Internet Appendix

Arbitrage Trading: the Long and the Short of It

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This Internet Appendix provides details of auxiliary analyses and robustness checks for the evidence presented in the main text. In Section I.1, we present the auxiliary results related to portfolio sorting on net arbitrage trading (NAT). Section I.2 contains robustness tests related to the Fama-MacBeth cross-sectional regression of stock returns on NAT. In Section I.3, we extend the examination of the relation between NAT and subsequent stock anomaly returns to 8 quarters. Section I.4 provides some evidence about the difference in anomaly characteristics between stocks traded by arbitrageurs and those not traded by arbitrageurs. Section I.5 considers institutional ownership as a measure of the difficulty to borrow stocks for short selling. Finally, in Section I.6, we examine pre-trends for pilot stocks and non-pilot stocks prior to Regulation SHO.

I.1 Auxiliary Tests of Portfolio Sorts

In this section, we perform several additional tests of portfolio sorts to assess the robustness of the predictive power of net arbitrage trading for stock returns in the cross section.

First, we present results from portfolio sorting for the base sample in some greater detail than in the main paper. As described in the main paper, our base sample excludes stocks with share price less than $5 and market capitalization below the 20th percentile size breakpoint of NYSE firms. The first section of Table I.1 reports the results, and Figure I.1 presents a graphical summary of hedge fund holdings and short interest in the sample in the back of this Internet Appendix.

We find that both abnormal hedge funds holdings (AHF), i.e., the long side, and abnormal short interest (ASR), i.e., the short side, have predictive power for future stock returns. However, the measure of net arbitrage trading exhibits stronger predictability than either the long or the short side. On average, stocks recently bought by arbitrageurs as a group (NAT-quintile 5) have a monthly excess return of 1.23% while stocks recently sold by arbitrageurs (NAT-quintile 1) have a monthly excess return of 0.49%. The high-minus-low NAT portfolio has a monthly return of 0.73% (t-value = 8.56). On a risk-adjusted basis, the monthly alpha of the high-minus-low NAT portfolio is 0.67% (t-value = 7.74) from the Fama-French (2015) five factor model.

Second, to assess the effect of the size filter on our inference, we perform portfolio sorting to the full sample by removing the restriction on firm size from our base sample. Specifically, we expand the base sample with stocks whose market capitalizations are below the 20th percentile breakpoint of NYSE firms at the time of portfolio formation. The results are presented in the second section of Table I.1. From the full sample, we continue to observe a strong predictive power of net arbitrage trading (NAT) for future stock returns. On average, stocks in the group NAT-5 have monthly excess return of 1.26% while those in NAT-1 have monthly excess return of 0.62%, which renders a monthly return spread of 0.63% (t-value = 9.04) for the high-minus-low NAT portfolio. Again, NAT exhibits stronger predictability than either the long or the short side alone. In addition, the return predictability holds on a risk-adjusted basis.

Third, we exclude firms whose hedge fund holdings or short interest equal to zero from the base sample. That is, we only keep stocks that have strictly positive hedge fund holdings and short interest in the sample. As reported in the third section of Table I.1, the result confirms that net arbitrage trading (NAT) significantly predicts stock returns in the cross section. For example, based on the Fama-French five factor model, the high-minus-low NAT portfolio shows a monthly alpha of 0.67% (t-value = 7.32). These results are very similar to those from the base sample.

Fourth, we examine whether our inference is robust to the sample period. In particular, we repeat our test to the base sample for the two halves of the entire sample period covering 1990:Q1–2002:Q4 and 2003:Q1–2015:Q4, respectively. Table I.2 reports the results. Over the first subperiod, the high-minus-low NAT portfolio has a Fama-French five factor alpha of 0.75% (t-value = 5.59) per month, while over the second subperiod the three factor alpha is slightly smaller at 0.62% (t-value = 5.45). Therefore, the evidence for both the subperiods suggests significant return predictability of net arbitrage trading.

In Panel C of Table 2 in the main paper, we ask whether NAT simply combines the return predictive power of AHF and ASR. There, to gauge the combined return predictive power, we perform a two-way independent sort on AHF and ASR. At the end of each quarter, we form tercile portfolios based on AHF and independently form tercile portfolios based on ASR. Then, 9 AHF-ASR portfolios are taken from the intersections of these two sets of tercile portfolios. We report an average excess return of 1.22% for stocks with high AHF and low ASR, and 0.44% for stocks with high ASR and low AHF. So the corresponding return spread of 0.78% measures the combined return predictive power of AHF and ASR, and the spread remains significant at 0.65% after five-factor risk adjustment.

Here, the comparable measure of NAT's return predictability is the high-minus-low portfolio average excess return from sorting the same stocks into 9 portfolios using NAT. Table I.3 reports the returns on the portfolios. The corresponding high-minus-low return spread is 0.85% and remains 0.81% after five-factor risk adjustment, which is higher than its counterpart from the double sort above. Comparing the single sort results to those from the double sort, we conclude that NAT is a better measure of arbitrage trading while both AHF and ASR are incomplete proxies.

Next, we first normalize HF and SR by the aggregate level of institutional ownership (IO), and then compute AHFIO, ASRIO, and eventually NATIO using the scaled HF and SR. Here, the aggregate institutional ownership serves as a proxy for the total supply of borrowable shares on a stock. Table I.4 presents the results. The high-minus-low NATIO portfolio has a monthly alpha of 0.60% (t-value = 6.92) based on the Fama-French five factor model. The return predictability lasts for at least two quarters. These results are similar to those presented in the main paper, suggesting that our inference is robust to the scaling of IO.

Finally, we replace abnormal hedge funds holdings with abnormal institutional holdings, to check whether institutional ownership (IO) can also capture arbitrage trading. Table I.5 reports the results of double sorting on abnormal institutional holdings (AIO) and abnormal short interest (ASR), with AIO defined similarly to AHF. Interestingly, the result is dramatically different from that based on AHF. The level of AIO does not predict future stock return or alpha. Furthermore, there is no predictive power even when AIO is combined with ASR. This suggests that hedge funds, as organized arbitrageurs, are substantially different from other types of institutional investors, consistent with the finding of Cao, Chen, Goetzmann, and Liang (2017).

I.2 Robustness Checks to the Fama-MacBeth Regressions

We perform robust checks to the Fama-MacBeth regressions in this section. First, we restrict our sample to only stocks that have strictly positive hedge fund holdings and short interest. Panel A of Table I.6 reports the results. Based on this sample, the measure of net arbitrage trading (NAT) is still significantly associated with stock return in the next quarter, even after controlling for other stock return predictors. In particular, the average regression coefficient on NAT is 0.23% (t-value = 4.31). That is, when NAT increases by one standard deviation in a quarter, the stock return will, on average, rise by 0.23% per month in the next quarter.

Next, we repeat the Fama-MacBeth analysis for the two subperiods of 1990:Q1–2002:Q4 and 2003:Q1–2015:Q4. The results are reported in Panels B and C of Table I.6. For the first subperiod, the regression coefficient on NAT is 0.21% (t-value = 4.69). For the second subperiod, the regression coefficient on NAT is 0.16% (t-value = 4.97). This result corroborates the evidence from portfolio sorting presented above, and the predictability of NAT for stock returns is consistent over both the subperiods.

Finally, note that NAT exhibits significant forecasting power for stock returns after we have controlled for various stock characteristics that previous studies have shown to predict stock returns in the cross section. This suggests that the information possessed by arbitrageurs, revealed by NAT, goes beyond a simple linear combination of well-known stock anomalies.

I.3 NAT and Anomaly Return in the Long Run

In this section, we further examine the relation between NAT and stock anomaly returns by extending the horizon of tracking subsequent stock returns to up to 8 quarters. As described in the main paper, we examine a set of 10 anomalies, including book-to-market ratio, gross profitability, operating profit, momentum, market capitalization, asset growth, investment-to-capital ratio, net stock issues, accrual, and net operating assets. These anomalies have been documented in the previous literature.[1]

First, as shown in Panel A of Table I.7, the long-minus-short spreads in future returns averaged across the anomalies are both economically and statistically significant. Even on a risk-adjusted basis (using the Fama-French five factors), the monthly alpha of the long-short portfolio built on these anomalies is around 0.14%–0.17% and statistically significant at the 5% level in the first 5 quarters after portfolio formation. By extending the horizon to 8 quarters, we do not find return reversal in the long run. This finding is in line with the previous studies on stock anomalies.

More importantly, among anomaly stocks we identify those traded by arbitrageurs. We classify an anomaly stock to be traded by arbitrageurs if it is in the long portfolio and recently bought by arbitrageurs (its NAT belongs to the top 30%), or it is in the short portfolio and recently sold short (its NAT belongs to the bottom 30%). As shown in Panels B and C of Table I.7, anomaly returns are completely driven by stocks traded by arbitrageurs. The long-short portfolio of anomaly stocks traded by arbitrageurs delivers a monthly Fama-French five factor alpha of 0.71% (t-value = 7.31), which is much larger than the value of 0.17% associated with all anomaly stocks. This alpha gradually decreases to about 0.27% (t-value = 2.79) in 5 quarters post portfolio formation. While the alpha is statistically insignificant afterwards, there is no return

[1] As an incomplete list, see Banz (1981), Rosenberg, Reid, and Lanstein (1985), Ritter (1991), Fama and French (1993), Jegadeesh and Titman (1993), Loughran and Ritter (1995), Sloan (1996), Hirshleifer, Hou, Teoh, and Zhang (2004), Cooper, Gulen, and Schill (2008), Fama and French (2008), Xing (2008), Novy-Marx (2013), Fama and French (2015), and Hou, Xue, and Zhang (2015).

reversal. In addition, the alpha comes mostly from the short leg, consistent with the finding of Stambaugh, Yu, and Yuan (2012).

Meanwhile, anomaly stocks that are not traded by arbitrageurs earn much smaller return spreads. In fact, the alpha of the long-short portfolio is statistically insignificant in any of the 8 quarters after portfolio formation. This is also the case for both the long and the short leg. The finding that abnormal returns appear only among anomaly stocks traded by arbitrageurs is consistent with the hypothesis that arbitrageurs are informative about stock mispricing.

I.4 NAT and Anomaly Characteristics

In this section, we examine the relation between net arbitrage trading and anomaly characteristics in the cross section. In particular, for each of the 10 stock anomalies, we compare the anomaly characteristic between stocks traded by arbitrageurs and stocks not traded by arbitrageurs. At the end of each quarter, for the long leg, we identify stocks traded by arbitrageurs as those having NAT in the top 30%, and stocks not traded by arbitrageurs as those having NAT in the middle 40%. For these two portfolios (traded and not-traded by arbitrageurs), we compute the difference in portfolio-level anomaly characteristic by equal-averaging stocks in each portfolio. Similarly, for the short leg, we identify stocks traded by arbitrageurs as those having NAT in the bottom 30%, and stocks not traded by arbitrageurs as those having NAT in the middle 40%.

Table I.8 reports the results. For the long leg, we find some evidence that arbitragers tend to trade stocks with higher book-to-market ratio, higher operating profit, higher gross profit, higher momentum, and smaller size, lower asset growth, lower investment, lower accrual, lower net stock issue, and lower net operating assets. Thus, arbitragers seem to trade in the right direction in terms of picking stock characteristics. A similar pattern exists for the short leg. However, the differences in these anomaly characteristics are generally small. In addition, our earlier results from the Fama-MacBeth regressions (Section 2.5 of the main paper and Section I.2

of this Internet Appendix) suggest that arbitragers are not simply trading stocks with extreme characteristics but use information beyond a simple combination of well-known stock anomalies.

I.5. Institutional Ownership and Anomaly Returns Based on NAT

For each anomaly, on the short leg, we identify those stocks that have high (top 10%) and low (bottom 10%) institutional ownership (IO). Then, within the short leg–high IO group and the short leg–low IO group, we identify stocks traded by arbitrages as those stocks that have low NAT (bottom 30%). We repeat similar analysis for the long leg as well. The conjecture is that IO may have implications for arbitrage trading and future returns, since low IO stocks tend to be hard to borrow, hence hard to short and realize low future returns. Table I.9 reports the results. The average monthly return over the next eight quarters is 0.16% for low IO stocks and 0.50% for high IO stocks, consistent with the notion that low-IO stocks in the short leg is indeed more overpriced. The return difference after Fama-French five-factor risk adjustment becomes smaller. The average monthly abnormal return over the next eight quarters is -0.49% for low IO stocks and -0.39% for high IO stocks, suggesting that IO is likely chosen endogenously and therefore correlated with stock characteristics underlying the Fama-French risk factors. For this reason, we focus on using Regulation SHO as an instrument for generating random variation in short-sale constraints.

I.6. Testing Pre-trends of Pilot and Non-pilot Stocks

In the main paper, we exploit Regulation SHO as an instrument for limits-to-arbitrage. Regulation SHO relaxed short-sale restrictions for a random set of pilot stocks from the Russell 3000 index, which reduced limits-to-arbitrage while having little effect on ex ante mispricing. This feature helps isolate the impact of limits-to-arbitrage on arbitrage activity. Here, we test pre-trends of pilot stocks and non-pilot stocks prior to Regulation SHO.

In our analysis the pilot period is defined as June 2005–July 2007. We examine the difference in average short interest between pilot stocks and non-pilots over each of the four years before 2005. As shown in Table I.10, there are no pre-trends for pilot stocks and non-pilot stocks prior to Regulation SHO. This finding, together with those results described in Section 3.3 of the main paper, supports Regulation SHO as a valid instrument of limits-to-arbitrage.

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Table I.1 Portfolio Sorts

At the end of each quarter, we form stock portfolios based on abnormal hedge fund holdings (AHF), abnormal short interest (ASR), or net arbitrage trading (NAT) defined as the difference between AHF and ASR, and track their monthly excess returns in the next quarter as the equal-weighted average of excess returns on all stocks in each portfolio. We adjust for risk exposures using the Fama-French five factors (FF5). Panels A, B, and C present results for the quintile portfolios formed on AHF, ASR, and NAT, respectively. In each panel, the left columns present excess returns and alphas, while the right columns report their t-values. Section I is our base sample, for which, in each quarter, we exclude firms with market capitalization below the 20th percentile size breakpoint of NYSE firms. Section II removes the restriction on firm size applied in our base sample by expanding the base sample with stocks whose market capitalizations are below the 20th percentile breakpoint of NYSE firms. Section III restricts our sample to stocks that have strictly positive hedge fund holdings (HF) and short interest (SR). Returns and alphas are in percent per month. The sample period is from 1990:Q1 to 2015:Q4.

	Section I: Base Sample				Section II: Full Sample				Section III: HF>0, SR>0			
	Ret.	FF5	t(Ret.)	t(FF5)	Ret.	FF5	t(Ret.)	t(FF5)	Ret.	FF5	t(Ret.)	t(FF5)
Panel A: Quintile Portfolios Formed on AHF												
AHF1	0.70	-0.08	2.11	-1.04	0.83	0.11	2.33	0.97	0.74	-0.05	2.21	-0.62
AHF2	0.62	-0.15	2.20	-1.97	0.92	0.28	2.94	2.16	0.65	-0.12	2.27	-1.60
AHF3	0.75	-0.05	3.06	-0.80	1.19	0.67	4.32	4.66	0.83	0.00	3.26	0.08
AHF4	0.90	0.07	3.19	1.15	0.99	0.28	3.54	2.94	0.92	0.07	3.18	1.08
AHF5	1.18	0.36	3.44	4.41	1.21	0.43	3.58	5.02	1.21	0.37	3.44	4.17
AHF-HML	0.48	0.44	5.24	4.87	0.38	0.32	4.92	4.01	0.47	0.42	4.86	4.32
Panel B: Quintile Portfolios Formed on ASR												
ASR1	1.01	0.18	3.14	2.41	1.07	0.35	2.86	2.33	1.05	0.21	3.22	2.63
ASR2	0.95	0.10	3.59	1.67	1.18	0.51	4.00	4.24	0.96	0.10	3.54	1.69
ASR3	0.84	0.05	3.30	0.72	1.31	0.74	4.92	5.62	0.93	0.11	3.57	1.78
ASR4	0.78	0.00	2.75	0.06	1.07	0.40	3.87	3.88	0.82	0.03	2.85	0.48
ASR5	0.58	-0.18	1.61	-1.95	0.51	-0.21	1.44	-2.28	0.58	-0.19	1.58	-1.96
ASR-HML	-0.43	-0.36	-4.43	-4.06	-0.56	-0.56	-5.18	-4.92	-0.47	-0.41	-4.53	-4.24
Panel C: Quintile Portfolios Formed on NAT												
NAT1	0.49	-0.28	1.41	-3.29	0.62	-0.10	1.74	-1.01	0.51	-0.28	1.43	-3.11
NAT2	0.67	-0.11	2.38	-1.44	0.92	0.26	3.22	2.59	0.70	-0.09	2.42	-1.14
NAT3	0.79	0.03	3.22	0.43	1.23	0.71	4.70	5.32	0.87	0.07	3.41	1.12
NAT4	0.97	0.12	3.57	2.00	1.11	0.42	3.80	3.86	1.03	0.18	3.73	2.85
NAT5	1.23	0.39	3.67	5.05	1.26	0.50	3.54	4.43	1.25	0.39	3.65	4.72
NAT-HML	0.73	0.67	8.56	7.74	0.63	0.60	9.04	8.31	0.74	0.67	8.25	7.32

Table I.2 Portfolio Sorts for Subperiods

In this table, we split our sample period into two halves and examine the subperiods separately. At the end of each quarter, we form stock portfolios based on abnormal hedge fund holdings (AHF), abnormal short interest (ASR), or net arbitrage trading (NAT) defined as the difference between AHF and ASR, and track their monthly excess returns in the next quarter as the equal-weighted average of excess returns on all stocks in each portfolio. We adjust for risk exposures using the Fama-French five factors (FF5). In each quarter, we exclude firms with market capitalization below the 20th percentile size breakpoint of NYSE firms. Panels A, B, and C present results for the quintile portfolios formed on AHF, ASR, and NAT, respectively. In each panel, the left columns present excess returns and alphas, while the right columns report their t-values. Returns and alphas are in percent per month. Section I covers 1990:Q1–2002:Q4 and Section II covers 2003:Q1–2015:Q4.

	Section I: Subperiod 1990:Q1-2002:Q4				Section II: Subperiod 2003:Q1-2015:Q4			
	Ret.	FF5	t(Ret.)	t(FF5)	Ret.	FF5	t(Ret.)	t(FF5)
Panel A: Quintile Portfolios Formed on AHF								
AHF1	0.48	-0.15	0.98	-1.15	0.92	-0.01	2.07	-0.08
AHF2	0.46	-0.18	1.19	-1.44	0.78	-0.09	1.88	-1.26
AHF3	0.58	-0.16	1.82	-1.58	0.92	0.06	2.46	1.17
AHF4	0.72	-0.04	1.82	-0.43	1.09	0.19	2.67	2.91
AHF5	1.03	0.30	2.01	2.28	1.33	0.41	2.92	4.48
AHF-HML	0.55	0.45	3.59	2.93	0.41	0.42	4.09	4.20
Panel B: Quintile Portfolios Formed on ASR								
ASR1	0.91	0.21	1.95	1.75	1.11	0.17	2.51	2.01
ASR2	0.88	0.11	2.53	1.22	1.02	0.12	2.55	1.60
ASR3	0.62	-0.13	1.85	-1.32	1.05	0.22	2.77	3.48
ASR4	0.58	-0.11	1.44	-1.01	0.98	0.12	2.43	1.55
ASR5	0.29	-0.32	0.53	-2.09	0.87	-0.06	1.85	-0.57
ASR-HML	-0.61	-0.53	-4.04	-4.09	-0.25	-0.23	-2.05	-1.96
Panel C: Quintile Portfolios Formed on NAT								
NAT1	0.21	-0.42	0.39	-3.01	0.78	-0.16	1.71	-1.70
NAT2	0.49	-0.19	1.24	-1.50	0.86	-0.01	2.11	-0.15
NAT3	0.67	-0.01	2.10	-0.16	0.92	0.08	2.43	1.32
NAT4	0.85	0.07	2.32	0.70	1.08	0.20	2.71	3.32
NAT5	1.06	0.33	2.16	2.73	1.39	0.46	3.08	4.71
NAT-HML	0.86	0.75	6.47	5.59	0.61	0.62	5.63	5.45

Table I.3 Nine Portfolios Based on NAT

At the end of each quarter, we form 9 stock portfolios based on net arbitrage trading (NAT) defined as the difference between AHF and ASR, and track their monthly excess returns in the next quarter as the equal-weighted average of excess returns on all stocks in each portfolio. We adjust for risk exposures using the Fama-French five factors (FF5). Portfolio 9 has the highest value of NAT and Portfolio 1 has the lowest value of NAT. In each panel, the left columns present excess returns and alphas, while the right columns report their t-values. In each quarter, we exclude firms with market capitalization below the 20th percentile size breakpoint of NYSE firms. Returns and alphas are in percent per month. The sample period is from 1990:Q1 to 2015:Q4.

	Ret.	FF5	t(Ret.)	t(FF5)
NAT1	0.46	-0.31	1.21	-2.92
NAT2	0.53	-0.27	1.66	-3.21
NAT3	0.70	-0.06	2.42	-0.72
NAT4	0.69	-0.07	2.63	-0.99
NAT5	0.79	0.01	3.21	0.14
NAT6	0.90	0.09	3.54	1.45
NAT7	1.01	0.16	3.66	2.41
NAT8	1.08	0.23	3.51	2.99
NAT9	1.31	0.50	3.67	5.17
NAT-HML	0.85	0.81	7.69	7.12

Table I.4 Portfolio Sorts on NATIO

In this table, we repeat the quintile NAT sorting but with HF and SR scaled by total institutional ownership (IO). Accordingly, the variable NATIO represents the NAT constructed using scaled HF and SR. At the end of each quarter, we form quintile portfolios based on the NATIO and track their monthly excess returns in the next quarters. Quintile 5 has the highest values of NATIO. We adjust for risk exposures using the Fama-French five factors (FF5). Returns and alphas are in percent per month. The sample period is from 1990:Q1 to 2015:Q4.

	Ret.	FF5	t(Ret.)	t(FF5)
Panel A: Quintile Portfolios Formed on AHFSRIO				
NATIO1	0.50	-0.24	1.41	-2.92
NATIO2	0.71	-0.10	2.55	-1.30
NATIO3	0.79	-0.03	3.07	-0.38
NATIO4	0.99	0.15	3.65	2.56
NATIO5	1.17	0.36	3.55	4.86
NATIO-HML	0.68	0.60	7.71	6.92

Panel B: Return Spread in Subsequent Quarters

	Return Spread				t-value			
Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
NATIO-HML	0.68	0.37	0.17	0.05	7.71	4.00	1.88	0.52
FF5	0.60	0.31	0.18	0.07	6.92	3.36	1.86	0.79

Table I.5 Double Sorts on AIO and ASR

In this table, we present results of double sorts on abnormal institutional ownership (AIO) and abnormal short interest (ASR). We adjust for risk exposures using the Fama-French five factors (FF5). In each panel, the left columns present excess returns and alphas, while the right columns report their t-values. Returns and alphas are in percent per month. The sample period is from 1990:Q1 to 2015:Q4.

	Excess Return and Alpha				t-value			
	AIO1	AIO2	AIO3	AIO-HML	AIO1	AIO2	AIO3	AIO-HML
Panel A: Excess Return								
ASR1	1.04	0.90	0.81	-0.23	3.32	3.32	2.44	-1.92
ASR2	1.01	0.79	0.89	-0.12	3.81	3.29	3.01	-1.14
ASR3	0.65	0.61	0.71	0.07	1.81	2.07	1.99	0.42
ASR-HML	-0.39	-0.29	-0.09		-3.53	-2.93	-0.86	
Panel B: FF5 Alpha								
ASR1	0.22	0.03	-0.01	-0.23	2.49	0.35	-0.12	-1.93
ASR2	0.22	-0.01	0.06	-0.16	2.70	-0.16	0.70	-1.64
ASR3	-0.12	-0.20	-0.03	0.10	-0.88	-2.25	-0.30	0.63
ASR-HML	-0.34	-0.23	-0.01		-3.13	-2.32	-0.14	
Panel C: Extreme Portfolios								
	Excess Return				t-value			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
AIO3, ASR1	0.81	0.86	0.83	1.06	2.44	2.49	2.36	2.93
AIO1, ASR3	0.65	0.89	0.80	1.07	1.81	2.49	2.31	2.94
Diff.	0.16	-0.03	0.03	-0.01	0.97	-0.19	0.19	-0.04
	FF5 Alpha				t-value			
AIO3, ASR1	-0.01	0.01	0.03	0.09	-0.12	0.09	0.21	0.70
AIO1, ASR3	-0.12	0.13	-0.05	0.10	-0.88	0.90	-0.35	0.70
Diff.	0.11	-0.12	0.07	0.00	0.66	-0.76	0.49	-0.02

Table I.6 Fama-MacBeth Regressions

In Panel A, we restrict our sample to stocks that have strictly positive hedge fund holdings (HF) and short interest (SR). We perform Fama-MacBeth regressions of average monthly stock excess returns over the next quarter on AHF, ASR, or NAT of the current quarter. The control variables include book-to-market ratio (BM), gross profitability (GP), operating profit (OP), momentum (MOM), market capitalization (MC), asset growth (AG), investment growth (IK), net stock issues (NS), accrual (AC), and net operating assets (NOA). We take natural logs for BM and MC. All the explanatory variables are winsorized at 1% and 99% levels and standardized at the end of each quarter. Stock excess returns are in percent per month. The t-values, reported in parentheses, use Newey-West standard errors with four lags. The sample period is from 1990:Q1 to 2015:Q4. Panels B and C split the entire sample period into two halves.

	Dependent Variable = Excess Return in the Next Quarter								
	Panel A: HF>0 and SR>0			Panel B: 1990-2002			Panel C: 2003-2015		
AHF	0.062			0.100			0.127		
t-value	1.08			2.31			4.08		
ASR		-0.236			-0.187			-0.081	
t-value		-3.61			-3.98			-2.29	
NAT			0.228			0.208			0.157
t-value			4.31			4.69			4.97
Stock characteristics as control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.073	0.076	0.074	0.063	0.064	0.063	0.049	0.050	0.050

Table I.7 Net Arbitrage Trading and Stock Anomaly Returns in the Long Run

For each return anomaly, at the end of each quarter, we construct quintile portfolios and compute monthly portfolio returns in the next 8 quarters (Q1 to Q8). In Panel A, we report the return spread between the long- and the short-leg of anomaly stocks. The column "Avg." reports results for a portfolio equally-investing in the 10 anomalies. Based on the Fama-French five factor model, we report the alphas for the long-minus-short strategy of the composite portfolios, denoted Alpha(LMS); the long portfolio Alpha(L); and the short portfolio Alpha(S). Similar analysis is performed to the mispricing measure MISP of Stambaugh, Yu, and Yuan (2015), where the alphas are denoted Alpha(LMS)MISP, Alpha(L)MISP, and Alpha(S)MISP. Next, at the end of each quarter, for the long leg, we identify stocks traded by arbitrageurs as those belonging to the NAT group 3 (top 30%), and those not traded by arbitrageurs as those stocks that have middle 40% values of NAT. Similarly, for the short leg, we identify stocks traded by arbitrageurs as those belonging to the NAT group 1 (bottom 30%), and those not traded by arbitrageurs as those stocks that have middle 40% values of NAT. We track monthly equal-weighted average returns of these four portfolios. In Panel B, we report the return spread between the long- and the short-leg of anomaly stocks traded by arbitrageurs. In Panel C, we report the return spread between the long- and short-leg of anomaly stocks not traded by arbitrageurs. Returns and alphas are in percent per month. The sample period is from 1990:Q1 to 2015:Q4.

	Avg	Alpha (LMS)	Alpha (L)	Alpha (S)	Avg	Alpha (LMS)	Alpha (L)	Alpha (S)	Avg	Alpha (LMS)	Alpha (L)	Alpha (S)
	Panel A: Return Spread				Panel B: Traded				Panel C: Not Traded			
Q1	0.29	0.17	0.02	-0.15	0.88	0.71	0.28	-0.43	0.01	-0.08	-0.10	-0.01
Q2	0.26	0.16	0.01	-0.15	0.60	0.45	0.13	-0.32	0.10	0.02	-0.05	-0.07
Q3	0.22	0.15	0.01	-0.14	0.41	0.33	0.07	-0.26	0.13	0.06	-0.02	-0.08
Q4	0.20	0.14	0.02	-0.12	0.32	0.26	0.05	-0.21	0.13	0.08	0.01	-0.07
Q5	0.20	0.15	0.03	-0.12	0.32	0.27	0.10	-0.17	0.14	0.09	0.00	-0.09
Q6	0.14	0.09	0.00	-0.09	0.20	0.11	0.02	-0.09	0.11	0.09	0.00	-0.09
Q7	0.14	0.09	0.02	-0.08	0.24	0.18	0.03	-0.14	0.08	0.05	0.01	-0.04
Q8	0.09	0.05	-0.01	-0.06	0.18	0.12	-0.01	-0.12	0.05	0.01	-0.01	-0.03
						t-value						
Q1	4.44	3.24	0.47	-2.10	7.95	7.31	4.33	-4.62	0.22	-1.39	-1.92	-0.20
Q2	4.17	2.89	0.15	-1.95	5.46	4.45	1.83	-3.08	1.71	0.41	-0.74	-0.94
Q3	3.58	2.50	0.11	-1.70	4.04	3.21	0.85	-2.50	2.05	0.96	-0.30	-0.99
Q4	3.47	2.57	0.32	-1.46	3.25	2.50	0.54	-2.00	2.22	1.40	0.16	-0.88
Q5	3.48	2.72	0.47	-1.44	3.47	2.79	1.11	-1.69	2.32	1.59	0.05	-1.12
Q6	2.57	1.87	0.05	-1.10	2.08	1.18	0.19	-0.92	2.10	1.74	-0.07	-1.18
Q7	2.67	1.98	0.25	-0.97	2.52	1.90	0.35	-1.55	1.60	1.03	0.14	-0.53
Q8	1.80	1.01	-0.14	-0.75	1.85	1.31	-0.06	-1.27	0.99	0.25	-0.20	-0.36

Table I.8 Differences in Characteristics of Anomaly Stocks Traded and Not Traded

At the end of each quarter, for the long leg, we identify stocks traded by arbitrageurs as those belonging to the NAT group 3 (the top 30%), and stocks not traded by arbitrageurs as those that have middle 40% values of NAT. Similarly, for the short leg, we identify stocks traded by arbitrageurs as those belonging to the NAT group 1 (the bottom 30%), and stocks not traded by arbitrageurs as those that have middle 40% values of NAT. For these two portfolios (Trades and Not Traded), we compute the portfolio-level anomaly characteristic by equal-averaging stocks in each portfolio. Panel A presents the difference in characteristics between the "Traded" portfolio and the "Not Traded" portfolio for the long-leg of each anomaly. Panel B repeats this analysis for the short-leg. The anomaly characteristics are in their original units.

	BM	GP	OP	MOM	MC	AG	IK	NS	AC	NOA
Panel A: Traded – Not Traded, Long Leg										
Traded	1.203	0.718	1.800	0.618	440	-0.085	-0.420	-0.050	-0.199	0.143
Not traded	1.165	0.712	1.772	0.600	444	-0.079	-0.411	-0.045	-0.188	0.145
Difference	0.038	0.006	0.027	0.017	-4	-0.006	-0.006	-0.005	-0.005	-0.002
t-value	3.17	1.79	1.32	3.98	-2.79	-3.06	-3.06	-6.07	-6.07	-0.60
Panel B: Traded – Not Traded, Short Leg										
Traded	0.150	0.010	0.060	-0.380	11690	0.720	1.860	0.240	0.230	1.080
Not traded	0.160	0.030	0.110	-0.340	15201	0.650	1.690	0.220	0.210	1.030
Difference	-0.010	-0.020	-0.050	-0.040	-3511	0.070	0.070	0.020	0.020	0.040
t-value	-5.89	-5.60	-6.80	-7.94	-12.98	5.54	5.54	3.92	3.92	10.01

Table I.9 Institutional Ownership and Anomaly Returns Based on NAT

For each return anomaly, at the end of each quarter, we identify stocks in the long leg with low or high institutional ownership (IO). Then, among low and high IO groups, we identify stocks traded by arbitrageurs as those belonging to the NAT group 3 (top 30% of values of NAT). Low (High) IO contains stocks whose values of IO are at the bottom (Top) 10%. Similarly, for the short leg, we identify stocks traded by arbitrageurs as those belonging to the NAT group 1 (bottom 30%). We track monthly equal-weighted average returns of the long leg (L), short leg (S) and long-minus-short (LMS) portfolios in the next eight quarters (Q1-Q8). We consider the following anomalies: book-to-market ratio (BM); gross profitability (GP); operating profit (OP); momentum (MOM); market capitalization (MC); asset growth (AG); investment growth (IK); net stock issues (NS); accrual (AC); net operating assets (NOA) and the mispricing measure (MISP). Results are average across anomalies. The FF5 stands for abnormal returns based on the Fama-French five factors. Returns and alphas are in percent per month. The sample period is from 1990 to 2015.

	Low IO						High IO				
	Port	Ret	t-value	FF5	t-value		Port	Ret	t-value	FF5	t-value
Q1	S	-0.22	-0.58	-0.77	-4.88	Q1	S	0.09	0.28	-0.73	-4.59
Q2	S	0.01	0.02	-0.52	-2.94	Q2	S	0.25	0.71	-0.61	-3.78
Q3	S	-0.02	-0.06	-0.57	-3.12	Q3	S	0.36	1.01	-0.53	-3.17
Q4	S	0.20	0.54	-0.46	-2.34	Q4	S	0.70	1.99	-0.26	-1.58
Q5	S	0.29	0.82	-0.45	-2.45	Q5	S	0.61	1.75	-0.30	-1.90
Q6	S	0.21	0.62	-0.48	-2.74	Q6	S	0.65	1.83	-0.18	-1.12
Q7	S	0.37	1.04	-0.35	-2.13	Q7	S	0.54	1.54	-0.38	-2.36
Q8	S	0.41	1.21	-0.33	-2.01	Q8	S	0.77	2.15	-0.14	-0.85
Q1	L	0.83	2.60	0.00	0.00	Q1	L	1.06	3.06	0.11	0.70
Q2	L	1.00	3.11	0.26	1.97	Q2	L	0.88	2.55	-0.09	-0.57
Q3	L	0.81	2.52	0.12	0.83	Q3	L	0.86	2.54	-0.01	-0.08
Q4	L	0.91	2.79	0.08	0.51	Q4	L	0.82	2.37	-0.20	-1.20
Q5	L	1.01	3.03	0.17	1.09	Q5	L	0.77	2.27	-0.19	-1.26
Q6	L	0.91	2.76	0.11	0.72	Q6	L	0.58	1.67	-0.39	-2.34
Q7	L	0.82	2.55	-0.02	-0.15	Q7	L	0.79	2.20	-0.23	-1.39
Q8	L	0.67	1.97	-0.23	-1.35	Q8	L	0.78	2.16	-0.18	-1.02
Q1	LMS	1.06	5.21	0.78	4.18	Q1	LMS	0.97	5.29	0.84	4.39
Q2	LMS	0.99	4.65	0.77	3.77	Q2	LMS	0.65	3.52	0.55	2.89
Q3	LMS	0.83	3.96	0.69	3.21	Q3	LMS	0.45	2.47	0.46	2.39
Q4	LMS	0.70	3.22	0.54	2.39	Q4	LMS	0.10	0.50	0.03	0.12
Q5	LMS	0.72	3.68	0.61	2.99	Q5	LMS	0.09	0.48	0.06	0.31
Q6	LMS	0.69	3.46	0.59	2.87	Q6	LMS	0.01	0.03	-0.14	-0.71
Q7	LMS	0.45	2.15	0.32	1.56	Q7	LMS	0.25	1.39	0.14	0.71
Q8	LMS	0.26	1.28	0.11	0.52	Q8	LMS	0.03	0.16	-0.02	-0.08

Table I.10 Testing Pre-trends for Pilot and Non-pilot Stocks

This table tests pre-trends for pilot stocks and non-pilot stocks prior to Regulation SHO. Pilot stocks are the stocks in the Russell 3000 index with short-sale constraints relaxed due to Regulation SHO during the pilot period. The pilot period is defined as June 2005–July 2007. We present the average short interest for pilot stocks and non-pilot stocks in each of the four years prior to 2005. Short interest is reported in percent.

Short interest	2001	2002	2003	2004
Pilot	2.10	2.70	3.38	3.85
Non-Pilot	2.06	2.67	3.30	3.71
Difference	0.04	0.03	0.08	0.14
t-value	0.77	0.52	1.07	1.75

Figure I.1 Average Hedge Fund Holdings and Short Interest over Time

We plot value-weighted average, across the sample stocks, of the following variables: hedge fund holdings (HF), defined as the ratio between shares owned by hedge funds and the number of outstanding shares; short interest (SR), defined as the ratio between shares shorted and the number of shares outstanding; abnormal hedge fund holdings (AHF), defined as the percentage change of HF from its average over the previous four quarters; abnormal short ratio (ASR), defined as the percentage change of SR from its average over the previous four quarters; the difference between HF and SR (HFSR). The sample period is from 1990:Q1 to 2015:Q4.