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Short selling meets hedge fund 13F: An anatomy of online 16 September 2016

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ABSTRACT

The existing literature treats the short side (i.e., short selling) and the long side of hedge fund trading (i.e., fund holdings) independently. The two sides, however, complement each other: opposite changes in the two are likely to be driven by information, whereas simultaneous increases (decreases) of the two may be motivated by hedging (unwinding) considerations. We use this intuition to identify informed demand and document that it exhibits highly significant predictive power

Cohen, Diether, and Malloy, 2007; Boehmer, Jones, and Zhang, 2008; Boehmer, Huszar, and Jordan, 2010; Sa and Sigurdsson, 2011; Hirshleifer, Teoh, and Yu, 2011; Akbas, Boehmer, Erturk, Sorescu, 2013; Boehmer and Wu, 2013). The question of whether managers are informed and whether they can deliver superior performance is also at the core of the analysis of the hedge fund industry (e.g., Fung and Hsieh, 1997; Ackermann, McEnally, and Ravenscraft, 1999; Agarwal and Naik, 2004; Getmansky, Lo, and Makarov, 2004; Kosowski, Naik, and Teo, 2007; Agarwal, Daniel, and Naik, 2009, 2011; Aragon and Nanda, 2012; Sun, Wang, and Zheng, 2012; and Cao, Chen, Liang, and Lo, 2013, just to name a few).

However, a *joint* analysis of hedge funds and short selling—for instance, regarding changes in both hedge fund holdings and short interest—is lacking in the literature. This inattention is surprising because joint information is needed in many situations to understand motivations for hedge fund trading. Consider, for instance, the case in which aggregate hedge fund ownership of a specific stock increases. While such a “net buy” may be driven by private information that predicts positive changes in stock prices, it may also arise because of hedging—e.g., hedge fund managers use the long position to hedge the systematic risk of their arbitrage strategy. It is not surprising, therefore, that changes in hedge fund ownership have not been found to be informative ex ante (e.g., Gri n and Xu, 2009), which may simply reflect the prevalence of the second (hedging) effect. In the presence of both hedging and information-driven trading motivations, therefore, assessments of the informational content of hedge fund trading can hardly be complete if we focus only on one class of trades.

In this paper, we bridge this gap by proposing a novel approach that *jointly* considers short selling and hedge fund holdings to differentiate between various trading motivations. Returning to the previous example, if short interest decreases over the *same* period in which aggregate hedge fund ownership increases, hedge funds as a whole are likely to trade on a positive signal, which we refer to as *informed long demand*. When the opposite trading pattern occurs, i.e., when short interest increases over the *same* period in which hedge fund ownership decreases, the trading reflects *informed short demand*. By contrast, a simultaneous increase (decrease) in both short interest and hedge fund ownership may occur when hedge funds use both the long and the short sides to form arbitrage portfolios (or to unwind existing arbitrage positions), which we can loosely refer to as *hedging* (*unwinding*) demand.[2] Given that the direction of the signals for *hedging/unwinding* demand cannot be easily identified ex ante, it is critical to focus on *informed long/short demand* to properly assess the informativeness of hedge fund trading.

This novel identification strategy allows us to shed new light on the informational content of hedge fund trading using information from both hedge fund 13F filings and short selling information for the complete list of U.S. stocks for the period from 2000 to 2012. Because we observe only aggregate information regarding short selling activities for each stock (rather than how each hedge fund conducts short selling), we aggregate hedge fund ownership at the stock level, so that the two sides of information can be used jointly to infer informed demand at the stock level. We proceed in three steps.

In the first step, we examine the predictive power of informed demand for out-of-sample abnormal returns. We find strong evidence that informed long (short) demand is associated with positive (negative) out-of-sample abnormal stock returns, suggesting that such demand is indeed informative. The economic magnitude is sizable. For instance, if we define informed long (short) demand as a dummy variable that takes a value of one when changes in short interest and hedge fund holdings belong to the most positive (negative) quintiles of stocks in the same period, we find that this proxy is related to a 6.6% (−3.2%) annualized abnormal return in the next quarter under the traditional Fama-MacBeth specifications. In other words, stocks characterized by informed long demand outperform stocks characterized by informed short demand by as much as 9.8% per year. If we directly construct portfolios, rebalanced at quarterly frequency, that buy/sell stocks with the top 20% informed long/short demand, the abnormal return over the entire sample period is approximately 10.5% per year. This magnitude is on par

[2] Alternatively, one can also view the long side and short side of trading as coming from two different groups of traders and interpret *hedging* demand as a situation in which the two groups have different opinions regarding expected stock returns. The interpretation of our main results, however, remains the same.

each subsample of stocks. We find that return predictability is more significant for stocks with high market capitalization, a high turnover ratio, high analyst coverage, and high analyst dispersion. The association with the first three characteristics suggests that our findings are unlikely to be driven by (small) size-related firm characteristics, (low) liquidity-related market conditions, or (low) analyst coverage-related public information, whereas the association with the last characteristic suggests that improved information processing (e.g., Kim and Verrecchia, 1994; Engelberg, Reed, and Ringgenberg, 2012) could play a role in the predictive power of informed demand.

Motivated by this finding, we further explore the informational content of informed demand by examining the extent to which it can predict firm fundamentals, especially those unexpected by the market. Following Akbas, Boehmer, Erturk, Sorescu (2013), we consider several types of proxies for firm fundamentals. The first is a proxy for the future (real) performance of firms, which is proxied by future returns on assets (ROA) or future changes in ROA, where ROA can be either adjusted or unadjusted by industry peers. The second relates to the unexpected component of earnings, measured by standardized unexpected earnings (SUE). In addition, we investigate whether informed demand can predict the future behavior of other market participants, including revisions of recommendations by analysts (Analyst revision) and responses of the public to unexpected news about firm-level fundamentals, where the latter is proxied by cumulative abnormal returns around earnings announcements (CARs).

We find that informed demand has significant forecasting power for all of the above measures, suggesting that the savvy traders behind such demand are not only well informed about firm-level financial information (ROA, SUE) but also su ciently sophisticated to predict analyst revisions and market reactions to firm-level information. Jointly, these results imply that the predictive power of informed demand may come from the discovery of information about firm fundamentals above and beyond what the market or even analysts know. Hence, return predictability documented in previous tests could be directly related to hedge fund managers' superior ability to process firm-level information. Hedging demand and unwinding demand, by contrast, do not exhibit similar forecasting power.

However, if return predictability arises from managerial skill, skillful managers should be able to deliver persistent performance at the fund level. Indeed, persistent performance is the key way to validate managerial skill. Our next task, therefore, is to examine whether performance associated with informed demand is persistent at the fund level. To this end, we quantify the performance of informed trac [(ev)7(e3f 6.3761c [(]TJ 1 2220487.5854 262.269 g 0 Tc ( )Tj /F1 1 Tf 7

perhaps the most sophisticated/informed investors in the market. Building on this intuition, our tests further document that a key component of their informativeness may arise from information discovery regarding firm fundamentals, which subsequently affects dissemination of information in the financial markets.

To the best of our knowledge, we are the first to propose such a joint analysis of short selling and hedge fund holdings and to link it to fundamental stock analysis. Our findings shed new light on the informational content of both short sellers (e.g., Senchack and Starks, 1993; Asquith and Meulbroek, 1995; Aitken, Frino, McCorry, and Swan, 1998; Cohen, Diether, and Malloy, 2007; Boehmer, Jones, and Zhang, 2008; Saffi and Sigurdsson, 2011; Akbas, Boehmer, Erturk, and Sorescu, 2013; Boehmer and Wu, 2013) and hedge fund managers (e.g., Fung and Hsieh, 1997; Ackermann, McEnally, and Ravenscraft, 1999; Agarwal and Naik, 2004; Getmansky, Lo, and Makarov, 2004; Kosowski, Naik, and Teo, 2007; Agarwal, Daniel, and Naik, 2009, 2011; Aragon and Nanda, 2012; Sun, Wang, and Zheng, 2012; Cao, Cheng, Liang, and Lo, 2013).

Our paper is closely related to Griffin and Xu (2009), which we extend by proposing that the use of information from short selling is necessary to complement holdings-based information in order to identify informed demand shocks that are otherwise hidden among various trading motivations. Chen, Da, and Huang (2015) link the difference between abnormal hedge fund holdings and abnormal short interest to the profitability of anomalies, finding that the former reduces mispricing. We differ in proposing a more flexible empirical framework to understand various trading motivations and in documenting that the return predictability of informed demand may arise from its predictive power vis-à-vis firm fundamentals. Such return predictability can be interpreted as an explicit type of managerial skill in the hedge fund industry.

The remainder of the paper is organized as follows. Section 2 presents the data that we employ and the main variables constructed for the analysis. Section 3 describes the main empirical findings. Section 4 relates informed demand to firm fundamentals and discusses the implications of the findings. Section 5 presents additional tests and robustness tests, and a brief conclusion follows.

2. Data and construction of the variables

The data that we use are compiled from various databases. We first retrieve hedge fund holding information from 13F filings from the Securities and Exchange Commission (SEC). Since 1978, institutional investors with at least one hundred million U.S. dollars under management have been required to file 13F forms with the SEC each quarter for U.S. equity holdings of more than two hundred thousand dollars or more than ten thousand shares. This regulation allows us to construct holding or ownership data for each stock based on aggregations of various types of institutional investors.

The identities of the hedge funds, which are collected from the Thomson Reuters Institutional Holdings (13F) database, are cross-referenced with 13F filings from the FactSet LionShares database. As noted by Ben-David, Franzoni, Landier, and Moussawi (2013), the hedge fund list identified in the Thomson Reuters 13F database is consistent with the FactSet LionShares identifications of hedge fund companies. We identify hedge funds in the Thomson Reuters 13F database as follows. Institutional investors are divided into five types in this database: 1) bank trust departments, 2) insurance companies, 3) investment companies and their managers, 4) independent investment advisers, and 5) others. We exclude institutions classified as type 1 or type 2.[5] For each remaining institution, we manually check its SEC ADV forms. Following Brunnermeier and Nagel (2004) and Griffin and Xu (2009), we require an institution to have more than 50% of its investments listed as "other pooled investment vehicles," including private investment companies, private equity, and hedge funds, or more than 50% of its clients listed as "high net worth individuals" for inclusion in our hedge fund sample. We also require that institutions charge performance-based fees to be included in the hedge fund sample. Finally, we manually check the website of each institution satisfying the above requirements to confirm that its primary business is hedge fund-related activity.[6]

Although our sample can be extended to earlier periods, we focus on the post-2000 period because the number of hedge funds in 13F filings became reasonably large only toward the end of the 1990s. Furthermore, the destabilizing effects of hedge funds on stock prices during the tech-bubble period of the late 1990s are well documented by Brunnermeier and Nagel (2004) and Griffin, Harris, Shu, and Topaloglu (2011). We must therefore avoid the confounding effects associated with the tech-bubble period.

With regard to stocks, we start with all the publicly listed companies for which we have accounting and stock market information from Center for Research in Security Prices (CRSP)/Compustat. We then exclude American depositary receipts (ADRs) and stocks with incomplete information to construct control variables (as detailed below).[7] Finally, we match the remaining stocks with the hedge fund holdings and short interest data. Our final sample includes 5,357 stocks for the period from 2000 to 2012, invested in by 1,397 hedge fund holding companies that report quarterly equity holdings in 13F filings.

Our main variables are constructed as follows. First, to construct our main dependent variable for the return predictability tests, we obtain the quarterly return, $r_{i,\,t}$, for stock i in a given quarter t as the compound monthly returns reported by CRSP. Following Daniel, Grinblatt, Titman, and Wermers (DGTW, 1997), we compute the

[5] It is well-known that the type classification in the 13F database is inaccurate after 1998. However, the classification errors are almost entirely driven by misclassifying type 3 or 4 institutions as type 5 institutions (Lewellen, 2011); therefore, they do not affect our sample.

[6] Some of these institutions do not have websites. However, for most of them, we were able to determine whether they are hedge funds through a news search. The remaining institutions are included in the hedge fund sample because discussions with hedge fund managers indicate that some hedge funds are reluctant to maintain websites. Excluding these funds does not lead to qualitative changes in our results.

[7] Excluding penny stocks (stocks priced at less than $1/share) does not change our results. See Ince and Porter (2006) for a more detailed discussion of these screening criteria.

abnormal performance of a stock, which we refer to as the DGTW-adjusted return, as the return of the stock net of the return of its style benchmark based on its size, book-to-market, and prior-period return characteristics.[8] We then compute the quarterly DGTW-adjusted return for each stock, denoted as $DGTW3_{i,\,t}$, as the compound monthly DGTW-adjusted return of the stock in the quarter. We also compute the abnormal return over a 1-year horizon, denoted $DGTW12_{i,\,t}$, in a similar way.

Next, to construct our main independent variables, we compute short interest (*SI*) as the average monthly dollar value of short interest scaled by the total dollar value of all outstanding shares of the stock in the month, both of which are obtained from Compustat. Because our hedge fund holding data are available at quarter-end, we use $SI_{i,\,t}$ at the end of the quarter to extract quarterly changes in short interest. The use of the average short interest within a quarter leads to very similar results. Moreover, because our ultimate goal is to retrieve informed trading from both the long and short sides of trading at the stock level, we also aggregate hedge fund holdings to compute hedge fund ownership for each stock, which we label $HFOwn_{i,\,t}$ for stock i in a given quarter t.

We define *informed long demand* as a dummy variable, $DLong_{i,\,t}$, that takes a value of one when hedge fund ownership increases from quarter $t-1$ to quarter t and short interest decreases over the same period and zero otherwise. That is,

$$DLong_{i,t} = I\{\Delta HFOwn_{i,t} > 0\} \times I\{\Delta SI_{i,t} < 0\},$$

where $I\{.\}$ is an indicator function, and $\Delta HFOwn_{i,\,t} = HFOwn_{i,\,t} - HFOwn_{i,\,t-1}$ and $\Delta SI_{i,\,t} = SI_{i,\,t} - SI_{i,\,t-1}$ denote changes in hedge fund holdings and short interest, respectively.

Similarly, *informed short demand* is defined as a dummy variable, $DShort_{i,\,t}$, that takes a value of one when hedge fund ownership decreases from quarter $t-1$ to quarter t and short interest increases over the same period and zero otherwise, i.e., $DShort_{i,\,t} = I\{\Delta HFOwn_{i,\,t} < 0\} \times I\{\Delta SI_{i,\,t} > 0\}$.

In addition to informed demand, we also define *hedging* (*unwinding*) *demand* as a simultaneous increase (decrease) in both hedge fund ownership and short interest, denoted $DHedge_{i,\,t} = I\{\Delta HFOwn_{i,\,t} > 0\} \times I\{\Delta SI_{i,\,t} > 0\}$ ($DUnwind_{i,\,t} = I\{\Delta HFOwn_{i,\,t} < 0\} \times I\{\Delta SI_{i,\,t} < 0\}$). Unwinding demand can be triggered by the need to liquidate existing trading positions to lock in profits or by fire sales. These two variables can not only provide placebo tests to validate the informational content of *informed demand*, but also enrich our understanding regarding various strategies adopted by the hedge fund industry, as later sections will show.

A second, alternative, way to define informed demand is to sort stocks into terciles according to $\Delta HFOwn_{i,\,t}$ or $\Delta SI_{i,\,t}$ and then to define informed long (short) demand as a dummy variable that takes a value of one if the stock's $\Delta HFOwn_{i,\,t}$ belongs to the top (bottom) tercile and its $\Delta SI_{i,\,t}$ belongs to the bottom (top) tercile and zero otherwise. In other words, *informed long demand* can be defined as the simultaneous occurrence of both the "highest" increase in hedge fund holdings and the "highest" decrease in short interest, where the "highest" increase or decrease is defined on the basis of tercile values of $\Delta HFOwn_{i,\,t}$ and $\Delta SI_{i,\,t}$ in a given period. To avoid confusion, we refer to tercile-based *informed demand* variables as $DLong^{Ter}_{i,t}$ and $DShort^{Ter}_{i,t}$. Similarly, we also define *informed long (short) demand* on the basis of quintiles of $\Delta HFOwn_{i,\,t}$ and $\Delta SI_{i,\,t}$ values and denote it as $DLong^{Quin}_{i,t}$ ($DShort^{Quin}_{i,t}$). Unreported tests using quartile-based variables yield very similar results.

Tercile- or quintile-based proxies enable sharper identification based on more profitable information in the case of informed demand and stronger hedging motivations in the case of hedging demand. However, the previous proxies based on positive or negative changes in short interest and holdings (e.g., $DLong_{i,\,t}$ and $DShort_{i,\,t}$) are likely to be more representative—as more stocks are involved—yet less informative. We will therefore mainly rely on $DLong_{i,\,t}$ and $DShort_{i,\,t}$ to establish our main results. We will then verify that these results are robust to alternative definitions of informed demand and use quintile-based partitions to illustrate the economic magnitude of return predictability.

We also construct a set of control variables following Gompers and Metrick (2001). *DIV* is the dividend yield calculated as dividends divided by market capitalization; *Age* is the number of months since the stock first appeared in CRSP; and *Price* refers to the stock price per share. *Turnover* is the stock turnover rate (volume divided by shares outstanding) in the last month prior to the beginning of the quar

[8] A detailed description and data are available at http://www.rhsmith.umd.edu/faculty/rwermers/ftpsite/DGTW/coverpage.htm.

Table 1

Summary statistics.

This table provides summary statistics for the main variables. Panel A tabulates the year-by-year information of hedge fund ownership and short interest. More specifically, for stocks that have nonzero hedge fund (HF) ownership, short interest, and mutual fund (MF) ownership and non-missing price information, the first three columns report the average ownership of hedge funds (in % with respect to the total number of shares outstanding), average short interest (in % with respect to the total number of shares outstanding), as well as the average ownership of mutual funds (in % with respect to the total number of shares outstanding) of stocks. The next three columns tabulate the year-by-year changes in these variables. Panel B reports the mean, median, standard deviation, and 10% and 90% quantile values for main variables. Panel C reports the correlation matrix for these variables. A detailed definition of these variables is provided in Appendix A.

Panel A: Hedge fund ownership and short-selling activities by years

Year	Hedge fund ownership	Short interest	Mutual fund ownership	HF ownership changes	Short interest changes	MF ownership changes
2000	2.38%	1.78%	16.80%	0.40%	0.07%	0.53%
2001	2.78%	2.31%	18.63%	0.40%	0.54%	1.83%
2002	3.19%	2.83%	21.24%	0.41%	0.51%	2.61%
2003	3.72%	3.25%	21.85%	0.53%	0.42%	0.61%
2004	5.15%	3.60%	21.50%	1.43%	0.35%	−0.35%
2005	6.45%	3.99%	22.00%	1.30%	0.39%	0.50%
2006	7.65%	4.78%	22.90%	1.20%	0.79%	0.89%
2007	9.04%	6.00%	23.45%	1.39%	1.22%	0.55%
2008	8.34%	6.61%	24.50%	−0.70%	0.61%	1.06%
2009	6.73%	4.60%	25.19%	−1.61%	−2.00%	0.69%
2010	6.79%	4.73%	24.87%	0.06%	0.12%	−0.32%
2011	7.10%	4.82%	25.65%	0.31%	0.09%	0.78%
2012	7.45%	4.56%	25.50%	0.34%	−0.26%	−0.16%

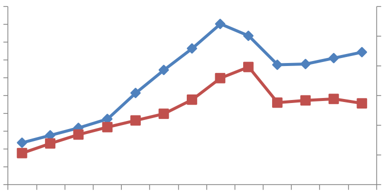
Panel B: Summary statistics of major variables

	Mean	Std Dev	10%	Median	90%
DLong	0.2465	0.4310	0	0	1
DShort	0.2405	0.4274	0	0	1
DHedging	0.2640	0.4408	0	0	1
DUnwinding	0.2418	0.4282	0	0	1
DGTW 3m	0.0044	0.2342	−0.2216	−0.0072	0.2254
DGTW 12m	0.0146	0.5298	−0.4404	−0.0291	0.4591
Div	0.0161	0.0398	0	0	0.0427
LgAge	234.71	198.89	53.00	171.00	480.00
LgPrc	25.93	40.64	3.58	19.20	51.99
LgTurn	0.1637	0.1536	0.0258	0.1186	0.3559
LgVol	0.1277	0.0806	0.0553	0.1105	0.2168
SP500	0.1586	0.3653	0	0	1

Panel C: Correlation matrix

	DLong	*DShort*	*DHedging*	*DUnwinding*	DGTW 3m	DGTW 12m	*Div*	*LgAge*	*LgPrc*	*LgTurn*	*LgVol*	*SP500*
DLong	1											
DShort	−0.3219	1										
	(0.0000)											
DHedging	−0.3426	−0.3371	1									
	(0.0000)	(0.0000)										
DUnwinding	−0.323	−0.3178	−0.3382	1								
	(0.0000)	(0.0000)	(0.0000)									
DGTW 3m	0.0171	−0.015	0.0088	−0.0109	1							
	(0.0000)	(0.0000)	(0.0023)	(0.0002)								
DGTW 12m	0.0179	−0.0154	0.0027	−0.0056	0.4649	1						
	(0.0000)	(0.0000)	(0.3547)	(0.0572)	(0.0000)							
Div	−0.0012	−0.0035	−0.003	0.0033	0.0053	0.0079	1					
	(0.6685)	(0.2216)	(0.2902)	(0.2467)	(0.0665)	(0.0075)						
LgAge	0.0162	0.0033	−0.0041	−0.0113	0.0038	0.0068	0.0846	1				
	(0.0000)	(0.2500)	(0.1572)	(0.0001)	(0.1834)	(0.0212)	(0.0000)					
LgPrc	0.0026	0.0041	0.0066	−0.0072	−0.0028	−0.0086	−0.0357	0.1599	1			
	(0.3585)	(0.1493)	(0.0225)	(0.0126)	(0.3337)	(0.0035)	(0.0000)	(0.0000)				
LgTurn	−0.0238	0.0107	−0.0173	0.0458	−0.015	−0.0104	−0.0276	−0.0219	0.0344	1		
	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0004)	(0.0000)	(0.0000)	(0.0000)			
LgVol	−0.0071	−0.0076	−0.0233	0.0371	0.0093	0.0193	−0.0618	−0.1987	−0.2103	0.2294	1	
	(0.0134)	(0.0080)	(0.0000)	(0.0000)	(0.0012)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		
SP500	0.0249	0.0101	−0.014	−0.0134	0.0063	0.0091	0.0298	0.4418	0.1882	0.1038	−0.1851	1
	(0.0000)	(0.0005)	(0.0000)	(0.0000)	(0.0281)	(0.0020)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	

A. Hedge fund ownership, short interest, and mutual fund ownership (right scale)



$$DGTW_{i,t+1} = \alpha_i + \beta_i \times Informed\ Demand_{i,t} + C \times M_{i,t} + \epsilon_{i,t+1}, \quad (1)$$

where $DGTW_{i,\,t+1}$ refers to the out-of-sample DGTW-adjusted abnormal return of stock i accumulated over quarter $t+1$; $Informed\ Demand_{i,\,t}$ is a vector of informed demand variables, including $DLong_{i,\,t}$ and $DShort_{i,\,t}$ in the lagged quarter; and $M_{i,\,t}$ stacks a list of control variables, including *DIV*, *LgAge*, *LgPrc*, *LgTurn*, *LgVol*, and *SP500*.[10]

The results are reported in Table 2. In Panel A, Models (1)–(3) provide the results of the baseline regression on the quarterly return predictability of $DLong_{i,\,t}$ and $DShort_{i,\,t}$. We find that, independently or jointly, $DLong_{i,\,t}$ forecasts positive abnormal returns and $DShort_{i,\,t}$ forecasts

Table 2
Results of the baseline regression.

Panel A reports the results of the following baseline Fama-MacBeth regression at a quarterly frequency:

$$DGTW_{i,t+1} = \alpha_i + \beta_i \times Informed\ Demand_{i,t} + C \times M_{i,t} + \epsilon_{i,t+1},$$

where $DGTW_{i,\ t+1}$ refers to the out-of-sample DGTW-adjusted abnormal return of stock i accumulated over quarter $t+1$; $Informed\ Demand_{i,\ t}$ refers to a vector of informed demand variables, including $DLong_{i,\ t}$ and $DShort_{i,\ t}$ in the lagged quarter; and $M_{i,\ t}$ stacks a list of control variables, including *DIV*, the dividend yield calculated as dividends divided by market capitalization, *LgAge*, the logarithm of number of months since the stock first appeared in CRSP, *LgPrc*, the logarithm of the stock price per share, *LgTurn*, the logarithm of stock turnover rate prior to the beginning of the quarter, *LgVol*, the logarithm of the standard deviation of returns over the past 24 months, and *SP500*, a dummy equal to one for stocks in the S&P 500 index and zero otherwise. Panel B replaces the dependent variable with the out-of-sample DGTW-adjusted abnormal return of stock i accumulated over 1 year starting from quarter t. A detailed definition of these variables is provided in Appendix A. The superscripts ***, **, and * refer to the 1%, 5%, and 10% levels of statistical significance, respectively. The sample period is from 2000 to 2012.

Panel A: Out-of-sample quarterly abnormal return (DGTW-adjusted) regressed on informed demand variables

	DLong by positive/negative changes in long/short positions						DLong by terciles	DLong by quintiles
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DLong	0.008***		0.006***				0.012***	0.016***
	(4.06)		(3.49)				(3.91)	(2.97)
DShort		−0.007***	−0.005***				−0.007**	−0.008**
		(−4.11)	(−3.47)				(−2.37)	(−2.31)
DHedging				0.005**		0.003*	0.005*	0.006
				(2.51)		(1.98)	(1.80)	(1.46)
DUnwinding					−0.005**	−0.004**	−0.005*	−0.007*
					(−2.56)	(−2.09)	(−1.98)	(−1.81)
Div	−0.017	−0.017	−0.017	−0.016	−0.017	−0.017	−0.016	−0.017
	(−0.40)	(−0.39)	(−0.40)	(−0.37)	(−0.41)	(−0.39)	(−0.37)	(−0.39)
LgAge	0.002*	0.002*	0.002*	0.002*	0.002*	0.002*	0.002*	0.002*
	(1.88)	(1.94)	(1.91)	(1.93)	(1.93)	(1.94)	(1.88)	(1.79)
LgPrc	−0.005*	−0.005*	−0.005*	−0.006*	−0.006*	−0.006*	−0.006*	−0.006*
	(−1.76)	(−1.78)	(−1.76)	(−1.83)	(−1.84)	(−1.86)	(−1.81)	(−1.82)
LgTurn	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(0.54)	(0.55)	(0.57)	(0.48)	(0.52)	(0.50)	(0.54)	(0.50)
LgVol	−0.006	−0.006	−0.006	−0.006	−0.006	−0.006	−0.006	−0.006
	(−1.02)	(−1.03)	(−1.03)	(−1.01)	(−1.01)	(−1.01)	(−1.03)	(−1.06)
SP500	0.004	0.005	0.004	0.005	0.004	0.005	0.004	0.005
	(1.30)	(1.33)	(1.29)	(1.40)	(1.32)	(1.37)	(1.20)	(1.29)
Constant	−0.003	0.000	−0.002	−0.003	0.000	−0.001	−0.002	−0.002
	(−0.18)	(0.01)	(−0.09)	(−0.15)	(0.01)	(−0.06)	(−0.11)	(−0.10)
Observations	121,216	121,216	121,216	121,216	121,216	121,216	121,216	121,216
R-square	0.022	0.022	0.023	0.022	0.022	0.023	0.024	0.024

Panel B: Out-of-sample annual abnormal return (DGTW-adjusted) regressed on informed demand variables

	DLong by positive/negative changes in long/short positions						DLong by terciles	DLong by quintiles
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DLong	0.017***		0.013**				0.022***	0.029***
	(3.57)		(2.46)				(3.07)	(3.98)
DShort		−0.016***	−0.012***				−0.015**	−0.021**
		(−4.16)	(−2.73)				(−2.39)	(−2.09)
DHedging				0.009**		0.006*	0.010	0.011
				(2.36)		(1.93)	(1.19)	(1.03)
DUnwinding					−0.008	−0.005	−0.003	0.007
					(−1.47)	(−1.00)	(−0.51)	(0.85)
Div	−0.115	−0.115	−0.115	−0.116	−0.114	−0.115	−0.116	−0.115
	(−1.26)	(−1.27)	(−1.27)	(−1.29)	(−1.28)	(−1.29)	(−1.29)	(−1.28)
LgAge	0.011**	0.011**	0.011**	0.011**	0.011**	0.011**	0.011**	0.011**
	(2.59)	(2.65)	(2.63)	(2.65)	(2.61)	(2.64)	(2.59)	(2.62)
LgPrc	−0.034**	−0.034**	−0.033**	−0.034**	−0.034**	−0.034**	−0.034**	−0.034**
	(−2.46)	(−2.46)	(−2.45)	(−2.47)	(−2.46)	(−2.47)	(−2.44)	(−2.46)
LgTurn	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.003
	(0.51)	(0.52)	(0.53)	(0.48)	(0.53)	(0.51)	(0.49)	(0.42)
LgVol	−0.016	−0.016	−0.016	−0.016	−0.016	−0.016	−0.017	−0.017
	(−0.89)	(−0.90)	(−0.89)	(−0.89)	(−0.88)	(−0.88)	(−0.91)	(−0.91)
SP500	0.024**	0.024**	0.024**	0.025**	0.024**	0.024**	0.024**	0.025**
	(2.24)	(2.26)	(2.23)	(2.29)	(2.27)	(2.28)	(2.16)	(2.23)
Constant	0.025	0.032	0.029	0.026	0.033	0.030	0.027	0.024
	(0.54)	(0.69)	(0.62)	(0.57)	(0.68)	(0.63)	(0.59)	(0.52)
Observations	114,713	114,713	114,713	114,713	114,713	114,713	114,713	114,713
R-square	0.021	0.021	0.021	0.020	0.020	0.021	0.023	0.022

Table 3
Informed demand vs. asset pricing anomalies.

This table extends the baseline quarterly Fama-MacBeth regression of Table 2 as follows:

$$DGTW_{i,t+1} = \alpha_i + \beta_i \times Informed\ Demand_{i,t} + C \times M_{i,t} + D \times Anomaly_{i,t} + \epsilon_{i,t+1},$$

where $DGTW_{i,\ t+1}$ refers to the out-of-sample DGTW-adjusted abnormal return of stock i accumulated over quarter $t+1$; $Informed\ Demand_{i,\ t}$ refers to a vector of informed demand variables, including $DLong_{i,\ t}$ and $DShort_{i,\ t}$ in the lagged quarter; $M_{i,\ t}$ stacks a list of control variables, including *DIV, LgAge, LgPrc, LgTurn, LgVol*, and *SP500*, and $Anomaly_{i,\ t}$ stacks a list of firm characteristics that could be associated with asset return, including book-to-market ratio (for value premium), the logarithm of firm size (for size premium), lagged return in the previous 12 months (for momentum), gross profit to assets ratio, operating profit, asset growth, investment growth, net stock issuance, accruals, and the logarithm of net operating assets. We focus on tercile-based informed demand variables, and tabulate the regression results here. The corresponding baseline regression without anomalies is reported in Model (7) in Panel A of Table 2. Using quintile-based informed demand variables leads to very similar results. A detailed definition of these variables is provided in Appendix A. The superscripts ***, **, and * refer to the 1%, 5%, and 10% levels of statistical significance, respectively.

Out-of-sample abnormal return (quarterly) regressed on informed demand (by terciles)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
DLong	0.011***	0.012***	0.011***	0.011***	0.012***	0.012***	0.012***	0.011***	0.011***	0.012***	0.009***
	(3.74)	(3.77)	(3.67)	(3.75)	(3.60)	(3.80)	(3.58)	(3.73)	(3.92)	(3.84)	(3.41)
DShort	−0.007***	−0.007***	−0.008***	−0.008***	−0.007**	−0.008***	−0.007**	−0.008***	−0.008***	−0.008***	−0.007**
	(−2.83)	(−2.82)	(−2.89)	(−2.92)	(−2.30)	(−3.05)	(−2.66)	(−3.08)	(−2.83)	(−2.92)	(−2.17)
DHedging	0.003	0.003	0.003	0.003	0.000	0.002	0.003	0.003	0.001	0.003	−0.002
	(0.98)	(1.03)	(0.99)	(0.90)	(0.05)	(0.57)	(1.01)	(0.86)	(0.37)	(0.98)	(−0.38)
DUnwinding	−0.006**	−0.006**	−0.006**	−0.006**	−0.003	−0.006**	−0.006**	−0.006**	−0.006**	−0.006**	−0.003
	(−2.22)	(−2.19)	(−2.17)	(−2.25)	(−1.00)	(−2.17)	(−2.42)	(−2.22)	(−2.03)	(−2.26)	(−0.93)
Value (B/M)	−0.000										0.005
	(−0.12)										(1.18)
Size (Log_size)		0.003									0.001
		(1.64)									(0.50)
Momentum (Lag Ret)			0.006*								−0.008***
			(1.77)								(−3.86)
Gross profit to assets				0.028***							0.015
				(3.89)							(1.61)
Operating profit					0.032***						0.033***
					(7.44)						(6.94)
Asset growth						0.040***					0.078***
						(4.46)					(4.68)
Investment growth							0.000				−0.003
							(0.13)				(−1.32)
Net stock issuance								0.024**			0.005
								(2.23)			(0.28)
Accruals									0.001		−0.005
									(0.18)		(−0.79)
Net operating assets										0.007	−0.042***
										(1.45)	(−3.84)
Controls and constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	118,418	118,418	118,418	118,397	76,881	118,413	108,724	118,358	93,047	118,401	73,542
R-square	0.027	0.028	0.027	0.030	0.034	0.033	0.027	0.028	0.027	0.028	0.067

Table 3 tabulates the results. To better understand the potential influence of asset pricing anomalies, we start with Model (7) in Panel A of Table 2 as the baseline model (which uses tercile-based informed demand variables to predict next-quarter abnormal returns). The above anomalies are included one by one in Models (1)–(10) and then combined in Model (11). We first observe that *value premium*, *size premium*, *investment growth*, and *accruals* insignificantly affect performance. Because these anomalies do not directly affect returns, they also have little impact on the return predictability of the informed demand variables.

Next, Model (3) suggests that, consistent with the existing literature, *momentum*, when included on its own, positively predicts future abnormal returns. However, the sign of the impact flips when all other anomalies are included, as in Model (11). At the same time, *gross profit to assets* and *net stock issuance* each have significant effects when they are included on their own—but the significance of these variables dissipates in the joint model. The reverse occurs for *net operating assets*: the return impact is significant in the joint model but not when included alone. The inconsistencies across the stand-alone and joint models suggest that the effects of these variables on returns are not robust to alternative specifications—as a result, they also have little impact on the return predictability of the informed demand variables.

Finally, the remaining two types of anomalies, *operating profit* and *asset growth*, exert consistent return effects across the stand-alone and joint models and may affect the power of the informed demand variables. In particular, *operating profit* in Model (5) absorbs the return predictability of unwinding demand, suggesting that the latter variable may be associated with public information related to the *operating profit* of a firm rather than private information processed by skilled hedge fund managers.

The impact of *operating profit* on the return predictability of informed long/short demand, however, is minor. Compared with Model (7) in Panel A of Table 2, the return predictability of $DLong_{i,\,t}$ and $DShort_{i,\,t}$ in Model (5) maintains a similar economic magnitude and level of statistical significance. Indeed, the economic magnitude and statistical significance of the two variables drop very little even when all anomalies are included, as in Model (11), suggesting that the return predictability of informed demand arises for very different economic reasons than the asset pricing anomalies discussed above.[11]

can

Before proceeding further, it is also worth noting that Table 3 highlights the aforementioned intuition that it is crucial to use short selling information to distinguish information-motivated trading from general changes in hedge fund holdings. Let us take positive changes in hedge fund holdings (i.e., holding-implied "net buy") as an example. Mathematically, positive changes in holdings are equivalent to the summation of $DLong_{i,\,t}$ and $DHedging_{i,\,t}$.[12] Hence, the return predictability of the former can be inferred from our regressions as the summation of the regression coefficients, $DLong_{i,\,t}$ and $DHedging_{i,\,t}$. From Model (11), while the return predictability of $DLong_{i,\,t}$ is significantly positive (with a regression coefficient of 0.009 and a t-statistic of 3.41), that of $DHedging_{i,\,t}$ is negative (with a regression coefficient of −0.002 and a t-statistic of −0.38), leaving the summation of the two coefficients—or the return predictability of a holding-implied net buy—not only smaller in magnitude than $DLong_{i,\,t}$ but also statistically insignificant (with an F-statistic of 2.63 and a p-value of 11.2%). This insignificant result confirms the importance of our proposal to use short selling information to further extend the analysis of Griffin and Xu (2009).[13]

3.3. Portfolio analysis

A better way to illustrate the economic magnitude of our results is to construct portfolios based on our informed demand variables and then compute long-term performance based on these portfolios. To implement such a strategy, we go long (short) in stocks characterized by substantial informed long (short) demand.

Model (1) in Table 4 displays the results of this empirical strategy. At the beginning of each quarter, we focus on stocks characterized by the highest informed long (short) demand constructed on the basis of either terciles of short interest and hedge fund ownership changes (Panel A) or quintiles of short interest and hedge fund ownership changes (Panel B). We report the long-run abnormal returns that can be generated by this strategy. The results show that stocks characterized by informed long (short) demand generate significant positive (negative) abnormal returns in the long run and that the difference between these qcallve

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[11] Another way to demonstrate the difference between informed and hedging/unwinding demand here is to examine whether high *operating profit* can directly lead hedge funds to increase hedging demand. When we regress hedge fund demand variables on lagged *operating profit* and other lagged control variables, we find that *operating profit* significantly increases (decreases) hedge fund hedging (unwinding) demand, and that such predicting power concentrates in periods with higher economic policy uncertainty (Baker, Bloom, and Davis, 2015). By contrast, *operating profit* does not predict informed demand. To save space, the results are tabulated Table IN1 of the Internet Appendix.

[12] As is easily seen, $DLong_{i,\,t}+DHedge_{i,\,t}=I\{\Delta HFOwn_{i,\,t} > 0\}\times I\{\Delta SI_{i,\,t} < 0\}+I\{\Delta HFOwn_{i,\,t} > 0\}\times I\{\Delta SI_{i,\,t} > 0\}=I\{\Delta HFOwn_{i,\,t} > 0\}\times(I\{\Delta SI_{i,\,t} < 0\}+I\{\Delta SI_{i,\,t} > 0\})=I\{\Delta HFOwn_{i,\,t} > 0\}$.

[13] We obtain very similar results when we use quartile- or quintile-based informed demand variables to conduct the same test: among the ten anomalies, *value premium, size premium, investment growth,* and *accruals* have insignificant effects on returns; *momentum, gross profit to assets, net stock issuance,* and *net operating assets* have inconsistent effects across the stand-alone and joint models. All these variables, when used alone, do not affect the return predictability of informed demand. Finally, *operating profit* and *asset growth* continue to exhibit consistent return effects across the stand-alone and joint models. In particular, *operating profit* also absorbs the return predictability of unwinding demand but not that of informed demand. Finally, the predictive power of $DLong_{i,\,t}$ and $DHedging_{i,\,t}$ are also significantly positive and insignificantly negative, leaving the summation of the coefficients smaller than that of $DLong_{i,\,t}$ and marginally insignificant. Because all the patterns are very similar to tercile-based informed demand, in the interest of brevity, we do not tabulate them here.

stocks

Table 4
Portfolio-based analyses.
In Panel A, we first independently double sort stocks into terciles based on hedge fund 13F holding changes and short interest changes. We then focus on two portfolios of stocks that have experienced the largest net-long and net-short demand shocks. We then report the DGTW-adjusted return that can be generated by the two portfolios over the entire sample period (2000–2012). A detailed definition of these variables is provided in Appendix A.

Panel A: Cumulative DGTW return of tercile information-based informed demand

	DGTW return of equal-weighted portfolio				DGTW return of value-weighted portfolio			
	$t+1$	$t+1$ to $t+2$	$t+1$ to $t+3$	$t+1$ to $t+4$	$t+1$	$t+1$ to $t+2$	$t+1$ to $t+3$	$t+1$ to $t+4$
Dlong= 1 in t	1.750%	3.260%	3.776%	4.041%	1.319%	2.398%	3.100%	3.413%
Dshort= 1 in t	−0.186%	−0.328%	−0.123%	−0.185%	−0.732%	−0.439%	0.320%	0.115%
Dlong-minus-Dshort	1.936%	3.588%	3.899%	4.226%	2.050%	2.836%	2.780%	3.298%
t-stat	(5.41)	(6.48)	(5.92)	(5.80)	(4.79)	(5.00)	(4.64)	(3.89)

Panel B: Cumulative DGTW return of quintile information-based informed demand

	DGTW return of equal-weighted portfolio				DGTW return of value-weighted portfolio			
	$t+1$	$t+1$ to $t+2$	$t+1$ to $t+3$	$t+1$ to $t+4$	$t+1$	$t+1$ to $t+2$	$t+1$ to $t+3$	$t+1$ to $t+4$
Dlong= 1 in t	2.122%	3.532%	4.249%	4.741%	1.729%	2.758%	3.100%	3.696%
Dshort= 1 in t	−0.409%	−1.008%	−1.003%	−1.053%	−0.330%	−0.055%	0.414%	0.595%
Dlong-minus-Dshort	2.531%	4.540%	5.252%	5.795%	2.059%	2.813%	2.686%	3.101%
t-stat	(4.75)	(5.76)	(5.50)	(4.98)	(3.58)	(3.25)	(2.59)	(2.55)

predictability of informed demand lies in the ability of the hedge funds to forecast firm fundamentals.

4.1. Subsample analysis

We start by splitting our sample into two subgroups based on a list of firm characteristics such as market capitalization, turnover ratio, analyst coverage, and dispersion of analyst forecasts. Splitting the sample into these subgroups allows us to better understand the effects of

Table 5
Subsample analyses.

This table applies the baseline regression from Table 2 to subsamples of stocks constructed based on different stock characteristics, including market capitalization, turnover ratio, analyst coverage, and dispersion of analyst forecasts. For each of the characteristics, we split the sample in any given quarter into two subsamples based on the median value. We then apply the baseline regression to each subsample of stocks and tabulate the regression results. Panels A and B apply the subsample analysis to the baseline regressions involving informed demand (Model 3 in Panel A and Panel B of Table 2, respectively). Panels C and D apply the subsample analysis to the baseline regressions regarding hedging/unwinding demand (Model 6 in Panel A and Panel B of Table 2, respectively). To save space, for Panels B–D, we only tabulate the coe cients for the main variables. A detailed definition of these variables is provided in Appendix A. The full specifications of the regression parameters can be found in the Internet Appendix. The superscripts ***, **, and * refer to the 1%, 5%, and 10% levels of statistical significance, respectively.

Panel A: Subsample analyses for out-of-sample quarterly abnormal return (DGTW-adjusted)

	Firm size		Turnover		Analyst coverage		Dispersion of analysts	
	(1) Small	(2) Large	(3) Low	(4) High	(5) Low	(6) High	(7) Low	(8) High
DLong	0.008***	0.005***	0.003	0.009***	0.006*	0.007***	0.011***	0.007***
	(2.71)	(2.69)	(1.25)	(3.88)	(1.98)	(3.36)	(3.47)	(2.76)
DShort	−0.004	−0.007***	−0.006**	−0.005***	−0.007**	−0.004**	−0.006	−0.005***
	(−1.02)	(−4.39)	(−2.13)	(−2.73)	(−2.35)	(−2.54)	(−1.58)	(−2.76)
Div	−0.016	0.020	0.036	−0.053	0.011	−0.079	−0.062	−0.025
	(−0.29)	(0.45)	(0.64)	(−0.97)	(0.20)	(−1.60)	(−0.70)	(−0.44)
LgAge	0.007***	−0.003	0.003**	0.000	0.006***	−0.001	0.001	−0.000
	(4.16)	(−1.50)	(2.10)	(0.23)	(4.38)	(−0.59)	(0.27)	(−0.14)
LgPrc	−0.008*	−0.004	−0.005*	−0.005	−0.005	−0.010**	−0.010***	−0.005
	(−1.80)	(−1.42)	(−1.77)	(−1.38)	(−1.54)	(−2.50)	(−2.70)	(−1.05)
LgTurn	−0.000	0.000	0.004*	−0.009*	−0.001	−0.000	0.001	0.000
	(−0.01)	(0.10)	(1.76)	(−1.95)	(−0.45)	(−0.09)	(0.21)	(0.00)
LgVol	−0.004	−0.008	0.000	−0.010	−0.005	−0.007	−0.005	−0.004
	(−0.73)	(−0.92)	(0.09)	(−1.44)	(−1.00)	(−0.88)	(−0.72)	(−0.51)
SP500	0.029**	0.004	0.003	0.003	0.009	0.005*	0.003	0.006
	(2.01)	(1.46)	(0.76)	(0.92)	(1.25)	(1.79)	(0.78)	(1.51)
Constant	−0.022	0.018	0.016	−0.022	−0.031	0.027	0.024	0.007
	(−1.06)	(0.88)	(0.84)	(−1.13)	(−1.54)	(1.43)	(1.15)	(0.34)
Observations	60,596	60,620	60,596	60,620	56,834	64,382	31,713	57,436
R-square	0.027	0.037	0.027	0.030	0.026	0.036	0.043	0.034

Panel B: Subsample analyses for out-of-sample annual abnormal return (DGTW-adjusted)

	Firm size		Turnover		Analyst coverage		Dispersion of analysts	
	(1) Small	(2) Large	(3) Low	(4) High	(5) Low	(6) High	(7) Low	(8) High
DLong	0.016	0.009**	0.010	0.017***	0.013	0.014***	0.011*	0.016***
	(1.45)	(2.52)	(0.87)	(3.46)	(1.13)	(3.80)	(1.88)	(3.58)
DShort	−0.012	−0.011***	−0.014*	−0.009*	−0.011	−0.012***	−0.008	−0.014**
	(−1.30)	(−3.72)	(−1.82)	(−1.92)	(−1.08)	(−2.93)	(−1.10)	(−2.39)

Panel C: Subsample analyses for out-of-sample quarterly abnormal return (DGTW-adjusted)

	Firm size		Turnover		Analyst coverage		Dispersion of analysts	
	(1) Small	(2) Large	(3) Low	(4) High	(5) Low	(6) High	(7) Low	(8) High
DHedging	0.002	0.004*	0.005*	0.001	0.004	0.002	0.001	0.003
	(0.80)	(1.99)	(1.94)	(0.48)	(1.66)	(0.82)	(0.37)	(1.19)
DUnwinding	−0.006**	−0.002	−0.001	−0.006***	−0.001	−0.005**	−0.004	−0.006**
	(−2.09)	(−0.91)	(−0.42)	(−2.70)	(−0.40)	(−2.16)	(−0.86)	(−2.26)

Panel D: Subsample analyses for out-of-sample annual abnormal return (DGTW-adjusted)

	Firm size		Turnover		Analyst coverage		Dispersion of analysts	
	(1) Small	(2) Large	(3) Low	(4) High	(5) Low	(6) High	(7) Low	(8) High
DHedging	0.011*	0.004	0.013**	−0.000	0.010	0.003	0.000	0.006
	(1.79)	(1.00)	(2.53)	(−0.07)	(1.63)	(0.65)	(0.08)	(1.18)
DUnwinding	−0.011	−0.001	−0.006	−0.005	−0.008	−0.003	0.002	−0.009
	(−1.19)	(−0.26)	(−0.63)	(−0.93)	(−0.85)	(−0.83)	(0.27)	(−1.62)

industries are defined by two-digit Standard Industrial Classification (SIC) codes. We repeat the return predictability regression as specified in Eq. (1) but replace the dependent variable, out-of-sample abnormal returns, with out-of-sample average ROA in the 12-month (four-quarter) period following the construction of informed demand.

The results are reported in Models (1)–(4) of Table 6. Across these specifications, we find that $DLong_{i,\,t}$ and $DShort_{i,\,t}$ forecast positive and negative ROA of firms, respectively. The predictive power is again highly significant, which is consistent with the notion that informed demand reflects capable traders' abilities to forecast firm fundamentals.

Although ROA reflects the long-term profitability of firms, the financial market typically pays special attention to short-term cash flows, such as earnings. Thus, another way to achieve return predictability is to process earnings-related information more effectively than the market. Hence, our second proxy for (unexpected changes in) firm fundamentals is related to the portion of earnings that is unpredicted by the market, namely, standardized unexpected earnings (*SUE*). If informed demand predictability is truly driven by information, we expect informed demand to forecast *SUE*. Following Hirshleifer, Myers, Myers, and Teoh (2008), we compute *SUE* as the seasonal difference in split-adjusted earnings per share scaled by the split-adjusted end-of-quarter price (i.e., the price at the end of the quarter prior to the earnings announcement).

We also supplement *SUE* with another important variable that may help us understand the informativeness of capable traders, namely, analyst revisions. *Analyst revision* is the change in the consensus analyst earnings estimate, computed as the difference in mean estimates from the previous month divided by the stock price at the end of the previous month. If informed demand forecasts not only *SUE* but also analyst revisions, then hedge fund managers behind the demand have the ability to process earnings-related information, and their informational advantage would exceed that of analysts. Models (5) and (6)

Table 6

Forecasting firm fundamentals.

This table explores the predictability of net demands on out-of-sample firm fundamentals. In Models (1) and (2) of Panel A, we regress firm ROA or changes in ROA in the following year on informed long or short demand. Models (3) and (4) further adjust ROA or changes in ROA by the industry average. Models (5) and (6) tabulate the results for similar predictive regressions when the dependent variables are next-period SUE and analyst revisions. Model (7) reports the predictability of informed demand for next-period CARs. Control variables include *BM*, the book-to-market ratio, *DIV*, the dividend yield calculated as dividends divided by market capitalization, *LgAge*, the logarithm of number of months since the stock first appeared in CRSP, *LgPrc*, the logarithm of the stock price per share, *LgSize*, the logarithm of market capitalization, *LgTurn*, the logarithm of stock turnover rate, *LgVol*, the logarithm of the standard deviation of returns over the past 24 months, *Ret3*, stock return in the last quarter, *Ret9*, stock return of the three quarters prior to the last quarter, and *SP500*, a dummy equal to one for stocks in the S&P 500 index and zero otherwise. Panel B applies the same tests to hedging and unwinding demand. A detailed definition of these variables is provided in Appendix A. The superscripts ***, **, and * refer to the 1%, 5%, and 10% levels of statistical significance, respectively.

Panel A. Predictability of informed demands

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Out-of-sample ROA or changes in ROA					SUE or analyst revision	Mkt response
Dependent variable =	ROA	ΔROA	Ind-adj ROA	Ind-adj ΔROA	SUE	Analyst revision	CAR
DLong	0.001***	0.001**	0.001**	0.001**	0.001***	0.010***	0.001***
	(3.18)	(2.40)	(2.44)	(2.44)	(2.76)	(2.94)	(3.09)
DShort	−0.001**	−0.001***	−0.001*	−0.001**	−0.001**	−0.006*	−0.001**
	(−2.29)	(−2.72)	(−1.84)	(−2.41)	(−2.62)	(−1.95)	(−2.31)
BM	0.002***	0.002***	0.003***	0.001***	0.004***	−0.041**	0.001*
	(3.05)	(3.49)	(4.73)	(3.25)	(3.86)	(−2.50)	(1.74)
Div	0.036***	0.002	0.028***	0.002	0.017	−0.105	−0.019***
	(5.19)	(0.49)	(3.82)	(0.48)	(0.75)	(−1.57)	(−3.08)
LgAge	0.003***	0.001***	0.003***	0.001***	0.001***	0.002	0.000*
	(11.21)	(3.27)	(10.15)	(3.26)	(3.37)	(0.56)	(1.96)
LgPrc	0.016***	−0.001**	0.014***	−0.001**	−0.005***	−0.002	0.001**
	(14.82)	(−2.36)	(15.06)	(−2.14)	(−4.61)	(−0.52)	(2.52)
LgSize	0.000	0.001***	0.002***	0.001***	0.001***	0.005*	−0.000
	(0.48)	(4.86)	(4.62)	(4.74)	(3.93)	(1.74)	(−0.92)
0LgT							

Table 6
Continued.

Panel B. Predictability of hedging/unwinding demands

Variables	(1) Out-of-sample ROA or changes in ROA	(2)	(3)	(4)	(5)	(6) SUE or analyst revision	(7) Mkt response
	ROA	ΔROA	Ind-adj ROA	Ind-adj ΔROA	SUE	Analyst revision	CAR
DHedging	−0.000	−0.000	−0.000	−0.000	−0.000	−0.002	0.000
	(−0.74)	(−1.28)	(−0.55)	(−1.59)	(−1.00)	(−0.52)	(0.27)
DUnwinding	−0.001**	0.000	−0.001**	0.000	0.000	−0.007	−0.000
	(−2.28)	(0.52)	(−2.12)	(0.35)	(0.65)	(−1.59)	(−1.32)
BM	0.002**	0.002***	0.003***	0.001***	0.004***	−0.041**	0.001
	(2.15)	(3.09)	(3.55)	(2.86)	(3.85)	(−2.51)	(1.57)
Div	0.036***	0.002	0.027**	0.002	0.018	−0.101	−0.019**
	(3.77)	(0.48)	(2.65)	(0.48)	(0.79)	(−1.55)	(−2.49)
LgAge	0.003***	0.001***	0.003***	0.001***	0.001***	0.002	0.000
	(8.43)	(3.27)	(7.79)	(3.04)	(3.38)	(0.55)	(1.52)

Table 7

Persistence in performance of informed demand (fund-level test).

This table examines the persistence in performance that can be generated by informed demand. To do so, we first define fund-level informed long demand for a particular fund f in any given quarter as $DLong_{f,\,i,\,t} = I\{\Delta HFOwn_{f,\,i,\,t} > 0\} \times I\{\Delta SI_{i,\,t} < 0\} = 1$, where $I\{.\}$ is an indicator function, and $\Delta HFOwn_{f,\,i,\,t} = HFOwn_{f,\,i,\,t} - HFOwn_{f,\,i,\,t-1}$ and $\Delta SI_{i,\,t} = SI_{i,\,t} - SI_{i,\,t-1}$ denote the changes in holdings of fund f and short interest, respectively, and quantify the performance for fund f to conduct informed trading as the average DGTW return that can be generated by stocks that have informed long demand as implied by its holdings. In any given quarter, we then sort all funds into ten deciles according to their realized performance in conducting informed trading as exhibited in the 12-month period, and create ten dummy variables to indicate their ranks (Decile 1 to Decile 10 for low to high performance). Models (1) and (2) then regress, in Fama-MacBeth specifications, the out-of-sample quarterly performance or performance rank of informed long demand on the rank dummies of realized performance. We further conduct an F-test on coe cient difference between *Decile 10* and *Decile 1* dummies for each regression model as well as an F-test on the coe cient difference between the summation of *Decile 9* and *Decile 10* and that of *Decile 1* and *Decile 2*. The testing results are of

To further examine the difference in performance persistency between top and bottom funds, we conduct an *F*-test of the difference between the coefficients for the *Decile 10* and *Decile 1* dummies in Model (1). The results are reported in the line "*F-test on Decile 10-Decile 1*" at the bottom of the table. The *F*-test shows that the difference is statistically significant. In other words, the top 10% of funds significantly outperform the bottom 10% of funds in generating out-of-sample performance reflective of informed long demand. Similarly, we also conduct an *F*-test of the difference between the summation of *Decile 9* and *Decile 10* coefficients and that of *Decile 1*

Table 8

The return predictive power of short selling.

This table further explores the return predicting power of short interest. In baseline Model (1), abnormal return is regressed on a dummy variable that takes the value of one when the quarterly short interest change of a stock belongs to the top tercile among all the stocks during the same period and zero otherwise. This dummy variable, labeled "Δ*SI_Top Tercile,*" captures large increases in short interest. In Model (2), we decompose this dummy variable into three components, where each component is represented by a dummy variable. Specifically, conditioning on the occurrence of top-tercile short interest changes (i.e., Δ*SI_Top Tercile=1*), the first (*DShort, Tercile-based*) and the second (*DHedging, Tercile-based*) dummy variables take the value of one when the contemporaneous change in hedge fund holdings of the same stock belongs to the bottom- and the top-tercile among all the stocks, respectively, and the third dummy variable (*D_Others*) takes the value of one otherwise. In Model (3), we further differentiate two scenarios of quarterly short interest changes, depending on whether short interest changes in each month of the quarter are along the same direction (*Consistent SI changes*) or not (*Inconsistent SI changes*), and apply the two scenarios to further further of contemporaneous hedge fund holding changes. We decompose the top-tercile short interest changes into three cases, depending on

Table 9
A placebo test using mutual fund holdings.
This table conducts a placebo test for the baseline quarterly Fama-MacBeth regression of Table 2 by replacing hedge fund holdings by mutual fund holdings as follows:

$$DGTW_{i,t+1} = \alpha_i + \beta_i \times Informed\ Demand^{MF}_{i,t} + C \times M_{i,t} + \epsilon_{i,t+1},$$

where $DGTW_{i,\,t+1}$ refers to the out-of-sample DGTW-adjusted abnormal return of stock i accumulated over quarter $t+1$; $Informed\ Demand^{MF}_{i,t}$ refers to a vector of informed demand variables contrasted from mutual fund holdings; and $M_{i,\,t}$ stacks a list of control variables, including *DIV, LgAge, LgPrc, LgTurn, LgVol*, and *SP500*. More specifically, $Informed\ Demand^{MF}_{i,t}$ is constructed in a similar way as before, except that we replace the aggregate hedge fund holdings information by the aggregate mutual fund holdings information. Models (1) and (2) regress quarterly and annual out-of-sample abnormal return on informed demand variables constructed from the aggregate mutual fund holdings, while Models (3) and (4) regress abnormal return on hedging and unwinding demand variables. Models (5)/(6) and Models (7)/(8) report similar regressions for tercile- and quintile-based informed demand variables, respectively. A detailed definition of these variables is provided in Appendix A. The superscripts ***, **, and * refer to the 1%, 5%, and 10% levels of statistical significance, respectively.

	DLong by changes				DLong by terciles		DLong by quintiles	
	Quarterly (1)	Annual (2)	Quarterly (3)	Annual (4)	Quarterly (5)	Annual (6)	Quarterly (7)	Annual (8)
DLong	−0.001	−0.002			0.001	0.004	0.003	0.008
	(−0.66)	(−0.43)			(0.54)	(0.79)	(0.86)	(1.13)
DShort	0.003	0.003			0.003	0.004	0.002	−0.000
	(1.40)	(0.60)			(1.22)	(0.59)	(0.98)	(−0.10)
DHedging			−0.003	−0.003	−0.002	−0.003	−0.005	−0.009
			(−1.60)	(−0.68)	(−0.93)	(−0.42)	(−1.46)	(−1.27)
DUnwinding			0.002	0.008*	0.005*	0.014*	0.010***	0.011
			(1.24)	(1.75)	(2.01)	(1.71)	(2.88)	(1.24)
Div	−0.015	−0.089	−0.014	−0.087	−0.015	−0.087	−0.013	−0.087
	(−0.42)	(−0.96)	(−0.38)	(−0.92)	(−0.41)	(−0.92)	(−0.35)	(−0.92)
LgAge	0.002	0.010***	0.002	0.010***	0.002*	0.010***	0.002*	0.010***
	(1.66)	(3.54)	(1.60)	(3.59)	(1.68)	(3.66)	(1.68)	(3.57)
LgPrc	−0.006**	−0.031**	−0.006**	−0.031**	−0.006**	−0.031**	−0.006**	−0.031**
	(−2.15)	(−2.57)	(−2.12)	(−2.53)	(−2.13)	(−2.57)	(−2.13)	(−2.56)
LgTurn	0.002	0.007	0.002	0.007	0.002	0.007	0.002	0.007
	(0.69)	(0.84)	(0.71)	(0.82)	(0.82)	(0.79)	(0.75)	(0.80)
LgVol	−0.005	−0.013	−0.005	−0.013	−0.005	−0.013	−0.005	−0.013
	(−0.86)	(−0.72)	(−0.85)	(−0.72)	(−0.85)	(−0.73)	(−0.85)	(−0.73)
SP500	0.007*	0.028**	0.006*	0.028**	0.006*	0.028**	0.006*	0.028**
	(1.99)	(2.57)	(1.92)	(2.57)	(1.76)	(2.46)	(1.81)	(2.49)
Constant	0.006	0.038	0.006	0.036	0.005	0.034	0.004	0.036
	(0.31)	(0.88)	(0.32)	(0.83)	(0.26)	(0.81)	(0.23)	(0.84)
Observations	133,417	126,087	133,417	126,087	133,417	126,087	133,417	126,087
R-square	0.021	0.018	0.021	0.018	0.022	0.019	0.022	0.019

demand), and that using monthly information could significantly increase the power of quarterly SI measures.

5.2. A placebo test based on mutual fund holdings

We now validate the importance of the hedge fund industry in processing information by conducting a placebo test in which we replace hedge fund holdings by mutual fund holdings. More specifically, beginning with Models (7) and (8) of Table 2, we replace informed demand variables in these regressions with similar variables constructed using mutual fund holdings. For instance, *informed long demand* is now defined as $DLong^{MF}_{i,t} = I\{\Delta HFOwn^{MF}_{i,t} > 0\} \times I\{\Delta SI_{i,t} < 0\}$, where $\Delta HFOwn^{MF}_{i,t} = HFOwn^{MF}_{i,t} - HFOwn^{MF}_{i,t-1}$ denotes changes in mutual fund holdings rather than hedge fund holdings.

The results are tabulated in Table 9. Models (1) and (2) regress quarterly and annual out-of-sample abnormal returns on informed demand variables. Models (3) and (4) regress abnormal return on hedging and unwinding demand variables. Models (5)/(6) and Models (7)/(8) report similar regressions for tercile- and quintile-based informed demand variables, respectively. We observe that mutual fund holding implied long and short demand variables are not informative. Hence, our previous analyses and conclusions are applicable only to the hedge fund industry. This finding is important in that it validates our motivation to jointly use hedge fund holdings and short selling information rather than combining the latter information with holdings of other institutional investors such as mutual funds.

5.3. Alternative explanations

Because mutual fund holdings are in general less informed than hedge fund holdings, hedge funds may exploit (less-informed) mutual fund trading, especially when such trading is driven by exogenous factors—such as large inflows and outflows, which may generate price pressures. If so, the aforementioned return predictability may be related to information on “dumb money”—i.e., exploitation of mutual fund flows. More specifically, if hedge funds can buy/sell stocks in which there are large mutual fund inflows/outflows, they may profit from the price effects of subsequent mutual fund trading induced by the inflows/outflows (e.g., Shive and Yun, 2013; Arif, Ben-Rephael, and Lee, 2014 provide evidence on daily frequencies). We therefore examine the relationship between

Table 10
Hedge fund demand and large mutual fund flows.
This table explores how informed demand predicts mutual fund flows. In Models (1)–(4) and Models (5)–(8) of Panel A, we regress, in Fama-MacBeth specifications, large mutual fund inflows and outflows on informed demand and hedging/unwinding demand, respectively. In Models (1), (2), (5), and (6), mutual fund flows at the stock level are measured by quarterly aggregate mutual fund holding changes scaled by lagged trading volume. Models (3), (4), (7), and (8) provide an alternative definition of extreme mutual fund flows, in which we compute the "active" part of mutual fund flows. More specifically, active flow is constructed as the difference between actual and expected number of shares held by mutual funds, divided by lagged trading volume. The expected number of shares held by fund *f* for stock *i* is computed as the value of the stock held by the fund if it keeps the same portfolio weights as last quarter adjusted for the passive effect of stock price change on portfolio weight change using the method of Kacperczyk, Sialm, and Zheng (2005) divided by stock price; we then sum this measure across all funds. Finally, large inflows and outflows are defined as mutual fund flows within the top and bottom 10% of the distribution in terms of magnitude, respectively. Panel B reports the results of Logit regression. To save space, we only tabulate the coefficients for the main variables. A detailed definition of these variables is provided in Appendix A. The full specifications of the regression parameters can be found in the Internet Appendix. The superscripts ***, **, and * refer to the 1%, 5%, and 10% levels of statistical significance, respectively.

Panel A: Fama-MacBeth regression of large mutual fund flows (top 10%) on hedge fund demand

	Total Inflow/Outflow		Active Inflow/Outflow			Total Inflow/Outflow		Active Inflow/Outflow	
	(1) Inflow	(2) Outflow	(3) Inflow	(4) Outflow		(5) Inflow	(6) Outflow	(7) Inflow	(8) Outflow
DLong	−0.006***	0.014***	−0.007***	0.002	*DHedging*	−0.001	−0.007***	0.002	−0.007***
	(−2.97)	(5.84)	(−3.01)	(0.60)		(−0.72)	(−2.95)	(0.70)	(−2.76)
DShort	0.005**	−0.010***	0.008***	−0.001	*DUnwinding*	0.003	0.003	−0.005**	0.013***
	(2.02)	(−4.86)	(3.17)	(−0.39)		(1.15)	(1.12)	(−2.03)	(4.02)
Controls	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Observations	119,644	119,644	119,626	119,626		119,644	119,644	119,626	119,626
R-square	0.057	0.025	0.035	0.113		0.057	0.024	0.034	0.114

Panel B: Logit regression of large mutual fund flows (top 10%) on hedge fund demand

	Total Inflow/Outflow		Active Inflow/Outflow			Total Inflow/Outflow		Active Inflow/Outflow	
	(1) Inflow	(2) Outflow	(3) Inflow	(4) Outflow		(5) Inflow	(6) Outflow	(7) Inflow	(8) Outflow
DLong	−0.061**	0.143***	−0.083***	0.065**	*DHedging*	−0.027	−0.063***	0.024	−0.132***
	(−2.34)	(6.08)	(−3.32)	(2.54)		(−1.06)	(−2.58)	(0.99)	(−5.15)
DShort	0.075***	−0.147***	0.098***	−0.018	*DUnwinding*	0.043*	0.052**	−0.030	0.097***
	(2.91)	(−5.78)	(3.95)	(−0.68)		(1.65)	(2.08)	(−1.20)	(3.59)
Controls	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Observations	119,644	119,644	119,626	119,626		119,644	119,644	119,626	119,626

mutual fund flows and informed demand. To the extent that the price effects are more significant for large flows, especially large outflows (e.g., Coval and Stafford, 2007), we explore whether informed or other demands can forecast large inflows and outflows associated with the mutual fund industry.

In the spirit of Shive and Yun (2013), we use quarterly aggregate mutual fund holding changes (scaled by lagged trading volume) to proxy for flows of capital into and out of stocks. Large stock-level inflows and outflows are subsequently defined as those among the top and bottom 10% in the cross section of mutual fund flows (our results are robust to alternative thresholds, such as 5%). We also provide an alternative definition of extreme mutual fund flows, in which we further compute the "active" part of mutual fund flows inferred from lagged portfolio weights.[17] Then, we regress these measures of large inflows/outflows on lagged hedge fund demand, and report the results in Table 10. We adopt Fama-MacBeth specifications in Panel A and Logit specifications in Panel B. In both panels, Models (1), (2), (5), and (6) and Models (3), (4), (7), and (8) report the results for the main and alternative proxies of flows, respectively.

The results are similar across the two panels. First of all, we find that informed long (short) demand predicts negative (positive) extreme inflows and positive (negative) large outflows. This result is the opposite of what a strategy of riding the price impact of large flows would predict. Hence, if anything, informed demand does not seem to be motivated by exploiting mutual fund flows. Rather, informed demand of hedge funds focuses on firm-specific information which mutual funds are not capable of replicating (e.g., Table 9), and mutual funds in this case may simply supply liquidity for such trades.

More importantly, we find that hedging/unwinding demand does seem to respond to mutual fund flows—i.e., hedge funds trade more on the potential occurrence of large outflows than inflows. If we look at the directions of trading, we see that hedge funds seem to unwind their positions before the occurrence of large outflows (i.e., unwinding demand increases while hedging demand decreases). Hence, hedge funds on average reduce their holdings before mutual fund fire sales, which can help them avoid the associated negative price impact of fire sales.

[17] More specifically, active flow is constructed as the difference between actual and expected number of shares held by mutual funds, divided by lagged trading volume. The expected number of shares held by fund *f* for stock *i* is computed as the value of the stock held by the fund if it keeps the same portfolio weights as last quarter [adjusted for the passive effect of stock price change on portfolio weight change using the method of Kacperczyk, Sialm, and Zheng (2005)] divided by stock price; we then sum this measure across all funds.

Table 11
Net demand and liquidity provision.

This table explores the relationship between liquidity and net demand changes. In Panel A, Models (1)–(3) regress the average turnover ratio of the firm in the concurrent period, the next quarter, and the next year with respect to the informed-demand quarter, on informed demand as well as a list of control variables. Models (4)–(6) apply the same analysis to hedging and unwinding demands. Panel B replaces the turnover ratio by the Amihud illiquidity measure of the corresponding period. To save space, we only tabulate the coe cients for the main variables. A detailed definition of these variables is provided in Appendix A. The full specifications of the regression parameters can be found in the Internet Appendix. The superscripts ***, **, and * refer to the 1%, 5%, and 10% levels of statistical significance, respectively.

Panel A: Turnover ratio vs. *hedge fund demands*

	(1) Concurrent	(2) Next quarter	(3) Next year		(4) Concurrent	(5) Next quarter	(6) Next year
DLong	−0.005***	−0.007***	−0.005***	*DHedging*	0.017***	0.017***	0.013***
	(−4.21)	(−5.62)	(−5.05)		(7.14)	(6.65)	(6.89)
DShort	−0.001	−0.000	−0.002	*DUnwinding*	−0.010***	−0.009***	−0.005***
	(−0.31)	(−0.03)	(−1.23)		(−7.25)	(−6.99)	(−4.78)
Controls	Yes	Yes	Yes		Yes	Yes	Yes
Observations	121,220	121,220	115,282		121,220	121,220	115,282
R-square	0.472	0.422	0.462		0.475	0.424	0.464

Panel B: Amihud illiquidity vs. *hedge fund demands*

	(1) Concurrent	(2) Next quarter	(3) Next year		(4) Concurrent	(5) Next quarter	(6) Next year
DLong	0.000	−0.000	−0.000	*DHedging*	0.000	−0.000	0.000
	(0.08)	(−1.19)	(−1.43)		(0.15)	(−0.28)	(0.02)
DShort	−0.000	0.000	−0.000	*DUnwinding*	0.000	−0.000	0.000
	(−1.27)	(0.16)	(−1.42)		(1.14)	(−0.29)	(1.10)
Controls	Yes	Yes	Yes		Yes	Yes	Yes
Observations	120,504	120,457	114,194		120,504	120,457	114,194
R-square	0.078	0.066	0.069		0.079	0.066	0.069

This pattern is consistent with Shive and Yun (2013). Using the 13F data, these authors find that hedge funds profit from trading against mutual fund flows and that hedge funds trade more on expected mutual fund fire sales than on inflows.

The above benefit alone, however, does not differentiate the potential motivations of hedge fund trading. Particularly, hedge funds may reduce their holdings before the occurrence of fire sales either due to risk management incentives (i.e., to reduce the total exposure to a potential risk) or because of profit-chasing reasons (i.e., to maximize the trading profits that can be reaped from mutual fund flows). Given that fire sales constructed at the stock level reflect the power of the entire mutual fund industry—and thus could be treated either as a source of risk or as a source of profit—it is di cult to judge, ex ante, which strategy will be preferred by the hedge fund industry. Short selling information, however, can be used to further differentiate the two. If hedge funds simply try to maximize trading profits, they should also open new short positions to ride on the negative price impact of fire sales. By contrast, risk management would motivate hedge funds to reduce both long and short positions—and thus their total exposure—to the potential source of risk. Since Table 10 demonstrates that hedge funds choose to also unwind their short positions, their trading behavior is more consistent with risk management incentives. Here again a *joint* analysis of hedge fund long and short information may shed new light on the interpretation of known empirical patterns.

Another possible explanation for the return predictability of informed demand is liquidity provision. If $DLong_{i,\,t}$ and $DShort_{i,\,t}$ are related to liquidity supply, i.e., stock purchases (sales) in the presence of selling (buying) pressure, these variables should be associated with a return premium that compensates for liquidity provision. To examine this potential explanation, we regress liquidity measured in different periods—concurrent, next quarter, and next year[18]—on $DLong_{i,\,t}$ and $DShort_{i,\,t}$. We use two different proxies for liquidity, turnover and the Amihud illiquidity measure.[19] We report the results for the turnover ratio in Panel A of Table 11, and the results for the Amihud illiquidity measure in Panel B. In each panel, we tabulate the results side by side for informed demand in Models (1)–(3) and for hedging and unwinding demands in Models (4)–(6).

Models (1)–(3) of Panel A show that informed long demand reduces concurrent and future liquidity, whereas informed short demand is unrelated to liquidity. The reduction in liquidity suggests that informed long demand, if anything, consumes liquidity rather than supplies it to the market. In Panel B, we find that not only does informed short demand remain unrelated to liquidity at any horizon, but informed long demand loses its power as well. Hence, informed demand does not appear to supply liquidity to the market. Furthermore, because the Amihud measure can also be interpreted as a price impact, informed short demand does not even appear to benefit from a price impact; this conclusion is consistent with our findings in Table 2. Models (4)–(6) in Panel A illustrate that hedging demand and unwinding demand may differ in their relationship with liquidity. However, neither demand is associated with Amihud illiquidity in Panel B, making a clean interpretation di cult to achieve.

Overall, these findings fail to support alternative interpretations of predictability that differ from the discovery of information about firm fundamentals.

6. Conclusion

We investigate the informational content of hedge fund trading through the joint use of information from both the long and short sides. We propose that opposite changes in short interest and hedge fund holdings are likely to be driven by information, whereas simultaneous increases (decreases) in short interest and hedge fund holdings are likely to be motivated by hedging (unwinding) incentives. This intuition allows us to utilize short selling and hedge fund holding information to identify informed long and short demand.

Using this identification strategy, we show that informed demand changes have high predictive power for returns. Furthermore, informed demand predicts out-of-sample firm fundamentals, such as ROA, earnings surprises, analyst revisions, and CARs. By contrast, informed demand does not appear to be driven by mutual fund flows or liquidity provision. These findings suggest that the observed return predictability of informed demand can be explained in terms of the discovery of information about firm fundamentals. This process, in turn, can be interpreted as reflecting a type of managerial skill in the hedge fund industry.

Our results suggest that short selling and hedge fund holdings complement each other in revealing important trading motivations of informed fund managers. More research that integrates short selling and hedge funds could therefore be fruitful in providing insights into information dissemination and asset price formation in the market.

Appendix A. Variable definitions

Informed and hedging (unwinding) demand variables	
DLong	Informed long demand: $DLong_{i,t}=I\{\Delta HFOwn_{i,t}>0\}\times I\{\Delta SI_{i,t}<0\}$, where $I\{.\}$ is an indicator function, and $\Delta HFOwn_{i,t}=HFOwn_{i,t}-HFOwn_{i,t-1}$ and $\Delta SI_{i,t}=SI_{i,t}-SI_{i,t-1}$ denote the changes in hedge fund holdings and short interest, respectively. *DLong* based on tercile or quintile partitions of $\Delta HFOwn$ and ΔSI is used in various tests as indicated in the tables.
DShort	Informed short demand: $DShort_{i,t}=I\{\Delta HFOwn_{i,t}<0\}\times I\{\Delta SI_{i,t}>0\}$. *DShort* based on tercile or quintile partitions of $\Delta HFOwn$ and ΔSI is used in various tests as indicated in the tables.
DHedge	Hedging demand: $DHedge_{i,t}=I\{\Delta HFOwn_{i,t}>0\}\times I\{\Delta SI_{i,t}>0\}$. *DHedge* based on tercile or quintile partitions of $\Delta HFOwn$ and ΔSI is used in various tests as indicated in the tables.
DUnwind	Unwinding demand: $DUnwind_{i,t}=I\{\Delta HFOwn_{i,t}<0\}\times I\{\Delta SI_{i,t}<0\}$. *DUnwind* based on tercile or quintile partitions of $\Delta HFOwn$ and ΔSI is used in various tests as indicated in the tables.
Stock performance and control variables	
$DGTW_i$	Benchmark-adjusted abnormal returns constructed following the method of DGTW (1997). Specifically, $DGTW_i$ is computed as the return of stock i net of the return of its style benchmark based on cross-sectional quintile partitions of market capitalization, book-to-market ratio, and prior 12-month returns.
Div	Dividend yield calculated as dividends divided by market capitalization.
Age	Number of months since the stock first appears in CRSP.
Prc	Price per share.
Turn	The average turnover (volume divided by shares outstanding) in the last month prior to the beginning of the quarter.
Vol	The standard deviation of returns over the past 24 months.
SP500	A dummy equal to one for stocks in the S&P 500 index and zero otherwise.
Characteristics related to anomalies	
B/M	Book-to-market ratio, defined as the book value of equity at the fiscal-year-end of the fiscal year ended before the most recent June 30, divided by the market capitalization on December 31 of that fiscal year.
Size	Market capitalization (in $ millions), defined as the product of stock price and the number of shares outstanding.
Lag Ret	Cumulative return from month −11 to month 0.
Gross profit to asset	Gross profit divided by total assets.
Operating profit	Gross profit minus selling, general, and administrative expenses minus interest expense, divided by book value of equity. Stocks with missing or negative book value are dropped.
Asset growth	Total assets divided by total assets of the previous fiscal year and then minus one.
Investment growth	Capital expenditure divided by capital expenditure of the previous fiscal year.
Net stock issuance	The split-adjusted shares outstanding divided by the split-adjusted shares outstanding of the previous fiscal year and then minus one. The split-adjusted shares outstanding are calculated as shares outstanding times the adjustment factor (AJEX).
Accruals	Change in operating working capital per split-adjusted share from last to current fiscal years divided by book value of equity per split-adjusted share. Operating working capital is computed as current assets minus cash and short-term investments minus the difference of current liability and debt in current liabilities.
Net operating assets	Operating assets minus operating liabilities, scaled by total assets at the end of last fiscal year. Operating assets are computed as total assets minus cash and short-term investment. Operating liabilities are computed as total assets minus debt included in current liabilities (filled as zero if missing) minus long-term debt (filled as zero if missing) minus minority interests (filled as zero if missing) minus book value of preferred stocks as described in the definition of book equity (filled as zero if missing), and minus common equity.

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