IVOL	0.40	0.84	0.64	0.55	0.81	
	(1.83)	(4.23)	(3.56)	(2.94)	(3.86)	

Panel B: Risk-Adjusted Returns **During** Market Depreciation, $[r_m - r_f]_t < 0$

	Most Overpriced	Next 20%	Next 20%	Next 20%	Most Underpriced	Overpriced-Underpriced
Highest IVOL (Top 20%)	-1.81	-1.31	-1.09	-0.83	-0.42	-1.39
	(-8.23)	(-6.69)	(-5.57)	(-4.29)	(-2.63)	(-5.94)
Next 20%	-0.83	-0.64	-0.40	-0.49	0.24	-1.07
	(-4.83)	(-3.75)	(-3.14)	(-3.65)	(1.95)	(-4.99)
Next 20%	-0.87	-0.28	-0.20	-0.06	-0.04	-0.83
	(-5.17)	(-1.99)	(-1.60)	(-0.44)	(-0.30)	(-3.92)
Next 20%	-0.04	0.27	0.02	0.29	0.40	-0.44
	(-0.20)	(2.03)	(0.14)	(2.87)	(3.35)	(-2.34)
Lowest IVOL (Bottom 20%)	0.60	0.84	0.63	0.36	0.57	0.03
	(3.77)	(5.15)	(4.98)	(3.69)	(5.10)	(0.15)
Highest IVOL - Lowest IVOL	-2.41	-2.15	-1.72	-1.19	-0.99	
	(-8.39)	(-7.33)	(-6.39)	(-5.30)	(-4.56)	

Excess Returns **During** the Negative Market State

Panel C: Excess-Returns **During Market Depreciation**, $[r_m - r_f]_t < 0$

	Most Overpriced	Next 20%	Next 20%	Next 20%	Most Underpriced	Overpriced-Underpriced
Highest IVOL	-7.03	-5.63	-5.00	-4.52	-3.74	-3.29
(Top 20%)	(-14.05)	(-13.79)	(-12.80)	(-12.16)	(-12.06)	(-9.09)
Next 20%	-5.50	-4.61	-4.16	-4.00	-3.01	-2.48
	(-13.50)	(-12.83)	(-14.02)	(-13.91)	(-11.27)	(-7.96)
Next 20%	-5.20	-4.02	-3.64	-3.43	-3.18	-2.02
	(-13.50)	(-12.86)	(-12.67)	(-13.68)	(-14.09)	(-6.11)
Next 20%	-4.08	-3.38	-3.50	-2.99	-2.69	-1.39
	(-13.28)	(-12.65)	(-12.58)	(-12.26)	(-12.16)	(-5.95)
Lowest IVOL	-3.18	-2.55	-2.56	-2.73	-2.45	-0.74
(Bottom 20%)	(-10.19)	(-10.42)	(-10.83)	(-12.75)	(-11.13)	(-3.12)
Highest IVOL -	-3.84	-3.08	-2.44	-1.79	-1.29	
Lowest IVOL	(-9.14)	(-8.20)	(-6.95)	(-5.33)	(-4.85)	

The Loosening of Arbitrage Capital Mechanism

- During the negative market state, stock prices fall.
- Margin ratios improve for investors who are **short in the most overpriced/highest IVOL stocks.**
- High margin ratios lead to an increase in short interest *in the next period*.
- This puts additional pressure on prices, which drop further.
- **End result:** a feedback effect between prices and short interest.
- This generates return momentum among the most overpriced/highest IVOL stocks following the negative market state.

Short Interest and The Market State

Panel A: Short Interest (%)

	Most Overpriced	Next 20%	Next 20%	Next 20%	Most Underpriced	Overpriced-Underpriced
Highest IVOL (Top 20%)	3.82	2.78	2.32	1.98	1.74	2.07
						(5.03)
Next 20%	2.68	2.04	1.75	1.46	1.34	1.34
						(5.99)
Next 20%	1.99	1.63	1.45	1.20	1.07	0.92
						(5.90)
Next 20%	1.56	1.34	1.21	1.03	0.90	0.66
						(4.83)
Lowest IVOL (Bottom 20%)	1.25	1.12	1.05	0.91	0.77	0.48
						(5.28)
Highest IVOL - Lowest IVOL	2.57	1.66	1.27	1.07	0.98	
	(4.18)	(5.19)	(4.77)	(4.40)	(4.57)	

Panel B: Δ Short Interest (%) **Following Market Depreciation**, $[r_m - r_f]_{t-2} < 0$

	Most Overpriced	Next 20%	Next 20%	Next 20%	Most Underpriced	Overpriced-Underpriced
Highest IVOL (Top 20%)	0.08	0.04	0.06	0.05	0.02	0.05
	(3.38)	(2.83)	(3.59)	(3.80)	(1.88)	(2.45)
Next 20%	0.05	0.02	0.02	0.01	0.00	0.05
	(3.24)	(1.20)	(1.24)	(1.33)	(0.28)	(2.81)
Next 20%	0.02	0.02	0.00	0.02	0.00	0.02
	(1.98)	(1.58)	(0.26)	(2.52)	(0.42)	(1.47)
Next 20%	0.01	0.01	0.01	0.00	0.01	0.00
	(0.66)	(1.38)	(1.33)	(0.35)	(1.32)	(-0.21)
Lowest IVOL (Bottom 20%)	0.01	0.02	0.00	0.00	0.01	0.00
	(1.02)	(2.04)	(-0.07)	(0.46)	(1.54)	(-0.21)
Highest IVOL - Lowest IVOL	0.07	0.02	0.06	0.05	0.01	
	(3.10)	(1.42)	(3.87)	(3.29)	(0.97)	

The Disposition Effect Among Long Investors

- **Prospect theory** (Kahneman and Tversky, Ecta 1979)

  Investors make decisions *not on expected outcomes*, but on the *losses and gains* on their portfolios.

- **The disposition effect** (Shefrin and Statman, JF 1985)

  Investors prefer to keep holding the stocks that have fallen in value rather than realize their losses.

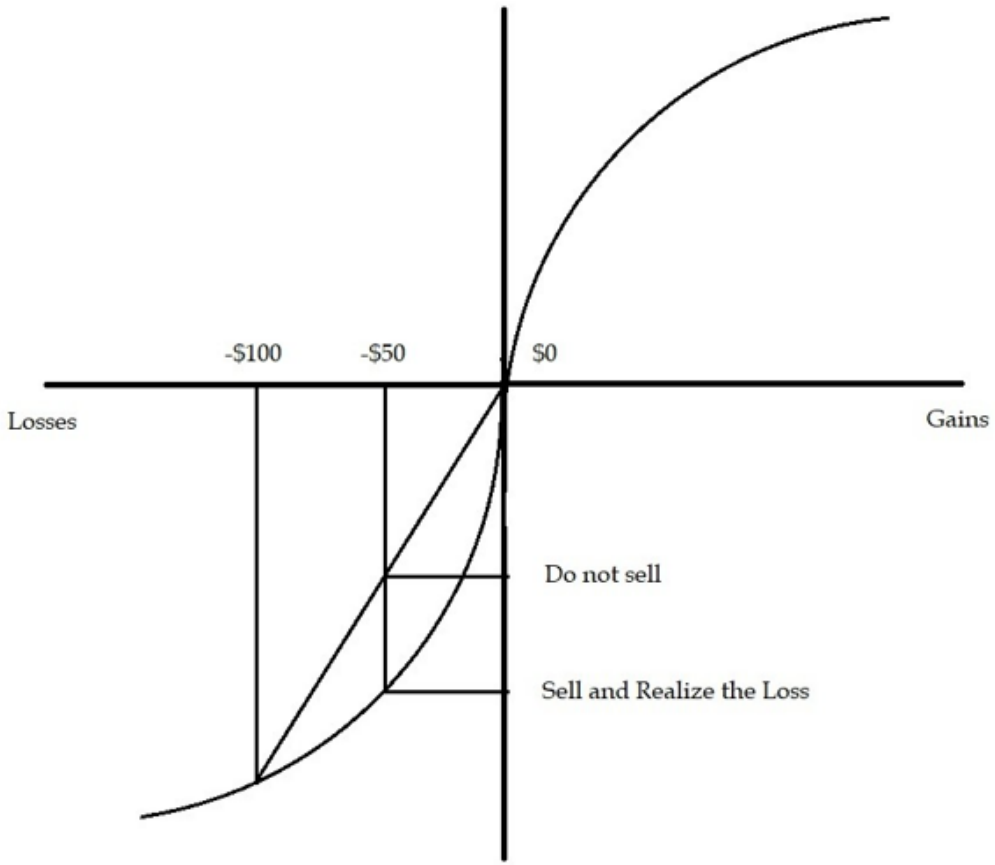
- **Short-Run Momentum**

  Not selling inhibits price discovery and causes a price underreaction.

  As price discovery continues in the next period, there is one-month ahead momentum.

The Disposition Effect

This figure demonstrates the disposition effect as in Frazzini (2006). Assume an investor previously purchased one share of stock at \$1000, the current price is \$950. In the next period, with an equal chance, the price could go up \$50 or down \$50. The investor must choose between selling now at \$950 to incur a loss of \$50, or to keep the share for the next period. This figure shows the utility the investor receives now under each alternative.



Illiquidity and The Market State

$$ILLIQ_{i,t} = \frac{1}{D_{i,t}} \Sigma_{t=1}^{D_{i,t}} \frac{|R_{i,t}|}{DVOL_{i,t}}$$

Panel A: Illiquidity (ILLIQ) Levels

	Most Overpriced	Next 20%	Next 20%	Next 20%	Most Underpriced	Overpriced-Underpriced
Highest IVOL (Top 20%)	0.27	0.25	0.23	0.21	0.19	0.08
						(4.86)
Next 20%	0.11	0.09	0.09	0.07	0.08	0.03
						(4.63)
Next 20%	0.07	0.05	0.05	0.04	0.04	0.02
						(5.20)
Next 20%	0.04	0.04	0.03	0.02	0.02	0.02
						(5.21)
Lowest IVOL (Bottom 20%)	0.02	0.02	0.02	0.01	0.01	0.01
						(7.51)
Highest IVOL - Lowest IVOL	0.25	0.23	0.22	0.19	0.18	
	(12.66)	(12.81)	(11.17)	(9.64)	(8.35)	

Panel C: Δ ILLIQ **During** Market Price Depreciation, $[r_m - r_f]_t < 0$

	Most Overpriced	Next 20%	Next 20%	Next 20%	Most Underpriced	Overpriced-Underpriced
Highest IVOL (Top 20%)	0.036	0.028	0.034	0.022	0.020	0.016
	(5.29)	(5.19)	(3.95)	(3.69)	(4.64)	(2.74)
Next 20%	0.017	0.012	0.008	0.013	0.012	0.005
	(4.27)	(4.59)	(1.83)	(5.29)	(4.56)	(1.79)
Next 20%	0.006	0.004	0.005	0.005	0.006	0.000
	(2.41)	(1.90)	(3.43)	(3.78)	(4.78)	(-0.12)
Next 20%	0.002	0.002	0.002	0.002	0.001	0.001
	(1.66)	(2.07)	(2.05)	(3.45)	(2.83)	(0.84)
Lowest IVOL (Bottom 20%)	-0.002	-0.002	-0.002	-0.001	-0.001	-0.002
	(-2.57)	(-3.13)	(-2.36)	(-2.23)	(-3.93)	(-1.86)
Highest IVOL - Lowest IVOL	0.039	0.030	0.036	0.022	0.021	
	(5.65)	(5.61)	(3.99)	(3.79)	(4.80)	

Summary of Contributions - Context

- The variation in the cross section of expected stock returns is often attributed to asset pricing anomalies.
- These anomalies can be effectively summarized by the Stambaugh, Yu and Yuan (2015) mispricing measure.
- Portfolios sorted on the mispricing measure interact strongly with idiosyncratic volatility, which motivates the use of 5x5 double-sorted mispricing-idiosyncratic volatility portfolios.
- Among these portfolios, the most overpriced/highest idiosyncratic volatility portfolio displays highly negative and significant risk-adjusted returns.
- Consequently, investors shorting this portfolio can earn highly positive and significant risk-adjusted returns.

Summary of Contributions - Results

- We demonstrate the crucial role of the market state in predicting the risk-adjusted returns of individual asset pricing anomalies and mispricing portfolios.
- For individual asset pricing anomalies, the results are consistently different across the two market states.
- For mispricing portfolios, the results are almost exclusively due to the negative market state.
- The empirical results are consistent with the loosening of arbitrage capital for short investors and the disposition effect for long investors.
- **Conclusion: The market state matters and it is the negative market state that drives the momentum in individual and aggregate return anomalies.**