(pre-1993 CAPM) alpha turned into (post-1993 funding liquidity & arbitrageur wealth portfolio) beta through the act of arbitrage.

once arbitrageurs turn alphas into betas, fundamental mispricing defined as the deviation of price from fundamental value can persist in the form of arbitrage driven risk rather than abnormal returns.

Turning alphas into betas: Arbitrage and endogenous risk

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Thummim Cho (韩国人)

Current Appointments

Department of Finance, London School of Economics and Political Science

Academic Background

•**PhD** in Economics，Harvard University,2017

•**BA** in Mathematics and Economics, Cornell University, 2007

Research fields: Asset pricing and macroeconomics

"Does Liquidity Cause Market Return Reversals? A Natural Experiment"
Presented at the 2016 AFA Annual MeetingReplicating anomalies (with Hou and Xue),
"The Unlegislated Tax Multiplier: A Placebo Test of Tax Multiplier Studies" with Yosub Jung

preliminary

1.Asset pricing “anomalies”

investment strategies with high expected returns but low identifiable risks

2.arbitrage capital shocks

套利资本kt 遵循 $dk_t = rk_t dt + x_t^T dR_t - c_t dt$
本文使用两种方法测量（arbitrage-driven risk）套利资本冲击：

3.Funding liquidity exposure

融资流动性区别于市场流动性，反映投资者的融资能力Markus（2009）。Funding betas strengthen (weaken) in periods in which arbitrageurs are likely to be constrained (unconstrained)

4.arbitrageur wealth portfolio shocks

arbitrageur wealth portfolio is value-weighted portfolio that goes long on the top decile and short on the bottom decile of stocks sorted on my measure of arbitrage position

Abstract

1. Using data on asset pricing anomalies, I test the idea that the act of arbitrage turns “alphas” into “betas” : Assets with high initial abnormal returns attract more arbitrage and covary（共变） endogenously more with systematic factors that arbitrage capital is exposed to. (套利资本所暴露的系统性因子在内生上有更多共变)

2. This channel explains the exposures of 40 anomaly portfolios to aggregate funding liquidity shocks and arbitrageur wealth portfolio shocks.

3. My results highlight that financial intermediaries that act as asset market arbitrageurs not only price assets given risks, but also actively shape these risks through their trades.

Innovation

1. asset pricing anomalies can appear to persist despite arbitrage because the act of arbitrage itself turns their CAPM alphas into intermediary asset pricing betas

2. draw out testable predictions of this endogenous risk view from intermediary asset pricing models

$$\beta^{post93}_{funding,i} = b_0 + b_1 \text{ Arbitrage position}^{post93}_i + u_i$$

$$\beta_{i,k} = b_0 + b_1 \alpha^{pre}_i + u_i$$

3. arbitrage wealth portfolio is value-weighted portfolio that goes long on the top decile and short on the bottom decile of stocks sorted on my measure of arbitrage position，

$$\beta^{post93}_{wealth,i} = b_0 + b_1 \text{ Arbitrage position}^{post93}_i + u_i$$

Contents

（1）background

Asset pricing anomalies—such as value and momentum—first gained widespread recognition among finance academics and investment managers in the early 1990s. Since then, arbitrageurs such as hedge funds have allocated growing amounts of capital to these anomalies。

Do arbitrageurs eliminate the abnormal returns on these anomalies without affecting their equilibrium risks?
Or do anomalies become increasingly exposed to "endogenous risks" because of the very fact that many arbitrageurs are attempting to exploit them？

?

1. introduction

（2）what to study

I show empirically that arbitrage activity exposes asset pricing anomalies to endogenous risks associated with the act of arbitrage.

I draw out testable predictions of this endogenous risk view from intermediary asset pricing models in which financial intermediaries act as rational asset market arbitrageurs

I also test if these betas generated by the act of arbitrage, henceforth called "arbitrage-driven" betas。 I use two measures of arbitrage capital shocks: the funding liquidity factor (Adrian et al. ,2014) and an arbitrageur wealth portfolio factor proxied by a long-short portfolio formed on estimated arbitrage positions.

1. introduction

（2）what to study

I show empirically that arbitrage activity exposes asset pricing anomalies to endogenous risks associated with the act of arbitrage.

I draw out testable predictions of this endogenous risk view from intermediary asset pricing models in which financial intermediaries act as rational asset market arbitrageurs

I also test if these betas generated by the act of arbitrage, henceforth called "arbitrage-driven" betas。I use two measures of arbitrage capital shocks: the funding liquidity factor (Adrian et al. ,2014) and an arbitrageur wealth portfolio factor proxied by a long-short portfolio formed on estimated arbitrage positions.

2. Methodology and data

（1）Theoretical background

Consider a continuous time economy in which uncertainty is captured by the N-dimensional Brownian motion B_t , where $\overline{D}$ is a constant N × 1 vector, There are N risky assets in zero net supply with cash flows

$$dD_t = \overline{D}dt + dB_t, \tag{1}$$

Arbitrageurs maximize power utility over consumption, γ ≥ 0 is the coefficient of relative risk aversion, A > 0 is their coefficient of absolute risk aversion， ρ is discount rate

$$E_0\left[\int_0^\infty e^{-\rho t}\frac{c_t^{1-\gamma}}{1-\gamma}dt\right], \tag{2}$$

The capital of arbitrageurs k_t evolves according to

$$dk_t = rk_t dt + x_t^T dR_t - c_t dt, \tag{3}$$

where x_t is the arbitrageur's position in risky assets and dR_t denotes risky asset returns in excess of the risk-free rate

2. Methodology and data

（1）Theoretical background

Proposition 1. In the absence of arbitrageurs, expected excess returns on assets follow u as distortions in asset demands that generate abnormal return opportunities

$$\frac{E_t[dR_t]}{dt} = Au. \quad (4)$$

$\alpha_i^{pre} \equiv Au$ is "pre-arbitrage" abnormal return

Proposition 2. In the presence of arbitrageurs, arbitrage positions x_t, endogenous return covariances with arbitrage capital, and expected excess returns of assets are given by

$$x_t = \tilde{x}(k_t)u, \quad (5)$$

$$\frac{Cov_t(dR_t, dk_t)}{dt} \propto u, \quad (6)$$

$$\frac{E_t[dR_t]}{dt} = \mu(k_t)u, \quad (7)$$

where $\tilde{x}(k_t) > 0$ and $\mu(k_t) > 0$ are increasing and decreasing in k_t, respectively.

Kondor and Vayanos (2019)

（1）Theoretical background

Hence, an abnormal return in the absence of arbitrageurs predicts endogenous risk exposure to arbitrage capital shocks (i.e., alphas turn into betas). When approximated as a linear relation, this implies a cross-sectional regression:

$$\beta_{i,k} = b_0 + b_1 \alpha_i^{pre} + u_i, \quad (8)$$

Alternatively, equilibrium arbitrage position explains the contemporaneous endogenous risk exposure to k_t, motivating a regression:

$$\beta_{i,k} = \tilde{b}_0 + \tilde{b}_1 x_i + \tilde{u}_i, \quad (9)$$

2. Methodology and data

（2）Data and measurement

① 40 anomaly portfolios are 20 anomaly characteristics

	Long (top decile)				Short (bottom decile)				Academic publication	
Type	No	Label	α^{pre}_{CAPM}	Mktcap share	No	Label	α^{pre}_{CAPM}	Mktcap share	Year	Sample
Beta arbitrage	1	beta(L)	**3.9**	0.09	21	beta(S)	−**5.3**	0.09	1973	1926-1968
Return on market equity	2	rome(L)	**9.6**	0.05	22	rome(S)	−**8.6**	0.03	1977	1956-1971
Ohlson's O-score	3	ohlson(L)	−0.4	0.29	23	ohlson(S)	−**4.8**	0.01	1980	1970-1976
Size	4	size(L)	2.8	0.02	24	size(S)	−1.1	0.58	1981	1926-1975
Long-run reversals	5	rev60m(L)	3.7	0.03	25	rev60m(S)	−**3.3**	0.13	1985	1926-1982
Value	6	value(L)	**6.8**	0.04	26	value(S)	−**4.4**	0.20	1985	1980-1990
Momentum	7	mom12m(L)	**6.0**	0.10	27	mom12m(S)	−**12.1**	0.04	1990	1964-1987
Net issuance	8	netissue(L)	**4.6**	0.11	28	netissue(S)	−**3.8**	0.08	1995	1980-1990
Net issuance monthly	9	netissue_m(L)	**4.4**	0.11	29	netissue_m(S)	−1.7	0.09	1995	1980-1990
Accruals	10	acc(L)	1.0	0.06	30	acc(S)	−**4.6**	0.05	1996	1962-1991
Return on assets	11	roa(L)	−0.0	0.17	31	roa(S)	−**7.4**	0.03	1996	1979-1993
Return on book equity	12	roe(L)	1.1	0.14	32	roe(S)	−**6.7**	0.04	1996	1979-1993
Failure probability	13	failprob(L)	0.5	0.16	33	failprob(S)	−**11.6**	0.02	1998	1981-1996
Piotroski's f-score	14	piotroski(L)	0.6	0.21	34	piotroski(S)	−**3.2**	0.09	2000	1976-1997
Investment	15	invest(L)	**4.7**	0.03	35	invest(S)	−**4.6**	0.07	2004	1973-1996
Idiosyncratic volatility	16	idiovol(L)	1.4	0.25	36	idiovol(S)	−**11.7**	0.04	2006	1986-2000
Asset growth	17	atgrowth(L)	3.3	0.03	37	atgrowth(S)	−**4.2**	0.10	2008	1968-2003
Asset turnover	18	ato(L)	**3.4**	0.05	38	ato(S)	0.9	0.09	2008	1984-2002
Gross margins	19	gm(L)	−1.8	0.20	39	gm(S)	0.5	0.04	2008	1984-2002
Gross profitability	20	profit(L)	0.4	0.10	40	profit(S)	−0.8	0.07	2010	1976-2005

40 anomaly portfolios formed by taking the long and short portfolios (top/bottom deciles) from a univariate sorting of stocks on 20 anomaly characteristics

Novy-Marx and Velikov (2016) , Kondor, P., Vayanos, D., (2019)

2. Methodology and data

（2） Data and measurement

② two kinds of systematic shocks to arbitrage capital

two kinds of systematic shocks to arbitrage capital

aggregate funding liquidity factor

aggregate arbitrage wealth portfolio

book leverage账面杠杆（the ratio of book assets to book equity） of security broker-dealers

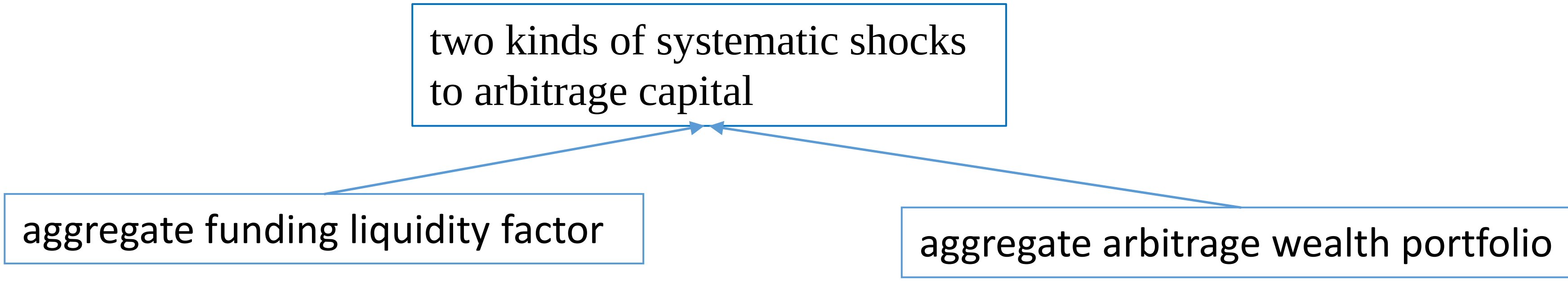
value-weighted portfolio that goes long on the top decile and short on the bottom decile of stocks sorted on my measure of arbitrage position

arbitrage positions----using abnormal short positions on underlying stocks
Each month, I estimate abnormal short position on each stock **as the residual** from a cross-sectional regression of short positions on dummy variables for size, liquidity, and convertible bonds outstanding.

2. Methodology and data

（2）Data and measurement

② two kinds of systematic shocks to arbitrage capital

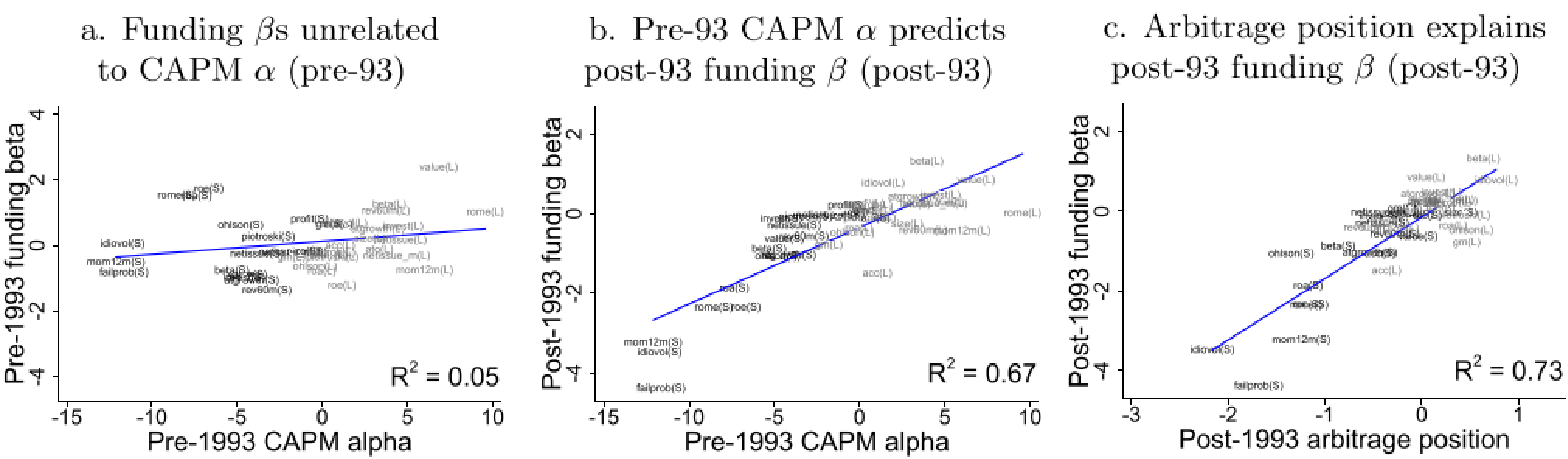


The funding liquidity factor and arbitrageur wealth portfolio returns have a small positive correlation of 0.075 over the sample period, implying that they capture different components of arbitrage capital shocks.

3. Funding liquidity exposure

山西财经大学
SHANXI UNIVERSITY OF FINANCE AND ECONOMICS

Explaining the cross-section of funding liquidity betas



Anomaly portfolios display a large cross-sectional variation in funding liquidity exposure in the post-1993 period.

In this section, I provide evidence that this variation arises endogenously through the act of arbitrage.

3. Funding liquidity exposure

（1）Cross-section of funding betas: $\beta^{post93}_{funding,i} = b_0 + b_1 \text{ Arbitrage position}_i^{post93} + u_i$

70%

	$\beta^{post93}_{funding}$								$\beta^{pre93}_{funding}$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Arbitrage position	**1.55**	**1.57**	**1.80**						0.68		
	(2.31)	(2.33)	(2.06)						(0.28)		
α^{pre93}_{CAPM}				**0.19**	**0.20**	**0.21**				−0.03	
				(2.62)	(2.54)	(2.27)				(−0.48)	
$\beta^{pre93}_{funding}$		0.24			−0.09		0.16				
		(1.07)			(−0.28)		(0.39)				
Size rank			0.10			−0.14		−0.41	−0.03	0.05	0.02
			(0.35)			(−0.52)		(−1.17)	(−0.11)	(0.29)	(0.10)
Value rank			0.11			−0.16		0.37	0.45	0.54	0.48
			(0.48)			(−0.48)		(1.50)	(1.57)	(1.71)	(1.82)
Profitability rank			−0.04			−0.14		0.19	0.07	0.13	0.09
			(−0.24)			(−0.65)		(0.83)	(0.37)	(0.60)	(0.46)
Investment rank			−0.06			−0.10		0.16	−0.07	−0.11	−0.09
			(−0.36)			(−0.55)		(0.99)	(−0.51)	(−0.93)	(−0.75)
Constant	−0.14	−0.16	−0.31	−0.34	−0.33	2.04	−0.56	−2.71	−2.71	−3.48	−2.89
	(−0.74)	(−0.80)	(−0.16)	(−1.13)	(−1.13)	(0.69)	(−1.56)	(−0.99)	(−1.13)	(−1.27)	(−1.30)
Observations	40	40	40	40	40	40	40	40	40	40	40
R^2_{adj}	0.72	0.75	0.75	0.67	0.66	0.71	−0.01	0.28	0.71	0.72	0.71

$$\beta_{i,k} = \tilde{b}_0 + \tilde{b}_1 x_i + \tilde{u}_i, \qquad (9)$$

Arbitrage capital plays a larger price-correcting role respond more to the variation in arbitrage capital due to funding liquidity shocks. the cross-sectional variation in funding liquidity exposure is mostly arbitrage driven.

3. Funding liquidity exposure

（1）Cross-section of funding betas:

$$\text{Arbitrage position}_{i,t} = b_0 + b_1 \alpha_i^{pre} \times \mathbf{1}(t > 1993q4) + b_2 \mathbf{1}(t > 1993q4) + b_3 t + b_4 t^2 + u_i + \epsilon_{i,t}$$

	α^{pre} = CAPM alpha					α^{pre} = FF3 alpha			α^{pre} = FF5 alpha			Long vs. short			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
α^{pre} × Post-1993	**0.076**		**0.058**	**0.051**	**0.052**	**0.058**	**0.055**	**0.045**	**0.066**	**0.061**	**0.051**				
	(3.92)		(3.12)	(1.97)	(2.52)	(3.15)	(2.14)	(2.18)	(3.56)	(2.36)	(2.47)				
α^{pre} × Post publication		**0.076**	0.032	0.019	0.027	0.034	0.029	0.012	**0.044**	0.036	0.022				
		(3.61)	(1.78)	(0.98)	(1.11)	(1.89)	(1.52)	(0.49)	(2.47)	(1.88)	(0.90)				
α^{pre} × Post sample				0.025			0.010			0.016					
				(0.94)			(0.36)			(0.60)					
α^{pre} × Post-1993 × Postpub					0.010			0.034			0.036				
					(0.27)			(0.96)			(1.00)				
Long × Post-1993												**0.643**		**0.534**	**0.507**
												(3.71)		(2.97)	(2.21)
Long × Post publication													**0.597**	0.195	0.152
													(3.28)	(1.16)	(0.92)
Long × Post sample															0.082
															(0.35)
Anomaly FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,880	6,880	6,880	6,880	6,880	6,880	6,880	6,880	6,880	6,880	6,880	6,880	6,880	6,880	6,880
R^2_{adj}	0.20	0.16	0.21	0.21	0.21	0.27	0.27	0.28	0.27	0.27	0.28	0.16	0.13	0.16	0.17

3. Funding liquidity exposure

（1）Cross-section of funding betas

	$\beta^{post93}_{funding}$								$\beta^{pre93}_{funding}$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Arbitrage position	**1.55**	**1.57**	**1.80**		67%				0.68		
	(2.31)	(2.33)	(2.06)						(0.28)		
α^{pre93}_{CAPM}				**0.19**	**0.20**	**0.21**				−0.03	
				(2.62)	(2.54)	(2.27)				(−0.48)	
$\beta^{pre93}_{funding}$		0.24			−0.09		0.16				
		(1.07)			(−0.28)		(0.39)				
Size rank			0.10			−0.14		−0.41	−0.03	0.05	0.02
			(0.35)			(−0.52)		(−1.17)	(−0.11)	(0.29)	(0.10)
Value rank			0.11			−0.16		0.37	0.45	0.54	0.48
			(0.48)			(−0.48)		(1.50)	(1.57)	(1.71)	(1.82)
Profitability rank			−0.04			−0.14		0.19	0.07	0.13	0.09
			(−0.24)			(−0.65)		(0.83)	(0.37)	(0.60)	(0.46)
Investment rank			−0.06			−0.10		0.16	−0.07	−0.11	−0.09
			(−0.36)			(−0.55)		(0.99)	(−0.51)	(−0.93)	(−0.75)
Constant	−0.14	−0.16	−0.31	−0.34	−0.33	2.04	−0.56	−2.71	−2.71	−3.48	−2.89
	(−0.74)	(−0.80)	(−0.16)	(−1.13)	(−1.13)	(0.69)	(−1.56)	(−0.99)	(−1.13)	(−1.27)	(−1.30)
Observations	40	40	40	40	40	40	40	40	40	40 (70%)	40
R^2_{adj}	0.72	0.75	0.75	0.67	0.66	0.71	−0.01	0.28	0.71	0.72	0.71

reverse causality → pre-1993 CAPM alpha measures the demand distortion in the anomaly portfolio that ultimately determines the equilibrium arbitrage position

$$\beta_{i,k} = b_0 + b_1 \alpha_i^{pre} + u_i, \quad (8)$$

(pre-1993 CAPM) alpha turned into (post-1993 funding liquidity) beta through the act of arbitrage

3. Funding liquidity exposure

（2）Panel of funding betas

$$\beta_{funding,i,t} = b_0 + b_1 \text{Arbitrage position}_{i,t} + \boldsymbol{b}_3' \boldsymbol{X}_{i,t} + b_4 t + b_5 t^2 + u_i + \epsilon_{i,t}$$

	OLS								2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Arbitrage position	**0.70**	**0.71**							**3.16**	3.08	3.40
	(2.09)	(2.11)							(1.99)	(1.83)	(1.84)
$\alpha_{CAPM}^{pre93} \times$ Post-1993			**0.18**	**0.18**			0.11				
			(2.02)	(2.10)			(1.51)				
$\alpha_{CAPM}^{pre93} \times$ Post publication					0.21	**0.22**	0.13				
					(1.92)	(2.08)	(1.46)				
Size rank		−0.03		−0.12		−0.18	−0.15	−0.12	0.27	0.26	0.30
		(−0.20)		(−0.79)		(−1.07)	(−0.98)	(−0.73)	(0.87)	(0.79)	(0.87)
Value rank		0.17		0.18		0.15	0.20	0.14	0.28	0.28	0.29
		(0.88)		(0.99)		(0.82)	(1.07)	(0.68)	(1.54)	(1.49)	(1.59)
Profitability rank		0.22		0.20		0.21	0.21	0.21	0.23	0.23	0.23
		(1.32)		(1.23)		(1.32)	(1.33)	(1.27)	(1.29)	(1.26)	(1.29)
Investment rank		0.22		0.22		0.27	0.24	0.23	0.20	0.20	0.19
		(1.52)		(1.35)		(1.81)	(1.49)	(1.54)	(1.05)	(1.03)	(1.00)
Anomaly FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760
R_{adj}^2	0.13	0.16	0.20	0.23	0.18	0.22	0.26	0.09	.	.	.
Instrumental variables											
$\alpha^{pre} \times$ Post-1993									✓	✓	
$\alpha^{pre} \times$ Postpub									✓		✓

3. Funding liquidity exposure

（2）Panel of funding betas

$\beta_{funding}$

The panel approach also suggests that alphas turned into betas through the act of arbitrage.

	(1)	(2)	(3)								(11)
Arbitrage position	**0.70**	**0.71**							**3.16**	3.08	3.40
	(2.09)	(2.11)							(1.99)	(1.83)	(1.84)
α_{CAPM}^{pre93} × Post-1993			**0.18**	**0.18**			0.11				
			(2.02)	(2.10)			(1.51)				
α_{CAPM}^{pre93} × Post publication					0.21	**0.22**	0.13				
					(1.92)	(2.08)	(1.46)				
Size rank		−0.03		−0.12		−0.18	−0.15	−0.12	0.27	0.26	0.30
		(−0.20)		(−0.79)		(−1.07)	(−0.98)	(−0.73)	(0.87)	(0.79)	(0.87)
Value rank		0.17		0.18		0.15	0.20	0.14	0.28	0.28	0.29
		(0.88)		(0.99)		(0.82)	(1.07)	(0.68)	(1.54)	(1.49)	(1.59)
Profitability rank		0.22		0.20		0.21	0.21	0.21	0.23	0.23	0.23
		(1.32)		(1.23)		(1.32)	(1.33)	(1.27)	(1.29)	(1.26)	(1.29)
Investment rank		0.22		0.22		0.27	0.24	0.23	0.20	0.20	0.19
		(1.52)		(1.35)		(1.81)	(1.49)	(1.54)	(1.05)	(1.03)	(1.00)
Anomaly FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760
R_{adj}^2	0.13	0.16	0.20	0.23	0.18	0.22	0.26	0.09	.	.	.
Instrumental variables											
α^{pre} × Post-1993									✓	✓	
α^{pre} × Postpub									✓		✓

3. Funding liquidity exposure

（2）Panel of funding betas

$$\beta_{funding,i,t} = b_0 + b_1 \text{Arbitrage position}_{i,t} + \mathbf{b}_3'\mathbf{X}_{i,t} + b_4 t + b_5 t^2 + u_i + \epsilon_{i,t}$$

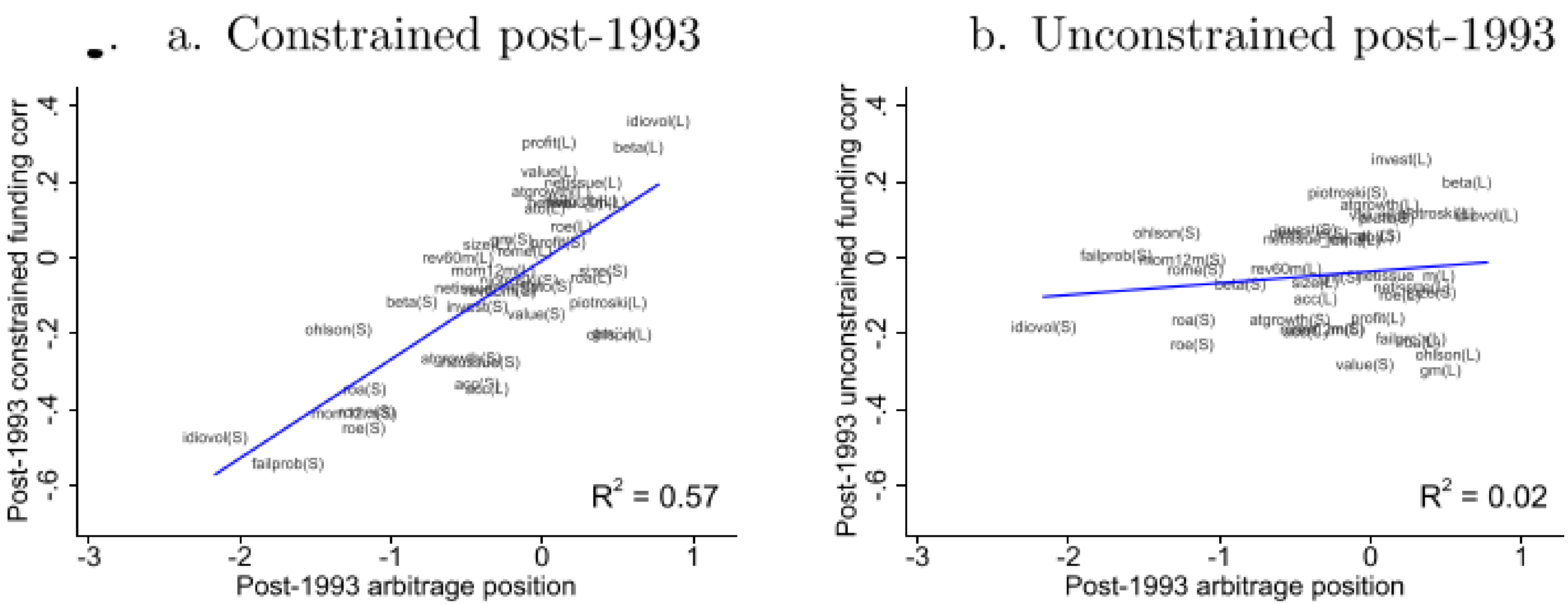
	OLS								2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Arbitrage position	**0.70**	**0.71**							**3.16**	3.08	3.40
	(2.09)	(2.11)							(1.99)	(1.83)	(1.84)
α^{pre93}_{CAPM} × Post-1993			**0.18**	**0.18**			0.11				
			(2.02)	(2.10)			(1.51)				
α^{pre93}_{CAPM} × Post publication					0.21	**0.22**	0.13				
					(1.92)	(2.08)	(1.46)				
Size rank		−0.03		−0.12		−0.18	−0.15	−0.12	0.27	0.26	0.30
		(−0.20)		(−0.79)		(−1.07)	(−0.98)	(−0.73)	(0.87)	(0.79)	(0.87)
Value rank		0.17		0.18		0.15	0.20	0.14	0.28	0.28	0.29
		(0.88)		(0.99)		(0.82)	(1.07)	(0.68)	(1.54)	(1.49)	(1.59)
Profitability rank		0.22		0.20		0.21	0.21	0.21	0.23	0.23	0.23
		(1.32)		(1.23)		(1.32)	(1.33)	(1.27)	(1.29)	(1.26)	(1.29)
Investment rank		0.22		0.22		0.27	0.24	0.23	0.20	0.20	0.19
		(1.52)		(1.35)		(1.81)	(1.49)	(1.54)	(1.05)	(1.03)	(1.00)
Anomaly FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760
R^2_{adj}	0.13	0.16	0.20	0.23	0.18	0.22	0.26	0.09	.	.	.
Instrumental variables											
α^{pre} × Post-1993									✓	✓	
α^{pre} × Postpub									✓		✓

The large estimated coefficient suggests that the time series of arbitrage position is indeed a noisy measure of actual arbitrage position and the two-stage approach identifies the effect of estimated arbitrage position changes that are more purely driven by actual arbitrage.

3. Funding liquidity

dot-com crash of 2000–2002 and the financial crisis of 2008–2009 as the periods in which arbitrageurs were constrained..

（3）Funding betas during const



arbitrage-driven betas arise primarily when arbitrageurs are constrained.

If funding betas were arbitrage-driven betas, they would arise primarily when arbitrageurs are constrained such that shocks to their capital that relax or tighten their constraint generate variation in arbitrage positions in the anomaly portfolios

3. Funding liquidity exposure

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（4）Funding betas as discount rate betas: cross-section of time-series return predictability

1st-stage time-series regression: $r^e_{i,t\to t+s} = \theta_0 + \theta_1 r^e_{i,t-L\to t} + \epsilon_{i,t\to t+s}$, $R^2_{\text{1st stage},i} = \frac{\sum_t (\hat{r}^e_{i,t\to t+s} - \overline{r^e_{i,+s}})^2}{\sum_t (r^e_{i,t\to t+s} - \overline{r^e_{i,+s}})^2}$

2nd-stage cross-sectional regression (baseline): $R^2_{\text{1st stage},i} = b_0 + b_1 \left|\beta_{funding,i}\right| + u_i$

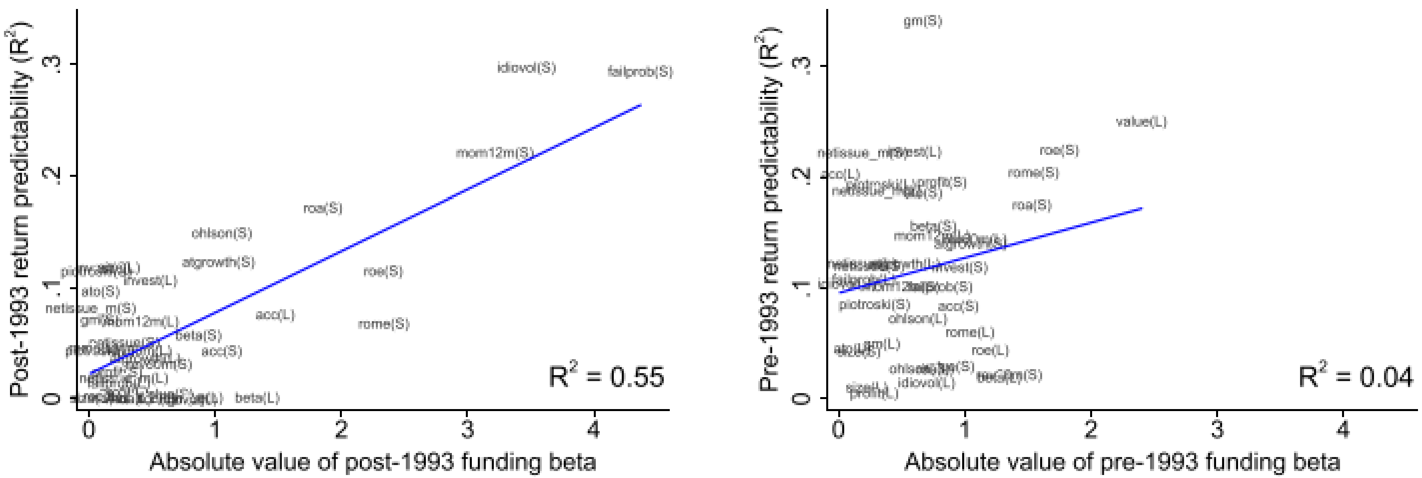
1st-stage prediction horizon s:	+12m return		+18m return		+24m return	
1st-stage predictor:	-3yr return	-5yr return	-3yr return	-5yr return	-3yr return	-5yr return
Right-hand variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Left-hand variable is the R^2 from 1st-stage predictive regressions in the post-1993 period						
$\lvert\beta^{post93}_{funding}\rvert$	**0.06**	**0.05**	**0.06**	**0.06**	**0.06**	**0.06**
	(2.22)	(2.19)	(2.31)	(2.27)	(2.27)	(2.23)
	[0.55]	[0.55]	[0.52]	[0.54]	[0.48]	[0.51]
$\lvert$Arbitrage position$^{post93}\rvert$	**0.12**	**0.11**	**0.13**	**0.12**	**0.12**	**0.12**
	(2.33)	(2.27)	(2.60)	(2.48)	(2.47)	(2.37)
	[0.58]	[0.56]	[0.54]	[0.53]	[0.51]	[0.51]
$\lvert\alpha^{pre93}\rvert$	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**
	(2.22)	(2.26)	(2.30)	(2.32)	(2.14)	(2.18)
	[0.47]	[0.49]	[0.41]	[0.44]	[0.39]	[0.42]
Panel B: Left-hand variable is the R^2 from 1st-stage predictive regressions in the pre-1993 period						
$\lvert\beta^{pre93}_{funding}\rvert$	0.03	0.04	0.04	0.04	0.05	0.05
	(0.87)	(1.03)	(1.09)	(1.16)	(1.31)	(1.40)
	[0.04]	[0.06]	[0.05]	[0.06]	[0.08]	[0.10]
$\lvert$Arbitrage position$^{pre93}\rvert$	−0.05	−0.04	−0.05	−0.04	−0.01	0.00
	(−0.30)	(−0.21)	(−0.28)	(−0.20)	(−0.08)	(0.02)
	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
$\lvert\alpha^{pre93}\rvert$	0.00	0.00	0.00	0.00	0.01	0.01
	(0.29)	(0.51)	(0.46)	(0.66)	(0.79)	(1.00)
	[0.01]	[0.02]	[0.01]	[0.02]	[0.04]	[0.06]

3. Funding liquidity exposure

（4）Funding betas as discount rate betas: cross-section of time-series return predictability

a. Post-1993 period

b. Pre-1993 period



Greater discount rate variation means greater variation in expected returns, so holding all else constant, portfolios with high funding betas should feature greater time-series return predictability.

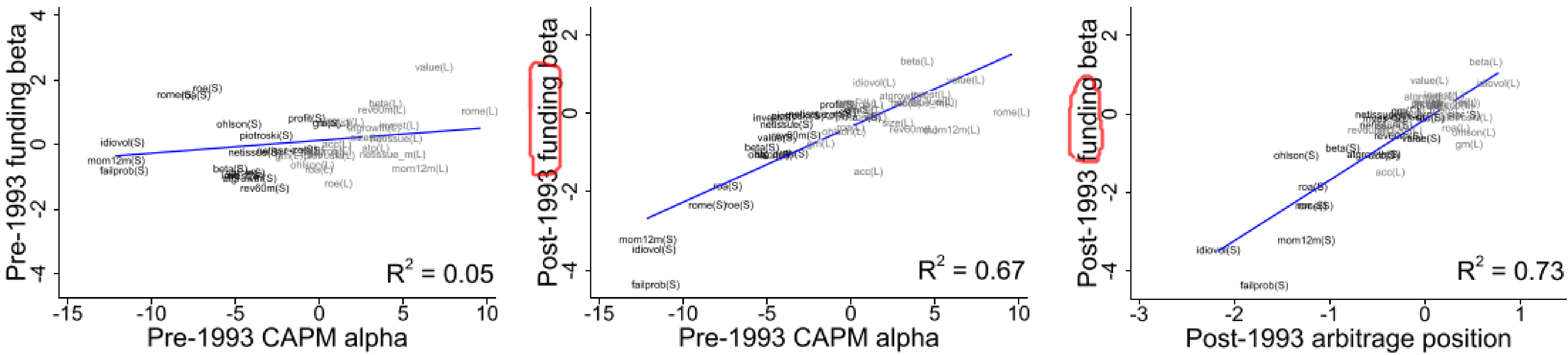
（1）Graphical evidence

Explaining the cross-section of arbitrageur wealth portfolio betas

a. Wealth βs unrelated to CAPM α (pre-93)

b. Pre-93 CAPM α predicts post-93 wealth β (post-93)

c. Arbitrage position explains post-93 wealth β (Post-93)



4. Exposure to arbitrageur wealth portfolio shocks

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（2）Cross-section of wealth portfolio betas

$$\beta^{post93}_{wealth,i} = b_0 + b_1 \text{ Arbitrage position}^{post93}_i + u_i$$

	β^{post93}_{wealth}								β^{pre93}_{wealth}		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Arbitrage position	**0.26**	**0.26**	**0.35**						−0.01		
	(2.73)	(2.61)	(2.16)						(−0.04)		
α^{pre93}_{CAPM}				**0.03**	**0.03**	**0.04**				−0.01	
				(3.13)	(2.80)	(2.91)				(−0.98)	
Share of wealth portfolio		0.46	0.37		0.36	0.48	1.79	1.34	0.33	0.37	0.32
		(0.75)	(0.52)		(0.55)	(0.68)	(1.84)	(1.67)	(0.60)	(0.72)	(0.61)
β^{pre93}_{wealth}		0.08			−0.24		−0.42				
		(0.41)			(−0.86)		(−1.32)				
Size rank			0.04			−0.00		−0.06	−0.03	−0.02	−0.03
			(0.61)			(−0.02)		(−0.90)	(−0.66)	(−1.13)	(−1.54)
Value rank			−0.01			−0.06		0.03	0.03	0.05	0.03
			(−0.22)			(−1.19)		(0.69)	(1.02)	(1.30)	(1.03)
Profitability rank			−0.01			−0.04		0.02	−0.03	−0.02	−0.03
			(−0.61)			(−1.12)		(0.65)	(−1.43)	(−0.75)	(−1.44)
Investment rank			−0.03			−0.04		0.00	−0.01	−0.02	−0.01
			(−1.05)			(−1.31)		(0.14)	(−0.82)	(−1.39)	(−1.11)
Constant	−0.00	0.02	0.15	−0.03	−0.01	0.65	0.02	−0.11	−0.11	−0.25	−0.11
	(−0.07)	(0.41)	(0.47)	(−0.83)	(−0.26)	(1.46)	(0.50)	(−0.23)	(−0.49)	(−0.98)	(−0.51)
Observations	40	40	40	40	40	40	40	40	40	40	40
R^2_{adj}	0.65	0.66	0.70	0.62	0.64	0.69	0.18	0.19	0.78	0.80	0.78

Both arbitrage position and pre-1993 CAPM alpha robustly explain the cross-sectional variation in wealth portfolio betas, In the pre-1993 period, wealth portfolio betas have little relation to arbitrage position or pre-1993 CAPM alpha.

（3）Additional evidence

a portfolio with a larger abnormal return attracts more arbitrage and attains a larger exposure to arbitrageur wealth portfolio shocks, consistent with the predictions of intermediary-based models.

5. Robustness

（1）Placebo factors

it is unlikely for a random factor to generate the strong results I obtain with the funding liquidity and the arbitrageur wealth portfolio factors. My monthly cross-sectional regression results are equally difficult to obtain using a random factor.

（2）The 1993 cutoff and other robustness checks

My cross-sectional analyses use the year 1993 to proxy for pre- versus post-arbitrage periods for anomalies, but my results are robust to using 1991, 1992, 1994, and 1995 as the end of the pre-arbitrage period

（3）A test without a factor: evidence from the quant crisis of 2007

Cumulative returns on anomaly portfolios during the crisis are cross-sectionally and strongly explained by their post-1993 arbitrage position and pre-1993 CAPM alpha. This is consistent with the key mechanism that generates a cross-section of arbitrage-driven betas.

6. conclusion

- This paper shows that financial intermediaries that act as arbitrageurs in the asset market play a crucial role in determining the equilibrium risk of assets.
- I show this in the context of equity anomaly portfolios, using funding liquidity and arbitrageur wealth portfolio shocks to measure risk from the perspective of arbitrageurs.
- My results suggest that asset pricing anomalies are, at least in part, alphas turned into betas.
- My findings in the equity market suggest that arbitrageurs may play similar risk determination roles in other asset classes. Understanding the sources of equilibrium risk exposure to arbitrage capital shocks in other asset markets.

THANKS
Q&A