How Constraining Are Limits to Arbitrage?

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We document the existence of a strategy designed to circumvent limits to arbitrage. Faced with short-sale constraints and noise trader risk, small arbitrageurs publicly reveal their information to induce the target’s shareholders (“the longs”) to sell, thereby accelerating price discovery. Using data for 124 short-sale campaigns in the United States between 2006 and 2011, we show that investors respond strongly to the information, with spikes in SEC filing views, volatility, order imbalances, realized spreads, turnover, and selling by the longs. Share prices fall by an aggregate $14.8 billion. Our findings imply that even extreme short-sale constraints need not constrain arbitrage. (JEL G12, G14, G23, G2)

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Imagine you have reason to believe that a particular stock is severely overvalued. Unfortunately, the market does not share your assessment: stock lenders are demanding high shorting fees, there are few stocks available for borrowing, and you have shallow pockets. What do you do?

Received wisdom tells you to walk away: the short-sale constraints you face are so severe that you cannot take a large enough short position to profitably correct the overvaluation, and even if you could, you would face the risk of the mispricing getting worse in the short-run, triggering margin calls, thereby forcing early liquidation of your position at a loss. This combination of short-sale constraints and what DeLong and others (1990) call noise trader risk results in mispricing persisting, which limits the market’s informational efficiency.

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Received wisdom needs reevaluating. We document the existence of an increasingly popular informational arbitrage strategy that is designed to circumvent limits to arbitrage of this kind. The strategy turns conventional arbitrage on its head. Instead of identifying a suitable target and quietly shorting its stock until the price adjusts, the arbitrageur publicly reveals her information. The aim is to engage the one group of investors who are not constrained: the target’s current shareholders (“the longs”). If the longs can be persuaded to sell, this will not only correct the mispricing but, in the process, will also accelerate price discovery and so reduce the duration (and hence risk) of the arbitrage gap. Prominent examples of this arbitrage strategy include Muddy Waters’ June 2011 report on Sino-Forest, a Chinese company listed in Toronto, which a year later went bankrupt, and Citron Research’s January 2011 report on China MediaExpress, a Chinese company delisted from NASDAQ 6 weeks later.

For the strategy to work, it is critical that the arbitrageurs (or “arbs” for short) provide information that is both credible and cannot be ignored. They do so by way of detailed reports, which they make available for free and to which they draw maximum media attention. The reports contain a wealth of new facts, often assembled with the help of forensic accountants and professional investigators, and tend to focus on questionable governance practices and aggressive accounting (sometimes bordering on fraud). They often include “smoking guns” in the form of recorded phone calls, video surveillance, and photographs. By presenting new facts that are impossible to ignore or dismiss out of hand, the arbs hope to induce a stampede (similar to a bank run), in which no long investor wants to be the last to sell.

Our sample consists of 31 arbitrageurs who are either individuals or small boutique hedge funds. We show that the arbs target companies with the most potential for overpricing, namely those with high idiosyncratic volatility (Pontiff 2006) or severe short-sale constraints in the form of a low and inelastic supply of shortable stock, high lending fees, and expensive put options. Despite these constraints, the arbs manage to correct mispricing. On average, the prices of the 124 target companies in our sample fall by around 7.5% when a report is released to the public and then continue to drift lower as further negative information comes to light: down by 21.4% to 26.2% over 3 months and by 42.3% to 47.3% over 12 months (depending on the benchmark used). Based on

1 A few words on terminology: it is useful to distinguish between informational arbitrage, which is risky because there is no perfectly correlated asset with which to hedge the short position in the overvalued stock, and statistical arbitrage as defined by Bondarenko (2003). To avoid clutter, we refer to the former as simply arbitrage. We follow the literature on risky arbitrage and use the term arbitrageur rather than the more generic term short seller. This helps distinguish our arbitrageurs from other short sellers (discussed in Section 4) who might mimic their trades in the spirit of Eber and Brunnermeier (2003).

2 Around half of the companies in our sample are Chinese firms listed in the United States; the other half are American.
the 3-month change in market value, we estimate that the average target was overvalued by an economically meaningful $119.7 million.

The observed price corrections appear sufficiently large to make arbitrage profitable. We estimate that the arbs earn cumulative abnormal profits averaging 24.1% over 3 months, net of short-sale fees, and risk-adjusted using the three Fama-French factors and a momentum factor. In dollar terms, these trading profits amount to $241,000 in gains for every $1 million in shorts. Given their shallow pockets and the unusually “tight” shorting conditions for their targets, the arbs can only short a few million dollars, which we estimate is nonetheless likely sufficient to cover the information production costs they incur in identifying and investigating their targets.

Much of our analysis focuses on empirically identifying the mechanism that allows these small information producers to move prices and thereby make profits on their short positions. Consistent with our argument that their aim is to induce unconstrained long investors to trade on their behalf, we find that investors appear to pay attention. Investors show abnormally high interest in targets’ SEC filings, with filing views up by an average of 80.7% the day the arbs release their reports. Volatility spikes up by 236% on average, as market participants process the information and share turnover spikes by even more, up by 339%.

We find that very little of the price correction comes from the short side of the market, consistent with our argument that the arbs seek to induce the longs to trade on their behalf. While we see evidence of the arbs building significant (albeit relatively small) short positions before releasing their reports, once the reports are out, there is no further abnormal shorting activity. This reflects a dramatic worsening in short-sale constraints: fees for initiating new shorts jump by 50% on average when a report is released, putting them in the 79th percentile of the distribution of all stocks in CRSP. Over the next 3 months, fees continue to climb, reaching the 86th percentile (up by 174% compared to the prerelease period). At the same time, the supply of stock available for borrowing falls, and put options become unusually expensive.

The price falls instead come about because of the trading behavior of the one group of investors who are unconstrained: investors with long positions in the targets. Our data show that turnover involving longs spikes by 524% on average when an arb releases her report; with the average institutional investor who is long, the target’s stock (according to ANcerno) selling 43.6% of its holding over the course of the report day and fully 65% of the average target’s long investors being net sellers that day. These patterns imply a massive increase in liquidity demand, which, coupled with the fact that widespread selling by the longs causes order imbalances to build up, results in liquidity providers increasing realized bid-ask spreads by 94.8% on average.

Clearly, the reports should only induce the longs to sell if the information they contain is credible. When we condition investors’ responses on an arb’s track record, we find that only arbs with a history of making credible claims

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(those with reports that have proved profitable in the past) are able to induce the longs to sell and thereby put pressure on a target’s share price. Moreover, it is only reports by credible arbs that generate profits, net of shorting fees: absent credibility, prices do not fall significantly.

Credibility matters, but not absolutely. To be listened to, an arb also has to have something new to say. We show that reports that present new facts previously unknown to investors result in longs selling and rapid price corrections, whereas reports that merely reinterpret known data do not. As a result, only reports that contain “scoops” generate significant profits for the arbs.

There is no indication that the arbs in our sample are “bear raiders” intent on manipulating share prices by disseminating falsehoods (a strategy sometimes called “short and distort”). In fact, subsequent events usually prove the arbs factually right. For example, 50% of targets are later delisted; 47% replace their auditors or see their auditors resign; and 23% restate earnings. Investigations by third parties such as the SEC, the Department of Justice, or a stock exchange come to similar conclusions as the reports in fully 90% of the cases. This is remarkable given that our sample is unbiased: we have a complete, ex ante list of target companies (rather than a self-reported selected list of only those that made money for the arbs).

Our study contributes to the asset-pricing and behavioral-finance literatures by showing that arbitrage need not be limited even when short-sale constraints are formidable, noise trader risk is high, and the arbitrageur has only limited capital and so little hope to correct mispricing on her own. In fact, the arbs in our sample are attracted to firms with extreme short-sale constraints (such as the targets in our sample) precisely because they are most likely to be overpriced. But the short-sale constraints are not meaningfully binding (beyond limiting the size of the arbs’ short position): it is by inducing the unconstrained longs to sell that the arbs correct the mispricing and turn a profit.

Our study also sheds light on how short sellers produce and transmit information. There is little prior evidence on what short sellers know or how they acquire information. Our data allow us to observe the information-discovery process at the level of individual information producers and to study how the information the arbs discover is then incorporated in security prices.3

Our findings highlight the economic importance of small arbitrageurs, such as those in our sample, to the market’s informational efficiency: while the extent of overvaluation—an aggregate of $14.8 billion across the 124 targets—is large, the magnitude of the arbitrage opportunity is relatively small, owing

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3 Previous research on short sales finds that they predict lower subsequent returns (Figlewski 1981; Amihud et al. 2008), and target overvalued firms (Dechow et al. 2001), and often precede negative corporate events such as negative earnings announcements, analyst downgrades, or financial misconduct. Christopher, Ferris, and Agee (2004); Ocean, Rho, and Vermaelen (2004); Christophe, Ferris, and Hassell (2007); Karpoff and Lee (2016). However, Engelberg, Reed, and Ringgenberg (2012) find that the short sellers in their sample are more likely to trade after corporate events. Another strand of the literature documents that short-sale constraints lead to overvaluation by withholding negative information from the market (Amihud and Thaler 1988; Nagel 2003; Beneish, Lee, and Nachman 2013).
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to the difficulty of shorting these particular targets. If it is too small to attract
the attention of deep-pocketed arbitrageurs, overvaluation will persist unless
small information producers, such as the arbs in our sample, can go after it
profitably.

What can and cannot be arbitraged this way? Because persuading the longs
to sell is key, arbs are unlikely to target companies for which new and
persuasive facts cannot easily be discovered at reasonable cost. This may seem
to rule out the possibility that the arbs can help prick asset-pricing bubbles.
Nonetheless, they may inadvertently contribute to doing so. As Kovbasyuk
and Pagano (2014) show in a contemporaneous theory paper, “advertising”
arbitrage opportunities can be particularly effective when the mispricing is
caused by limited attention: by focusing unconstrained investors’ attention
on a mispriced stock, mispricing can be reduced. This, in turn, can help
deflate broader bubbles. When confronted with new information about specific
targets, investors may start to pay closer attention to similar companies whose
characteristics make them unsuitable targets for the arbs. We present suggestive
evidence consistent with such informational spillovers. Specifically, we show
that as a critical mass of negative reports about Chinese companies listed in
the United States accumulated, other U.S.-listed Chinese stocks eventually saw
steep price falls.

1. Conceptual Framework

To frame our empirical analysis, consider an informational arbitrageur who is
risk averse and has limited capital. The arb’s strategy is to identify overvalued
stocks and trade against them. Doing so is both risky and costly. The main
risk is that targets could become even more overvalued, resulting in potentially
ruinous margin calls. DeLong and others (1990) label this noise trader risk.
The main cost of trading against overvalued stocks is the cost of initiating and
maintaining a short position.4 The more risk averse the arb, the more limited
her capital, or the higher the shorting costs are, the smaller the short position
the arb can take. And the smaller the short position is, the less likely it is that the
arb can exert sufficient downward pressure through shorting alone to correct
the overpricing.

To identify overvalued targets, the arb invests in the production of
information about the target. (We provide specific examples in Section 3.)

4 Short selling involves a shorting fee, which the short seller pays the stock lender in return for borrowing the stock
and the opportunity cost of the capital tied up through margin calls. Short sales tie up considerable amounts of
capital. Under Regulation T, the short seller is required to deposit the proceeds of the short sale in her margin
account, along with an additional 50% of the value of the short sale. In addition to this 150% initial margin
requirement, the short seller faces margin calls when the price of the stock moves against him. Under Regulation
T, this maintenance margin requirement amounts to 100% of the current value of the short sale plus a minimum
of 25%, though many brokers set higher additional margins. The short seller is required to post additional capital
when the stock price rises such that the maintenance margin exceeds the initial margin. When the stock price
falls such that the maintenance margin is below the initial margin, the excess margin capital is released to the
short seller.

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Naturally, the arb conditions her choice of how much to short on the signal she acquires, subject to the exogenous short-sale constraints she faces: all else equal, a stronger signal will prompt the arb to short more aggressively.

Maintaining the assumption that the arb cannot induce convergence to fundamental value through her trading alone, she remains exposed to noise trader risk however strong her signal. To counteract this risk, the arb may disclose her signal to the market. Her aim in doing so is to convince the long investors that the target is indeed overvalued and thus to persuade the longs to sell. If successful, disclosing her signal accelerates the price adjustment (thanks to the longs selling) and so reduces her exposure to noise trader risk. It also sidesteps the short-sale constraints that prevent her from correcting the mispricing through shorting alone: the longs, after all, face no constraints in selling the stock.

In equilibrium, there will be circumstances in which noise trader risk is so low that the arb need not disclose her signal publicly and instead waits for the market to discover the signal independently. This is the classic arbitrage strategy: short and keep mum. Because U.S. regulations do not require short positions to be disclosed, this strategy is difficult to capture in the data.

Our empirical focus is instead on circumstances in which it is optimal for the arb to disclose her signal publicly given her information production cost and the short-sale constraints she faces. The expected information production cost may be so high relative to the expected trading gain given short-sale constraints that the arb will refrain from investigating a particular target. Information production costs thus constrain the arb’s choice of target.

Credibility is key for the short-and-disclose strategy to work: the arb can only hope to induce the longs to sell if the signal she discloses is considered credible. Credibility in turn is a function of the arb’s reputation (i.e., her past track record of disclosing signals that were *ex post* verified to be true) and the quality of her evidence about the current target. We thus expect the longs to respond more strongly to the arb disclosing her signal, and the share price to fall by more, the better the arb’s reputation and the more compelling the signal she discloses.

We leave a richer model of arbs’ strategic choices to future work and focus instead on providing empirical support for the basic building blocks of such a model outlined above. For example, it would be interesting to explore the optimal timing of the arb’s disclosure. Early disclosure may be motivated by the arb’s signal being short-lived (for example, if it is likely that other arbs may discover the same signal). At the same time, given short-sale constraints, early disclosure may limit the size of the arb’s short position. A fuller treatment of these and other trade-offs requires a richer model than we are able to test, not least because we do not observe the delay between acquiring and disclosing the signal in our data.
2. Sample and Data

2.1 Arbitrageurs and reports
The arbitrage strategy we describe relies on publicity to induce the longs to sell and thereby generate a return on identifying overvalued companies. This makes finding the relevant arbitrageurs relatively straightforward: they are in the habit of drawing attention to their reports via the media and popular investor websites such as seekingalpha.com.

We search news sources (accessed via Factiva), as well as the Internet, for information producers who satisfy three main criteria: they target what they claim are overvalued companies listed in the United States, they disclose having a short position, and they share their information freely with the investing public in the form of written reports. The second criterion filters out bloggers who post casual comments on Internet forums and so restricts the sample to investors who make a living from information production. The third criterion filters out larger hedge funds that restrict access to their information to their own investors via password-protected websites or that “talk their book” at invitation-only investor conferences not open to the public. Our sample of targets starts in July 2006 (when DataExplorers first makes daily shorting data available). It ends in December 2011 to allow us to track their subsequent performance through 2015.

Our search yields 31 arbs, listed in Table 1. The pioneer is Asensio & Co., which was founded in 1992 and started publishing reports on overvalued companies in 1994. The most prolific arb in our sample is Citron Research, which has been in business since 2001 and which describes itself as an “activist short seller.” A firm that has come to prominence in the media is Muddy Waters, which describes itself as a “pioneer in on-the-ground, freely published investment research.”

Because private firms in the United States do not generally have to make public disclosures, we are unable to provide summary statistics on the 31 arbs. Inspection of their websites suggests that they are either one-man-bands or small hedge funds. Except for Asensio & Co., Bronte Capital, Kerrisdale, and Spruce Point, none of the arbs currently is, or has ever been, registered as an investment adviser or broker-dealer with the SEC or FINRA, suggesting that the arbs generally do not manage money on behalf of external clients (at least not in the United States).

What is unique about our setting is that these small and presumably shallow-pocketed arbs not only trade against overvaluation but also share the information they acquire with investors. For each arb, we collect every report for every target, so there is no selection bias. Specifically, from the arbs’

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5 To check how comprehensive our list of reports is, we use the Internet Archive (also known as the Wayback Machine), which stores historical web pages. We find no instance of an arb removing any reports.
Table 1
Summary statistics: Arbitrageurs

<table>
<thead>
<tr>
<th>Year started</th>
<th>Number of first reports</th>
<th>Number of covered reports</th>
<th>Total number of reports</th>
<th>Mean abnormal return on report date (first reports only)</th>
<th>Mean from report date to trading day (first 60 reports only)</th>
<th>Mean CAR from report date to trading day from 5 to trading day 60 (first reports only)</th>
<th>Fraction of all reports coded as “more credible”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citron Research</td>
<td>2001</td>
<td>43</td>
<td>46</td>
<td>106</td>
<td>−7.2</td>
<td>−27.4</td>
<td>23.5</td>
</tr>
<tr>
<td>Bronte Capital</td>
<td>2008</td>
<td>9</td>
<td>12</td>
<td>33</td>
<td>−5.8</td>
<td>7.4</td>
<td>−5.2</td>
</tr>
<tr>
<td>GeoInvesting</td>
<td>2011</td>
<td>8</td>
<td>10</td>
<td>16</td>
<td>−12.1</td>
<td>−46.9</td>
<td>48.2</td>
</tr>
<tr>
<td>Ian Bezek</td>
<td>2009</td>
<td>7</td>
<td>9</td>
<td>14</td>
<td>0.5</td>
<td>−27.3</td>
<td>28.9</td>
</tr>
<tr>
<td>Shareholder Watchdog</td>
<td>2009</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>−6.0</td>
<td>−38.9</td>
<td>30.4</td>
</tr>
<tr>
<td>Alfred Little</td>
<td>2010</td>
<td>6</td>
<td>13</td>
<td>37</td>
<td>−17.9</td>
<td>−28.5</td>
<td>29.7</td>
</tr>
<tr>
<td>Muddy Waters</td>
<td>2010</td>
<td>5</td>
<td>6</td>
<td>13</td>
<td>−17.3</td>
<td>−20.1</td>
<td>19.2</td>
</tr>
<tr>
<td>Kerrisdale Capital</td>
<td>2009</td>
<td>4</td>
<td>8</td>
<td>11</td>
<td>−7.5</td>
<td>−28.9</td>
<td>34.9</td>
</tr>
<tr>
<td>Asensio &amp; Co.</td>
<td>1994</td>
<td>4</td>
<td>5</td>
<td>34</td>
<td>−9.3</td>
<td>−42.2</td>
<td>42.8</td>
</tr>
<tr>
<td>Spruce Point</td>
<td>2010</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>−2.7</td>
<td>−40.5</td>
<td>42.8</td>
</tr>
<tr>
<td>Chiman Sang</td>
<td>2009</td>
<td>3</td>
<td>9</td>
<td>18</td>
<td>1.0</td>
<td>−8.6</td>
<td>21.2</td>
</tr>
<tr>
<td>Proscience Investment</td>
<td>2011</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>−14.5</td>
<td>−13.9</td>
<td>−25.4</td>
</tr>
<tr>
<td>Absaroka Capital Management</td>
<td>2011</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>−5.5</td>
<td>−48.1</td>
<td>40.2</td>
</tr>
<tr>
<td>Chinese Company Analyst</td>
<td>2010</td>
<td>2</td>
<td>4</td>
<td>11</td>
<td>1.0</td>
<td>−10.4</td>
<td>9.2</td>
</tr>
<tr>
<td>The Forensic Factor</td>
<td>2011</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>−10.4</td>
<td>−28.6</td>
<td>11.6</td>
</tr>
<tr>
<td>Glaucus Research</td>
<td>2011</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>−5.0</td>
<td>−0.5</td>
<td>1.7</td>
</tr>
<tr>
<td>OLP Global</td>
<td>2010</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>−3.9</td>
<td>−12.6</td>
<td>14.3</td>
</tr>
<tr>
<td>Average (across the 17 repeat arbs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>−7.2</td>
<td>−22.8</td>
<td>21.6</td>
</tr>
<tr>
<td>Average (across the 14 one-time arbs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>−9.5</td>
<td>−31.8</td>
<td>28.3</td>
</tr>
</tbody>
</table>

The sample contains 31 arbitrageurs who target 124 firms with 358 reports over the period from July 2006 to December 2011. Note that there are 126 first reports on 124 target companies, as two arbs release first reports on the same day in the case of two target companies. The table presents (for each of the 17 repeat arbs individually and for the 14 one-time arbs as a group), summary statistics on the number of reports and target firms, postrelease returns and profits, and the credibility of the arbs’ reports. Year started is the year in which the arb first released a report on an overvalued target. (Citron Research and Asensio & Co. started before the beginning of our sample period.) For variable definitions and details of their construction, see Appendix A.

We ignore reports published after December 2011, so that we have sufficient postreport share prices in CRSP to identify subsequent price corrections and measure the arbs’ trading profitability. We remove 31 reports on firms that are traded over-the-counter or on the Pink Sheets (for which we have no share price or other trading data) and 12 reports on firms that are listed outside the United States (for which we have no short selling data; this filter removes perhaps the most famous target firm, Sino-Forest, which was listed in Toronto). This process leaves a set of 358 reports.

Of the 31 arbs in our sample, 14 initiate coverage on a single company over our sample period. The remaining 17 “repeat” arbs publish an average of 20 reports each. As Table 1 shows, Citron Research accounts for 106 of the reports,

6 Four of the arbs (Chimin Sang, Ian Bezek, Shareholder Watchdog, and The Forensic Factor) do not have websites of their own and disseminate their research solely via third-party websites such as SeekingAlpha. As we show in the Online Appendix, our results are qualitatively unchanged if we exclude these four arbs from the sample.
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followed by Alfred Little with 37 reports, and Asensio & Co. with 34 reports. (The Online Appendix shows that all of our results are qualitatively unchanged if we exclude Citron from the sample.)

In total, the 31 arbs target 124 U.S.-listed companies over our sample period. This means there are 2.9 reports per company on average. Of the 358 reports in our sample, 126 are “first” reports in which a company is targeted by one of the arbs for the first time. (In two cases, two arbs initiated coverage of the same company on the same day.) The remaining 232 are follow-on reports, usually written by the same arb, though in 25 cases authored by one or more other arbs. Citron Research publishes the most first reports (43), followed by Bronte Capital (9). Given its longer history, Citron also covers the largest number of targets (46).

To dispel the notion that the patterns we document are driven by Chinese companies listed in the United States, which have received bad press over the last few years, we note that far from all sample companies are Chinese: 60 of the 124 companies come from China (48.4% of the sample) and the remaining 64 come from the United States (51.6%). As the Online Appendix shows, our results are qualitatively unchanged if we exclude Chinese targets from the sample.7

For each target firm in our sample, we know the arb who first targeted it and the exact date of each report. (We describe the target companies in Section 2.3 and the contents of the reports in Section 3.) We also extract information on material events before and after a report is released from SEC filings (such as 10-Ks, 10-Qs, and 8-Ks) and from Factiva. This gives us a complete timeline of all material events surrounding each report through October 2015.

Table 1 presents, for each of the 31 arbs, summary statistics for abnormal share-price returns on the day a company first becomes a target, cumulative abnormal returns from the report date to 60 trading days later, and an estimate of the arb’s trading profit. (For all variable definitions and details of their construction, see Appendix A.) For 14 of the 17 repeat arbs, share prices fall on average when a report is released. Alfred Little has the largest immediate market impact, averaging −17.9%, followed by Muddy Waters at −17.3% and Prescience Investment at −14.5%. The average repeat arb’s average report is associated with a 7.2% price fall. One-time arbs have a similar market impact, averaging a −9.5% price fall when sharing their information.

Measured over 3 months from the release date, 15 of the 17 repeat arbs see significant price falls (adjusted for the three Fama-French factors and momentum). Over this timeframe, Absaroka Capital Management has the largest price correction, averaging −48.1%, followed by GeoInvesting at −46.9% and Asensio & Co. at −42.2%. In the 3 months following a first

7 This finding mirrors Lee, Li, and Zhang’s (2014) conclusion that Chinese firms listing in the United States through reverse takeovers do not differ much from their U.S. counterparts, despite the bad press a minority of them have received.
report, prices fall by 22.8% and 31.8% on average for the average repeat and one-time arb, respectively. Only two repeat arbs see prices move against them on average over this timeframe.

As an estimate of the arbs’ trading profits, Table 1 reports returns to a marked-to-market borrow-and-hold strategy that shorts the target stock 5 days before the report day and closes out the short position 3 months after the report is released.8 The returns are net of shorting costs and risk-adjusted using the three Fama-French factors and momentum. By this measure, GeoInvesting’s reports yield the highest returns, averaging 48.2% over 3 months (not annualized), followed by Asensio & Co. at 42.8% and Spruce Point at 42.8%. For the average repeat and one-time arb, this borrow-and-hold strategy yields an average return of 21.6% and 28.3%, respectively.9

2.2 Other data sources
Daily price and trading data for the target companies are obtained from CRSP, accounting data from Compustat, intraday share-price data from Trade and Quote (TAQ), option data from OptionMetrics, and institutional trading data from ANcerno. Equity lending data come from DataExplorers, a research company that collects lending data directly from the security lending desks of leading financial institutions. The database contains comprehensive information on the supply of shares available for borrowing, the number of shares out on loan, and loan fees for over 85% of the global equity lending market (though our subscription covers only the U.S. market).10 Following convention, we proxy for actual short sales using shares out on loan.11

2.3 Target companies
Table 2 characterizes the 124 target companies by providing a snapshot of firm characteristics and shorting conditions as of 1 month before a first report is released. At that time, the average target is a midcap stock; its market capitalization of $969.3 million puts it in the 54th percentile of the distribution of CRSP firms. It has a book-to-market ratio of 0.38 (equal to the 28th percentile) and so comes from the growth part of the value-growth spectrum. Its daily share turnover averages 1.13% of shares outstanding (70th percentile). And it is fairly liquid, with an Amihud (2002) illiquidity measure of 0.06 (44th percentile).

Shorting conditions are relatively tight. One month before the first report is released, the average target company has a shorting fee of four basis points a
How Constraining Are Limits to Arbitrage?

Table 2
Summary statistics: Target firms

<table>
<thead>
<tr>
<th>Firm characteristics</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Lower quartile</th>
<th>Median</th>
<th>Upper quartile</th>
<th>Percentile in CRSP universe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market capitalization ($ million)</td>
<td>969.3</td>
<td>2,152.8</td>
<td>162.6</td>
<td>332.7</td>
<td>792.3</td>
<td>0.54</td>
</tr>
<tr>
<td>Book/market ratio</td>
<td>0.38</td>
<td>0.30</td>
<td>0.16</td>
<td>0.31</td>
<td>0.58</td>
<td>0.28</td>
</tr>
<tr>
<td>Daily turnover (%)</td>
<td>1.13</td>
<td>2.28</td>
<td>0.26</td>
<td>0.50</td>
<td>0.96</td>
<td>0.70</td>
</tr>
<tr>
<td>Monthly Amihud illiquidity measure</td>
<td>0.06</td>
<td>0.25</td>
<td>0.00</td>
<td>0.01</td>
<td>0.03</td>
<td>0.44</td>
</tr>
<tr>
<td>Monthly idiosyncratic volatility (%)</td>
<td>3.61</td>
<td>3.11</td>
<td>1.95</td>
<td>2.87</td>
<td>4.31</td>
<td>0.76</td>
</tr>
</tbody>
</table>

| Shorting conditions         |        |           |                |        |               |                            |
| Daily shorting fee (%)      | 0.04   | 0.06      | 0.00           | 0.01   | 0.05           | 0.74                       |
| Lendable (%)                | 5.43   | 7.80      | 0.22           | 1.45   | 7.46           | 0.40                       |
| Utilization (%)             | 67.48  | 36.08     | 33.01          | 87.77  | 99.17          | 0.83                       |
| Put-call implied volatility ratio | 1.15   | 0.26      | 1.02           | 1.07   | 1.19           | 0.69                       |

The sample contains 124 firms targeted by 31 arbs over the period from July 2006 to December 2011. The table reports summary statistics for key firm characteristics, measured as of the most recent calendar month before the release of the first report on the target. For each characteristic, the final column reports the percentile rank of the average target firm in the CRSP universe 1 month before the report release date. For variable definitions and details of their construction, see Appendix A.

day (10.1% annualized), which is in the right tail of the CRSP distribution (74th percentile). Consistent with Beneish, Lee, and Nichols (2013), this reflects a relatively tight supply of lendable stock: on average, only 5.43% of shares outstanding are available for borrowing (40th percentile), and 67.5% of the available shares are utilized, i.e., out on loan (83rd percentile). Putting downward pressure on a target’s share price via the options market would also be difficult because its put options are unusually expensive: the ratio of the implied volatility of puts to the implied volatility of calls on the target’s shares—which absent short-sale constraints would equal one—averages 1.15 (69th percentile). Finally, idiosyncratic volatility is high, averaging 3.61% per month (76th percentile). As Pontiff (2006) argues, high idiosyncratic volatility imposes a high holding cost on short sellers.

In sum, targets are growth companies of average size whose shares are heavily traded and quite liquid. But they are also difficult to arbitrage, as shorting fees are high, the supply of lendable stock is tight, put options are pricey, and volatility is high. And yet, as we will show, arbitrageurs manage to systematically correct mispricing in spite of these short-sale constraints.

3. Discovering Mispricing

3.1 Identifying mispriced firms

While we do not know how the arbs identify targets, there are some telltale signs. The arbs typically pick up suspicious signals from publicly observable information that the market, arguably, had simply missed or misinterpreted. As Table 3 shows, sell-side securities analysts had positive ratings on target stocks.
Table 3
Sell-side analysts’ views of companies targeted by sample arbs

<table>
<thead>
<tr>
<th>Event window</th>
<th>Mean recommendation score</th>
<th>Median recommendation score</th>
<th>Number of recommendations</th>
<th>% buy recommendation</th>
<th>% hold recommendation</th>
<th>% sell recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>(−60,−1)</td>
<td>2.01</td>
<td>2.01</td>
<td>6.88</td>
<td>71.68</td>
<td>21.96</td>
<td>6.36</td>
</tr>
<tr>
<td>(0,60)</td>
<td>2.04</td>
<td>2.01</td>
<td>6.91</td>
<td>70.10</td>
<td>23.00</td>
<td>6.90</td>
</tr>
<tr>
<td>(0,252)</td>
<td>2.10</td>
<td>2.08</td>
<td>6.78</td>
<td>64.84</td>
<td>27.93</td>
<td>7.23</td>
</tr>
<tr>
<td>(−60,−1) minus (0,60)</td>
<td>0.03</td>
<td>0.01</td>
<td>0.03</td>
<td>−1.59</td>
<td>1.04</td>
<td>0.55</td>
</tr>
<tr>
<td>(0,252) minus (−60,0)</td>
<td>0.09</td>
<td>0.07</td>
<td>−0.10</td>
<td>−6.84***</td>
<td>5.97**</td>
<td>0.87</td>
</tr>
</tbody>
</table>

Table 3 reports sell-side analyst recommendations accessed through the I/B/E/S summary files in the 60 trading days before the release of a first arb report on a target firm, as well as the 60 and 252 trading days after. For variable definitions and details of their construction, see Appendix A. We use ** to denote significance at the 5% level.

Before the arbs released their reports. Based on data from the I/B/E/S summary files, the consensus recommendation for the average target was 2.01 (i.e., a buy) measured over the 60 trading days before the report date, with 72% of analysts rating the average target a buy or a strong buy. There is little immediate evidence of analysts incorporating the arbs’ information in their recommendations. In the 60 trading days following the report day, the consensus recommendation for the average target remains 2.01 (i.e., a buy), with virtually the same fraction of analysts (70%) maintaining a buy or strong buy recommendation. Only over a 1-year window after a report do we see any significant updating, with the fraction of analysts on a buy falling from 72% before to 65% after, and the fraction of analysts with a hold recommendation increasing from 22% before to 28% after. (There is virtually no change in the fraction with a sell recommendation.) This finding suggests that analysts are slow to update their recommendations. Such inertia is consistent with the well-known tendency among analysts to avoid annoying the top management at the companies they cover.

Similarly, institutions filing 13f reports were net buyers of target stocks before the arbs released their reports, increasing their holdings in the average target from 33.8% in quarter −2 to 34.9% in quarter −1. These findings are consistent with analysts and institutional investors not paying attention to the public signals that prompted the arbs to investigate these firms.

Several targets caught the arbs’ attention because of unusual patterns of behavior (for example, constantly raising equity from shareholders while claiming to have large unused cash balances), a sequence of unexpected management changes, or implausible, too-good-to-be-true margins. The following example illustrates the latter:

“[The company] boasts an unjustifiable 40%+ gross margin in the domestic business and reports operating margins 46% higher than its strongest competitor, which is over 8x its size. With all of the major competitors being much larger publicly traded companies with manufacturing facilities and cost structure similar or superior,
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I see no validity to the Company’s explanation of its high margins due to its purportedly lower cost base and greater economy of scale."

Other telltale signs include the individuals behind the firms. Some Chinese targets, for example, used the services of a particular “promoter” to obtain a listing in the United States, and once some of the promoter’s companies became involved in regulatory investigations, his other clients also came into the arbs’ crosshairs. In other cases, target firms shared a little-known boutique auditor that had become the subject of an investigation by the Public Company Accounting Oversight Board for violating quality control and auditing standards.

In sum, the arbs in our sample conform well to patterns of behavior commonly assumed in the investment literature: they typically identify mispricing based on publicly observable signals such as company financials (Hirshleifer, Teoh, and Yu 2011) or accounting irregularities (Desai, Krishnamurthy, and Venkataraman 2006).

Why the market failed to notice these signals is an interesting question. One potential explanation, emphasized by Kovbasyuk and Pagano (2014), is limited attention: investors may simply have insufficient resources to process all value-relevant information. Another is that some investors may deliberately ignore information that does not conform to their beliefs—a form of confirmation bias (Shefrin 1999).

3.2 Investigating their targets

Once they have identified a potential target using publicly observable signals, the arbs follow up with in-depth investigations. Investigations may start with an extensive document review, not only of SEC filings but also of harder-to-access documents such as purchase agreements, customer orders, auditor reports, or tax returns, as well as the filings of key competitors. (A favorite, in the context of Chinese companies listed in the United States, is a comparison of Chinese-language filings with local regulators and English-language filings with the SEC, which often reveals aggressive accounting that flatters the company’s U.S. earnings.)

In a process that can take weeks, many investigations involve poking holes in claims the target made in public disclosures (such as its SEC filings) or conference calls. To this end, arbs may contact target firms’ management to clarify doubts (while secretly recording the conversations); consult industry experts for independent opinions; arrange authorized or unauthorized site visits, accompanied by industry experts or private investigators; or put a target’s

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13 See Peng and Xiong (2006) for a theoretical treatment and Barber and Odean (2001) and Della Vigna and Pollet (2008) for evidence consistent with limited attention affecting asset prices.
production facilities under video surveillance. To illustrate,

“Our on-site due diligence confirmed our thesis that the company is nowhere near the scale that it claims to be. On our visit, we saw a very small operation that appeared to be formerly government owned, and probably privatized for very little money. [The company] claims to have six legacy paper production lines, but despite our prior agreement to see all lines, it showed us only two. […] The equipment is clearly dated …”

Arbs may also visit a target’s distributors or customers to gauge the reliability and strength of its revenue prospects, or contact the target’s business partners and competitors to verify specific claims made by the target. For example, one arb conducted an extensive 10-city, 60-store channel check:

“[T]he investigators were instructed to count the number of small kitchen appliance brands, note the prices each brand was selling for, and ask the store/department managers and at least two different sales clerks a short list of questions about their experience selling products manufactured by the company and its competitors. For purpose of verification, the investigators were also instructed to record the name, address, phone # of the stores, as well as the name and cell phone # of the managers they spoke to.”

This particular channel check revealed that the target’s sales were suspiciously slow given the firm’s reported revenue growth.

The costs and risks of this information-discovery process are not trivial. Besides the difficulty of obtaining evidence to support their suspicions, the arbs often face open resistance (and occasionally hands-on obstruction) from target companies. The following example illustrates:

“Surveillance efforts are costly and difficult to conduct under very threatening conditions. […] Agents first must spend a few weeks watching and evaluating factory operations to determine the production cycle, factory entrances, and security surrounding the facility. The expensive cameras must be hidden so that the company does not find them, typically quite some distance from the factory and requiring use of a good zoom lens. […] Sometimes the cameras get stolen, in which case a backup camera is always on hand. Each day the local operative replaces the camera batteries (usually in the darkness of night) and memory card. […] The local operatives […] have been detained, questioned, and beaten by company security.”

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Though their reports enjoy first-amendment protection as free speech, the arbs also face the risk of being sued by their targets. On a more positive note, the risk of lawsuits will, to some extent, keep the arbs from making claims they cannot substantiate (and deter manipulators mimicking the arbs’ strategy with the intention of shorting and distorting). This, in turn, will make it likelier that their claims will be believed in the first place.

### 3.3 Making their case

Once an investigation is completed, the evidence is assembled into a detailed report that is subsequently disclosed to the investing public. To attract investors’ attention, reports often have catchy titles such as “Credibility is like virginity; once you lose it, you can never get it back.” (See Table A1 in the Appendix for further examples.)

Each report prominently discloses that the arb has a short position in the target stock. Effectively, therefore, arbs (legally) front run the publication of their reports. However, given how costly the targets are to arbitrage, there is a substantial risk that the arbs’ short positions are insufficient to correct the mispricing on their own—and thus that prices will move against the arbs, resulting in potentially unlimited losses. We argue that to counteract this risk, the arbs share their information with the market in an effort to convince the long investors to sell.

To be as convincing as possible, the reports include in-depth coverage of the issues identified during the investigation, often supplemented with scanned copies of original company documents, photos (of production facilities or distribution channels), and links to videos taken during site visits or to audio recordings of conversations with target executives. In several cases, reports provide “smoking gun” evidence in the form of audio clips of employees admitting misrepresentation, video clips contradicting production claims, or irreconcilable discrepancies between foreign and U.S. filings. One particularly egregious example involves apparent evidence of fraud (the target was subsequently investigated by the SEC and delisted by NASDAQ):

“We recorded a telephone conversation that contains an admission that [the company] is engaging in securities fraud.”

### 3.4 Types of reports

All sample reports claim that targets are overpriced, but they differ in the grounds for their claims and the evidence they can marshal. Based on a careful reading of the reports, we divide the sample into those reports that convey the...
Table 4
Range of allegations

Panel A: Reports producing new information (n = 295)

Concerns regarding financial reporting or governance
- Accounting irregularities: 0.34
  - Questionable performance: 0.22
  - Misrepresentation of financials: 0.11
- Questionable balance sheet: 0.11
- Other misrepresentation: 0.30
- Disclosure problems: 0.22
- Management: 0.19
- Auditor quality: 0.14
- Internal controls: 0.12

Red flag events
- Questionable business practice: 0.26
- Self-dealing/related-party transactions: 0.22
- Questionable acquisition: 0.18
- Questionable insider sales: 0.06
- Questionable capital raise: 0.06
- Outstanding legal actions: 0.03
- Questionable stock repurchase: 0.01

Panel B: Reports reinterpreting known information (n = 63)

Concerns regarding valuation: 0.18

Table 4 provides a breakdown of the 358 sample reports according to whether they convey the results of information production (i.e., the discovery of facts previously unknown to investors) or whether they result from information processing (i.e., the reinterpretation of already known data). The former type of report contains concerns regarding financial reporting, governance, or “red flag” events. Panel A presents a frequency breakdown of the main concerns based on our reading of the reports. The latter type of report, tabulated in Panel B, essentially claims a stock is overvalued based on a different interpretation of known data.

The vast majority of the reports (295 of 358) reveal new and hard information. Panel A of Table 4 tabulates the kinds of new information they contain. We distinguish between allegations regarding financial reporting (such as accounting irregularities or misleading disclosure) and questionable corporate governance practices (such as forgivable loans to executives) on the one hand, and concerns that arise from “red flag” events (such as suspicious acquisitions, self-dealing, undisclosed related-party transactions, and questionable insider trades) on the other. Accounting irregularities are particularly prominent.

The 63 sample reports without new information argue that a target is overvalued based on reinterpretations of known facts, claiming, for example, that a particular business model is unsustainable or expressing disagreements about industry trends or macroeconomic forecasts. These reports are thus essentially opinions, given the lack of new evidence, and so are more similar to “sell” recommendations issued by Wall Street analysts. As such, we might expect them to affect share prices a little more than Wall Street analysts tend to
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do when they downgrade a stock. As we will see, our estimates are consistent with this prediction.15

4. Correcting Mispricing

4.1 Reaction in the equity market: Prices

Table 5, Panel A, shows abnormal returns over various time windows around the release of a first report on a target company. We use three abnormal-return metrics: Fama-French/momentum four-factor cumulative abnormal returns (CARs), characteristics-adjusted abnormal returns computed as in Daniel and others (1997) (DGTW returns), and calendar-time abnormal portfolio returns (alphas). For further details on their construction, see Appendix A.

Between trading days $-20$ and $-6$, target companies’ shares perform roughly in line with our benchmarks.16 Over the week leading up to the release, there is some evidence of price falls, perhaps as a result of an arb building (or adding to) her short positions. The median CARs and DGTW returns of $-2.64\%$ and $-3.25\%$ are reliably statistically significant, though the means are smaller and insignificant, as is the calendar-time portfolio alpha.

Once an arb releases her report to the public, investors react strongly. On the release day, prices fall by an average (median) of $7.51\%$ ($4.7\%$) relative to the four-factor model, with fully $93$ of the $124$ targets falling in price. The DGTW returns and alpha are even more negative.17 These patterns suggest that the reports contain relevant and novel information, which investors take seriously. The reaction to a follow-on report, shown in Panel B, is smaller, with price falls averaging $3.1\%$ relative to the four-factor model and $2.91\%$ relative to characteristics-matched non-targets, and an alpha of $-2.96\%$. Each of these statistics is significant at the $1\%$ level.

Figure 1 plots the release-day price impact of each first report arranged in chronological order, along with a linear trend line. This reveals that the average price impact has increased over time, perhaps reflecting learning among investors and the establishment of credible track records by some of the arbs.

When a report is released, investors appear to respond rapidly. In five cases, we know the exact time the report was released. Figure 2 shows average continuously compounded raw returns over 5-minute intervals during the 8 trading hours before and after the release. At least for these five reports, prices fall by more than $10\%$ within 2 hours of release.

15 Using I/B/E/S data to identify 1,366 downgrades to strong sells in the universe of CRSP stocks (rather than in our sample), we estimate that analyst downgrades trigger price falls averaging $2.98\%$ during our sample period.

16 Even though CARs average a significant $3.16\%$ ($p=0.047$) over this timeframe, the median CAR is negative at $-2.34\%$ and statistically insignificant. Neither the DGTW returns nor the calendar-time alphas are statistically different from zero.

17 Removing potential outliers by trimming 5% in the tails makes little difference to any of our results; see Table IA.1 in the Online Appendix.
Table 5
Share-price changes around report releases

<table>
<thead>
<tr>
<th>Calendar-time</th>
<th>Cumulative abnormal returns (CARs)</th>
<th>Characteristics-adjusted abnormal returns (DGTW returns)</th>
<th>Calendar-time abnormal portfolio returns (alphas)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>Positive: negative</td>
</tr>
<tr>
<td>Positive: Positive:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel A: Abnormal returns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First reports:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trading days -20 to -6</td>
<td>3.16**</td>
<td>−2.34</td>
<td>57.65</td>
</tr>
<tr>
<td>Trading days -5 to -1</td>
<td>−1.05</td>
<td>−2.64**</td>
<td>49.73***</td>
</tr>
<tr>
<td>Trading day 0 (report date)</td>
<td>−7.51***</td>
<td>−4.70**</td>
<td>29.93***</td>
</tr>
<tr>
<td>Trading days 0 to +60</td>
<td>−26.13***</td>
<td>−27.83***</td>
<td>24.98***</td>
</tr>
<tr>
<td>Trading days 1 to +60</td>
<td>−19.83***</td>
<td>−23.46***</td>
<td>33.87***</td>
</tr>
<tr>
<td>Trading days 0 to +252</td>
<td>−42.86***</td>
<td>−55.19***</td>
<td>16.10***</td>
</tr>
<tr>
<td>Trading days 1 to +252</td>
<td>−38.31***</td>
<td>−52.15***</td>
<td>20.10***</td>
</tr>
<tr>
<td>Follow-on reports</td>
<td>−3.16***</td>
<td>−1.67***</td>
<td>78.140***</td>
</tr>
<tr>
<td>Panel B: Changes in market value of equity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in market value (unadjusted)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>Median</td>
<td>Positive: negative</td>
<td></td>
</tr>
<tr>
<td>Trading days 0 to +60</td>
<td>−$119.7m</td>
<td>−$38.5m***</td>
<td>32.92***</td>
</tr>
<tr>
<td>Trading days 0 to +252</td>
<td>−$33.5m</td>
<td>−$84.1m***</td>
<td>27.97***</td>
</tr>
</tbody>
</table>

Panel A reports three measures of abnormal returns (in percent): Fama-French/momentum four-factor cumulative abnormal returns (CARs), characteristics-adjusted abnormal returns computed as in Daniel and others (1997), and calendar-time abnormal portfolio returns. Each abnormal-return metric is measured over different event windows around the release of a report. Panel B reports raw changes in the market value of equity of target firms. For variable definitions and details of their construction, see Appendix A. The number of target companies for which we can compute CARs is lower than for DGTW returns because of the lack of sufficient prereport trading data for a few companies targeted shortly after their IPOs. We perform a two-sided t-test for means, a Wilcoxon test for medians, and a Wilcoxon sign test for the number of negative observations. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.
Interestingly, the price adjustment is not complete on the release day. In the full sample, prices fall by an additional 13.1% to 19.8% on average over the next 3 months, depending on the benchmark used, leaving them between 21.4% and 26.2% below the closing price on day $-1$. The drift reflects the back and
forth between the arb and target management: typically, the target denies the arb’s claims, prompting the arb to respond, while investors update their beliefs of the likelihood that the arb’s claims are true. As Figure 3 shows for CARs and DGTW returns, at no time over the 3 months after becoming a target does the average firm’s share price recover. These patterns suggest that the arbs’ information usually proves correct.18

18 Over a 1-year window, prices fall by 42.9% on average relative to the four-factor model, by 47.3% relative to characteristics-matched non-targets, and by 42.3% using the calendar-time portfolio approach. Depending
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To provide an estimate of the extent of overvaluation that the arbs help correct, we compute dollar changes in market value (not adjusting for market movements). As Table 5, Panel B, shows, the average (median) target’s market value falls by $119.7 million ($38.5 million) over the 3 months starting the day before a report is released, and by $133.5 million ($84.1 million) over 1 year. In dollar terms, therefore, aggregate market values fall by $14.8 billion over 3 months and by $16.6 billion over 1 year. These numbers highlight the economic importance of small arbitrageurs to the market’s informational efficiency.

4.2 Reaction in the equity market: SEC filing views

Another indication—besides falling share price—that investors pay close attention to the arbs’ reports comes from SEC filing views. The SEC publishes statistics on the number of times per day that a company’s regulatory filings are accessed through EDGAR. (See Drake, Roulstone, and Thornock [2005] for further details.) As Figure 4 shows, investors show abnormally high interest in a target’s SEC filings when a report is released: on average, filing views increase by 80.7% on the release day, compared to the firm’s baseline viewing pattern estimated in a 3-month window ending 21 trading days before the report day.

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19 In this and subsequent figures, we compute percentage changes relative to a baseline estimated over a 3-month period ending 1 month before a report date. Specifically, the “abnormal” value of variable $X$ is computed as the log difference between $X$ on day $t$ and average daily $X$ in a 3-month period beginning 80 trading days and ending 21 trading days before a report date (the “baseline period”). The log increase in filing views in Figure 4 shown on the benchmark, between 106 and 115 of the 124 targets experience negative abnormal returns over this timeframe.
The dashed lines, which represent 95% confidence intervals, indicate that this increase is highly statistically significant. Interest remains significantly elevated on day 1 (up 57.2%), day 2 (up 48.1%), day 3 (up 19.2%), and day 4 (up 25.7%), before returning to baseline levels.

Importantly, the spike does not coincide with targets filing new disclosures with the SEC that could explain the increase in investor interest. On day 0, only 5 of the 124 targets file an event-driven disclosure (an 8-K or 6-K) in response to the arbs; 9 targets file disclosures in connection with other events; and 1 target files a periodic disclosure (a 10-K). Removing these targets leaves the spike in Figure 4 unchanged. Instead, it is the target’s historic filings that investors are showing an increased interest in when the arbs release their reports.

4.3 Reaction in the equity market: Volatility, turnover, and liquidity

Just how big a shock to investors’ information sets the reports represent can be seen in Figure 5, which shows that volatility spikes when a report is released: on average, volatility increases by 236% on the release day compared to the firm’s baseline (i.e., by $\exp(1.211) - 1$). Volatility remains significantly elevated for the next 5 days, suggesting that investors take up to a week to process the information revealed in the average report.

The reports also trigger a massive increase in trading activity. Figure 6 shows that share turnover (i.e., number of shares traded scaled by shares outstanding) for day 0 is 0.592, meaning filing views are $\exp(0.592) - 1 = 80.7\%$ higher on day 0 than during the baseline period.
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Figure 6
Average abnormal turnover

begins to rise significantly relative to the baseline approximately 4 days before the report day (perhaps because the arbs build their short positions) and then spikes at 339% above the baseline on the release day (i.e., by $\exp(1.480) - 1$). In dollar terms, this represents a jump from an average baseline turnover of $8.9$ million per day to an average of $26.8$ million on the release day. Turnover stays significantly higher than normal for the next 23 trading days before returning to baseline levels.

All this extra trading affects liquidity in two ways. First, disclosure of the arbs’ information reduces information asymmetry in the market and thereby alleviates adverse selection concerns. As a result, trades have lower price impact than before disclosure. Figure 7a illustrates this effect using Amihud (2002) illiquidity measure as a proxy for price impact. Relative to the prereport baseline, price impact falls dramatically on the release day and remains significantly subdued for 31 trading days.

Second, we find evidence of sizable, albeit temporary, order imbalances on report days. When absorbing large trade volumes on one side of the bid-ask spread, liquidity providers’ inventories become ever more unbalanced, eventually necessitating costly inventory-adjustment trades (Ho and Stoll 1983). To recover these expected inventory costs, liquidity providers quote wider spreads. A standard spread decomposition allows us to isolate the component of the spread that is due to inventory and order processing costs, called the realized spread. Figure 7b shows a significant increase in realized

20 We obtain similar results using the adverse selection component of the spread, an alternative measure of price impact.
spreads on report days, up by 94.8% on average relative to the prereport baseline. This increase in realized spreads is consistent with liquidity providers requiring greater compensation for providing liquidity at a time when, as Figure 6 suggests, liquidity demand is abnormally high. The increase is...
4.4 Reaction in the short-sale and options markets

Who is responsible for the additional trading? Clearly, each trade involves a buyer and a seller, and only short sellers and current shareholders (the “longs”) can sell the stock. Therefore, the price pressure we see on the report day comes either from increased short selling or from increased selling by the longs. We first consider the short side of the market. Figure 8 tracks the contribution of short sellers to the trading spike by plotting the average daily number of new shorts (scaled by outstanding shares) relative to the pre-event baseline. One day before the release, new shorts spike at \( \exp(0.417) - 1 = 52\% \) above the prereport baseline \((p = 0.008)\), perhaps as the arbs build or add to their short positions.

The spike is, however, economically small: on average, only 0.45% of outstanding shares are newly shorted on day \(-1\). Given an average day \(-1\) market capitalization of \$951 million, this means that new shorts amount to only around \$4.28 million in trading \((\text{i.e.}, \ 0.0045 \times 951\text{m})\), not all of which will involve the arb in question. These small numbers underscore the fact that the arbs in our sample likely do not have particularly deep pockets. And yet, as Table 5 shows, they have a large price impact and eventually manage to help correct a substantial amount of misvaluation: shorts amounting to at most a few million dollars can help correct more than a hundred million dollars in overvaluation on average.

The spike in new shorts on day \(-1\) is not only small but also short-lived. Beginning on the release day itself, new shorts are no more numerous than
during the prereport baseline period. Thus, new shorts do not appear to be responsible for the massive increase in trading we saw in Figure 6. This is somewhat unexpected. Abreu and Brunnermeier (2002) argue that arbitrageurs face “synchronization risk,” meaning that they do not know when other arbs will start targeting an overvalued firm. If a critical mass of arbs is required for a shorting strategy to be profitable, synchronization risk can lead to a coordination problem and so to insufficient arbitrage. However, by publishing their information, arbs remove the synchronization risk; the publication is essentially a coordination device. Yet we see no increase in shorting activity. Why not?

The reason is simple. The lack of unusual activity in the shorting market, once a report has been released, reflects a drastic increase in the cost of shorting and a concomitant fall in the supply of lendable stock available for shorting. Figure 9a below shows that the cost of initiating new shorts rises significantly 1 day before a report is released (perhaps in response to the arbs building their short positions) and then jumps to 50% above the baseline on the release day on average. It continues to drift higher, to a level 174% above the baseline by trading day 60 (i.e., exp(1.009) – 1). As Figure 9b shows, this puts the cost of initiating new shorts in the 79th percentile of the universe of stocks traded in the United States on the release day, drifting up to the 86th percentile over the next 3 months.

Part of the reason for the cost increase is presumably an increase in demand by short sellers, but part of it appears to be the result of a fall in the supply of lendable stock. Anecdotally, some targets put pressure on their shareholders

![Figure 9a](https://academic.oup.com/rfs/article-abstract/29/8/1975/2583716)  
**Figure 9a**  
Average abnormal shorting fee

2000
How Constraining Are Limits to Arbitrage?

Figure 9b
Mean percentile rank

Figure 10
Average abnormal supply of lendable shares

to recall stock out on loan, to put a squeeze on short sellers. Figure 10, though noisy, shows that the supply of lendable stock becomes unusually low,

21 Twenty targets in our sample attempt to disrupt the arbs' ability to borrow shares, by asking shareholders not to lend out stock, having insiders purchase stock, or announcing share buybacks. To illustrate, a target issued the following press release in response to the release of a report: "The Company believes that short sellers' attempts to drive down the stock price and harm the Company's shareholders are likely to increase […] In this context, the

2001
Figure 11a: Average abnormal utilization

relative to the baseline, on the report date and remains at 20% to 30% below the baseline for the next 3 months. Notably this occurs even while lending fees are exceptionally high.

While the available supply contracts, the supply utilization rate (i.e., the fraction of shares available for lending that are out on loan) jumps. Figure 11a shows utilization relative to the pre-event baseline. The utilization rate increases significantly starting on day $-2$, consistent with the arbs building or adding to their short positions ahead of releasing their reports. On the release day, utilization is 26% above baseline; by day 60, it is 40% higher. Figure 11b shows that utilization is at the 86th percentile on the release day, climbing to the 90th percentile by day 60.

The fact that utilization increases significantly after report release (from what is already an exceptionally high level) implies that higher shorting demand cannot easily be met with the available supply. According to DataExplorers, utilization rates as high as those we see, both before and even more strongly after report release, are a strong signal of binding constraints in the equity lending market. The main reason is search costs: when the utilization rate hits 70%, it is said to become very difficult (if not impossible) to locate shares in this opaque over-the-counter market. Moreover, many would-be borrowers have margin accounts with only one or two brokers and cannot easily borrow stock from lenders outside their relationship networks.

Company believes that an important way to protect shareholder value is to limit short sellers’ ability to borrow stocks and shareholders can contribute by reviewing whether their custodians or brokers are lending their shares to third parties.” (PR Newswire, August 3, 2011)
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Figure 11b
Mean percentile rank

In light of this tightening in the short-sale market, investors might try to trade on the information revealed in the arbs’ reports via the option markets instead. However, this too appears to be difficult. Figure 12 shows an uptick in put-option trading on the report date (relative to trading in call options with
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Figure 13a
Average abnormal cost of put options

Figure 13a shows why the put trading volume does not increase significantly: puts become unusually expensive. The implied volatility of puts drifts up significantly in the 3 weeks before the report date (consistent with arbs buying puts to profit from the negative information they are about to release) and spikes at 44% above baseline on the report day. Part of this spike reflects the volatility increase shown in Figure 5, but whereas volatility quickly reverts to the baseline, implied put-option volatility remains significantly elevated, at around 25% above baseline, for the next 3 months. This suggests that puts are in unusually high demand.

Another way to see that puts become expensive—beyond what is reasonable given the (temporary) increase in volatility shown in Figure 5—is to compare the implied volatilities of puts to the implied volatilities of calls with the same strike price and exercise date. By put-call parity, the implied volatilities of puts and calls must be identical and thus the ratio of put and call implied volatilities should be one—unless there are significant costs of carry, such as short-sale constraints. Figure 13b shows that puts begin to depart from parity 3 days before the report date on average, with the ratio settling at 10% above the preevent baseline once the report has been released and remaining there for the next 3 months. This is consistent with short-sale constraints becoming even tighter, making puts unusually expensive. As Figure 13c shows, once the arbs release

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22 For details on how we construct this metric, see Appendix A.
How Constraining Are Limits to Arbitrage?

Figure 13b
Abnormal cost of puts relative to calls

Figure 13c
Mean percentile rank

In summary, the companies targeted by the arbs in our sample are simply too difficult to arbitrage directly—through shorting or put options—for publication of the reports to act as a coordination device in the sense of Abreu and Brunnermeier (2002). Another mechanism is therefore needed.
The patterns in Figures 8 to 13 show that neither new shorts nor trading in the options market are likely to be the main cause of the report-day price falls shown in Table 5. As noted earlier, this is not surprising, given that targets exhibit many of the characteristics traditionally associated with short-sale constraints and limits to arbitrage.

What then explains the price falls? The answer, we argue, is trading by the one group of investors who are unconstrained: investors with long positions in the target companies’ shares. We offer three pieces of evidence in support of this conclusion.

First, we disaggregate overall trading volume into long and short volume. Long volume is defined as the difference between one-way volume and new shorts. Figure 14 shows that the spike in overall trading volume we saw in Figure 6 involves a massive increase in long trading. On the report day, long trading is 524% above the baseline (= exp(1.831) – 1) and stays significantly elevated for the next month. Note that long trading necessarily involves selling by the targets’ existing investors: after removing new shorts from overall volume, the only investors who can sell and thereby contribute to the volume spike in Figure 14 are those who already own the stock.

Second, we use ANcerno data, which allow us to study signed trades for a large set of pension plan sponsors and mutual funds. For each trade, ANcerno

4.5 Reaction by long investors

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23 Goldstein, Irvine, and Puckett (2011) and Puckett and Yan (2011) report that ANcerno institutions account for around 8% of CRSP trading volume and 10% of institutional trading volume. Puckett and Yan (2011) show that ANcerno institutions on average do not differ from 13F institutions in stock holdings, return characteristics, and stock trades, although they are larger in size.
How Constraining Are Limits to Arbitrage?

reports the type (but not the name) of the institution, the stock ticker, the date and time the trade is executed, the number of shares traded, the execution price, and whether the trade is a buy or sell. Following Goldstein, Irvine, and Puckett (2011) and Puckett and Yan (2011), we separately aggregate sell and buy trades in ANcerno to the daily level. This gives us measures of aggregate selling and aggregate buying on a given day. The difference between the two measures gives us a third measure: daily net sales. We scale these three measures by baseline trading volume, estimated as the average daily one-way CRSP trading volume in our baseline pre-event period (trading days $-80$ to $-21$). Of our 124 target stocks, 110 have trading data in ANcerno during the $(-20, 60)$-day event window around a report release.

Figure 15 shows aggregate abnormal sales, buys, and net sales by ANcerno institutions. There is a clear and significant spike in sales on the day the arb releases her report. (Table 6 tabulates the point estimates and reports significance levels.) For the average target, aggregate sales amount to 133% of baseline trading volume. For comparison, in the 20 days before a report release, ANcerno institutions’ aggregate sales account for only 18% of trading volume on average. In other words, ANcerno institutions are more than seven times more active sellers when a report is released than normal. Net sales tell a similar story. These results confirm the central mechanism that the arbs’ strategy builds on: by releasing their information to the public, the arbs can induce the long investors to sell. We see no corresponding spike in buys, implying that the buyers on the other side of the trades are predominantly retail investors or non-ANcerno institutions, including short sellers who close out their positions.

Third, for a subset of targets, we can use the ANcerno data to estimate the fraction of each long institution’s prereport holding of a target company’s stock that is sold on the day that a report is released. This shows that the average (median) long institutional shareholder sells 43.6% (15.1%) of its holding over the course of the day on which a report is released. Fully 65% of the average target’s long investors as of day $-1$ are net sellers on the report day.

4.6 How accurate are the reports?
The reports not only make an impression on investors; they also influence the SEC, the stock exchanges, and (perhaps inevitably) trial lawyers. Using SEC filings and Factiva searches, we find that through the end of October 2015, 69% of targeted companies are involved in class-action lawsuits; 50% are delisted by an exchange (usually out of public-interest concerns); and 36% are formally investigated by the SEC or the Department of Justice (DoJ) (occasionally for

\[ \text{To estimate this, we restrict the sample to the 64 companies targeted before 2011. (From 2011 onward, ANcerno ceases to disclose institution-specific identifiers, so we cannot credit trades made in 2011 to specific institutions.) Of the 1,008 institutions covered in ANcerno pre-2011, 213 (21.1%) are long holders of our target stocks on the day before the first report.}\]
Investigations by regulators such as the SEC or the DoJ or by an exchange back up the reports in fully 90% of the cases.

Moreover, subsequent actions taken by the targets indirectly confirm that the arbs’ information is usually accurate rather than manipulative. Through

25 The SEC and the DoJ launch fraud investigations in 21 cases and bring fraud charges in 17 of these. Fraud is not an exclusively Chinese phenomenon; 6 of the 17 fraud charges involve U.S. firms.
How Constraining Are Limits to Arbitrage?

Table 6
Abnormal sales, buys, and net sales by ANcerno institutions

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. err</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional sells/baseline turnover on the first-report date</td>
<td>1.330</td>
<td>0.406</td>
<td>0.002</td>
</tr>
<tr>
<td>Institutional buys/baseline turnover on the first-report date</td>
<td>0.392</td>
<td>0.095</td>
<td>0.000</td>
</tr>
<tr>
<td>Institutional net sales/baseline turnover on the first-report date</td>
<td>0.753</td>
<td>0.346</td>
<td>0.033</td>
</tr>
</tbody>
</table>

Table 6 reports abnormal sales, buys, and net sales by ANcerno institutions on the first-report date. Of our 124 target stocks, 110 have trading data in ANcerno during the (-20, 60)-day event window around a report release. For variable definitions and details of their construction, see Appendix A. We use *** and ** to denote significance at the 1% and 5%, level, respectively.

Table 7
Timing of subsequent events

<table>
<thead>
<tr>
<th></th>
<th>Calendar days since first report</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Regulatory intervention</td>
<td>733</td>
</tr>
<tr>
<td>Delisting</td>
<td>680</td>
</tr>
<tr>
<td>Class-action lawsuit</td>
<td>540</td>
</tr>
<tr>
<td>Bankruptcy</td>
<td>1,409</td>
</tr>
</tbody>
</table>

Table 7 reports the distribution of the length of time that has elapsed between the first short-seller report on a target and the first regulatory intervention by the SEC, the Department of Justice, the Federal Trade Commission, the FDIC, the Consumer Bureau, or the FBI; a delisting action by an exchange; a class-action lawsuit being filed; or a target declaring bankruptcy.

October 2015, 92% of targets change management; 47% experience auditor turnover; and 23% restate earnings.

Table 7 shows that these subsequent events occur, for the most part, too long after our 60-day or 252-day event windows to be responsible for the price corrections seen in Table 5 and Figure 3. There are long delays between reports coming out and third-party actions. For example, it takes regulators on average 733 calendar days to intervene. This suggests that the market responses to these postreport regulatory interventions are unlikely to be responsible for the price declines we see in the immediate aftermath of the release of the arbs’ reports.

4.7 Do the arbs make money on their information production?

Our data allow us to estimate the arbs’ trading profits, gross of the costs involved in identifying and investigating targets. Assuming that the arbs take a short position 5 days before the report day (which looks consistent with the patterns found in Figures 8 and 9) and then follow a marked-to-market borrow-and-hold strategy, their cumulative abnormal profit equals the negative of the CARs shown in Figure 9 minus the cumulative shorting fee. Figure 16 shows that this

Our results are robust to excluding the five targets that experience a regulatory intervention, the four firms that are delisted, or the 35 firms subject to class-action lawsuits, in the first 60 trading days after the first report release.
strategy turns profitable as soon as the report is released. Relative to the four-factor model, shown on the left, the strategy makes an average return of 7.8% on the report day and a cumulative abnormal profit of 24.1% over 3 months. Relative to characteristics-matched non-targets, shown on the right, average trading profits are slightly smaller (7.5% on the report day and 21.8% over 3 months). Using a four-factor calendar-time approach (not shown in a graph) gives an average abnormal 3-month profit of 22.0%. Each of these estimates is highly statistically significant.
How Constraining Are Limits to Arbitrage?

These profit estimates are conservative to the extent that they ignore the potential for additional—and leveraged—returns using put options. They also ignore that the arbs, knowing that their reports will cause short-term spikes in volatility, could potentially set up profitable trading strategies in the options market (such as zero-beta straddles or butterflies) designed to capitalize on the volatility spike shown in Figure 5.

Whether the estimated trading profits are likely to cover the arbs’ information production costs depends on three factors: the dollar size of their short position, the cost of investigating each target, and the “yield,” i.e., how many companies have to be investigated to produce a viable target. Precise data on these factors are not publicly available, but with the help of interviews we have conducted with the arbs, it is possible to estimate ballpark numbers. We stress that these are crude estimates and that we cannot determine whether the trading profits simply represent “fair compensation” for the time, effort, and risks involved in this strategy.

We know that the arbs have shallow pockets and that the targets are expensive to short. This implies relatively small short positions, averaging a few million dollars. (Figure 5 suggests abnormal shorting on the day before a report is released amounts to no more than $5 million on average.) Using the results for the four-factor model to illustrate, the average 24.1% risk-adjusted return net of shorting fees seen in Figure 6 implies dollar gains of $241,000 on a short position of $1m, $482,000 on a short position of $2m, $723,000 on a short position of $3m, and so on—plus whatever profits the arbs can make through option-trading strategies. Anecdotally, the arbs tell us that an investigation typically costs between around $10,000 and $100,000. One of the early adopters of the short-and-disclose strategy claims a close to 100% yield; a later entrant claims to find three viable targets for every four he investigates. These numbers, if representative, suggest that the trading profits are large enough to cover analyst salaries, private investigators, and so on.

Another data point comes from Kerrisdale Capital, one of the arbs in our sample, whose performance data are available online. Kerrisdale reports a cumulative return since inception in 2009 of 753.6% (net of fees to investors), which the firm compares to cumulative returns of 90.2% on the S&P500 Index and 31.8% on the Barclays Hedge Fund Index.

It is unlikely that the short-and-disclose strategy will continue to generate returns of this magnitude indefinitely. Eventually, entry will reduce returns by reducing the yield. As Table 1 shows, the strategy has already attracted increasing numbers of entrants. While we know of only five arbs who practiced it up to 2008, the strategy was adopted by five new arbs in 2009, seven in

27 Anecdotally, we are told that the arbs tend to buy puts first, where possible, and then short the underlying stock.

28 Consistent with a prediction in Kovbasyuk and Pagano (2014), we are told that the arbs in our sample tend to target one company at a time and so take concentrated short positions, resulting in undiversified portfolios.

2010, and fifteen in 2011. According to the developer of a recently launched commercial database tracking “activist shorts,” more than 200 U.S.-listed companies were targeted in 2012 and 2013, nearly twice as many as over our 2006–2011 sample period.

5. Pinpointing the Mechanism

The results so far suggest that the arbs do not have deep enough pockets to correct the mispricing on their own, given the short-sale constraints surrounding their targets. Our conjecture is that the arbs attempt to circumvent these constraints by making their information public, in an effort to persuade the longs to sell. This would be consistent with the observed massive increase in trading by the longs. If successful, the strategy will not only result in a price correction that translates into gains on the arbs’ short positions but also reduce noise trader risk by making it less likely that prices diverge even further from fundamentals in the short-run and thereby put a squeeze on the arbs’ short positions.

For the short-and-disclose strategy to work, the reports need to contain credible information. In Section 5.1, we show that only credible reports result in price corrections and profits to the arbs. Section 5.2 adds nuance to this result by showing that only reports containing new information that is costly to acquire move prices. Section 5.3 asks what kind of mispricing can be arbitraged away using the short-and-disclose strategy.

5.1 Credibility

Reports should only induce the longs to sell if the information they contain is credible. The arbs clearly understand this: many prominently post their past performance on their websites. To illustrate, Citron Research maintains a list of its targets that have subsequently been targeted by regulators: more than 50 as of January 2014 (see http://en.wikipedia.org/wiki/Andrew_Left).

Rather than relying on these posts, we construct our own measure of credibility. Specifically, to determine whether a report is likely to be considered credible, we examine each arb’s prior track record, on the assumption that arbs with a stronger track record are more readily believed when they target a stock. We measure an arb’s track record at time \( t \) as the rolling mean of the 3-month CARs of all her previous reports (issued at least 3 months before time \( t \), to avoid look-ahead bias). Using all 358 reports in our sample, we then code a report issued at time \( t \) as more credible if the arb’s prior track record produced profits (a negative rolling mean CAR), and as less credible otherwise. This approach assumes that trading profits are a sufficient statistic for the market’s assessment of the credibility of an arb’s previous reports.

30 We require each arb to have issued at least two reports before we compute a track record. Results are not sensitive to the choice of a 3-month window.
We obtain 202 reports coded as more credible and 35 reports coded as less credible. Note that an arb’s track record evolves over time such that she can gain or lose credibility depending on how accurate her reports prove to be. The final column of Table 1 reports what fraction of each arb’s reports is coded as more credible.

Table 8, Panel A, splits the sample by this measure of credibility. When a more credible arb is the first to issue a report on a target, the target’s share price falls by an average of 9% relative to the four-factor model on the report day \((p<0.001)\). This is a significantly larger than the 2.2% average price fall for less credible reports, which in turn is not significantly different from zero \((p=0.539)\). If we include follow-on reports by this or other arbs, the pattern is similar: reports that are more credible are greeted with a significant price fall averaging 5.3% on the release day \((p<0.001)\), compared to a price fall of only 1.4% for less credible reports \((p=0.315)\). Turnover tells a similar story. Trading involving longs, defined as previously, responds significantly more strongly on the report day to more credible reports (up by 384%) than to less credible reports (up by 152%) \((p=0.055)\).

Consistent with these turnover patterns, prices converge faster in response to more credible reports. As Figure 17 shows, a borrow-and-hold strategy initiated 5 days before the release day of a more credible report becomes profitable immediately upon release and generates abnormal profits, relative to the four-factor model and net of shorting fees, averaging 16.5% by day +60. The rapid speed with which the price correction occurs implies a much reduced noise trader risk. Less credible reports, in contrast, do not move prices significantly, either on the release day or with any kind of lag. By day +60, for example, cumulative abnormal profits average an economically small and statistically insignificant 6.6% net of shorting fees \((p=0.226)\).

While the 10-point difference in profitability is economically large, it is not statistically significant. One reason is likely the small number of reports classified as less credible. Another becomes evident when we disaggregate the net trading profit into the market impact and the cumulative shorting fee. As Table 8 shows, reports that are more credible have significantly larger market impact, with CARs of \(-23.3\%\) for more credible reports versus \(-10.4\%\) for less credible reports. This suggests that investors do pay more attention to more credible reports. At the same time, we also see that the shorting fees are significantly greater for more credible reports: they average 6.8% over the assumed 3-month mark-to-market holding period (26% annualized), considerably more than the 3.9% average among less credible reports (14.9%)

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31 We lose 121 of the 358 reports, in part because we require at least two reports to compute a track record; and in part, because we require that prior reports are at least 60 trading days old before we can classify the current report as more or less credible.

32 The table reports CARs, DGTW characteristics-adjusted returns, and calendar-time portfolio alphas, but since the results are nearly identical, we discuss only the CAR estimates in the text.
Abnormal returns and trading by type of report

Table 8 reports average abnormal returns, as well as shorting profits and trading statistics in subsamples sorted by the credibility of the report (Panel A) and the nature of the information discovery (Panel B). Because the subsamples in Panels A and B include follow-up reports for the same target, we also report abnormal returns on the day the first report is released. All returns, shorting profits, and fees are shown in percent. For variable definitions and details of their construction, see Appendix A. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

Annualized). A plausible explanation is that stock lenders, who likely have market power given the tight shorting conditions shown in Table 8, charge higher fees in response to borrowing demand from the more credible arbs. This would allow stock lenders to extract part of the value these arbs create when they release their reports. Such behavior would tend to reduce the profitability gap between more and less credible reports.

5.2 Report content

Credibility appears to be necessary but is probably not sufficient to ensure the longs will listen. What likely also matters is what the arb has to say. Table 8 reports average abnormal returns, as well as shorting profits and trading statistics in subsamples sorted by the credibility of the report (Panel A) and the nature of the information discovery (Panel B). Because the subsamples in Panels A and B include follow-up reports for the same target, we also report abnormal returns on the day the first report is released. All returns, shorting profits, and fees are shown in percent. For variable definitions and details of their construction, see Appendix A. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided), respectively.

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Panel B, splits the sample of reports into those that reveal new evidence and those that merely reinterpret already known data. On first-report days, CARs average \(-9\%\) for evidence-based reports \((p < 0.001)\), compared to a statistically insignificant \(-2.2\%\) for opinion-based reports \((p = 0.151)\). In other words, investors largely ignore claims of overvaluation if not backed up by new facts. The difference between the two cases is highly statistically

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In fact, many of the 29 reports in Table[4] that failed to result in a share-price fall upon release are opinion-based.
significant ($p = 0.004$). Turnover tells a similar story: both the overall increase in turnover and the reaction by the longs is stronger for reports that reveal new evidence, with the former difference being statistically significant ($p = 0.024$).

These patterns imply that reports containing new facts should make higher profits than simple claims a stock is overvalued without the support of new information. Consistent with this prediction, Table 8 shows that evidence-based reports generate significant abnormal trading profits as soon as they are released while opinion-based reports have little immediate price impact and generate significantly lower abnormal trading profits, regardless of how we compute abnormal profits. Using four-factor CARs to illustrate, Figure 1 shows that average abnormal trading profits peak at 18.8% by day $t+60$ for reports containing new evidence, twice as much as the 9.5% average abnormal trading profit for opinion-based reports. The difference is marginally statistically significant ($p = 0.072$). Similar (indeed, stronger) results obtain when we compute abnormal trading profits using DGTW returns or calendar-time portfolio alphas.

5.3 What can be arbitraged using the short-and-disclose strategy?
Our results suggest that arbs who credibly reveal novel information about their targets are able to persuade long shareholders to sell and thereby contribute to a price correction, which in turn generates an economically meaningful return on the arbs' information production. What are the limits to this short-and-disclose strategy?

To have an incentive to engage in information discovery, two conditions must hold: the arbs need to be able to take a sufficiently large short position, via the cash or the options markets, to cover their expected information-discovery costs; and they need to expect to find sufficiently compelling hard evidence with which to induce the longs to sell. This implies that they are unlikely to target companies whose potential for misvaluation is too expensive to investigate or for which hard facts are unlikely to be discovered. We explore these limits to the strategy by sorting targets on various measures of arbitrage costs. The higher the arbitrage costs are, the more difficult it should be for the arbs to make profits.

Our first measure sorts targets by the average daily shorting fee during the trading month ending 1 month before the first report and splits the sample at the median. Table 9, Panel A, shows that the arbs make money regardless of how high the shorting fees are. For high-shorting-fee stocks the cumulative abnormal 3-month profits average 24.9% based on four-factor CARs ($p < 0.001$), slightly more in fact than the average profit of 22.9% on low-shorting-fee stocks ($p < 0.001$). (The profit difference is marginally wider when using DGTW returns or calendar-time portfolio alphas.)

---

34 Results are nearly identical using DGTW returns or calendar-time portfolio alphas.
How Constraining Are Limits to Arbitrage?

We obtain similar results when we sort on the supply of lendable stock available for borrowing or on the utilization rate. Again splitting the sample at the median, Panel B shows that the arbs make money, net of shorting fees, regardless of how tight the supply of lendable stock is. If anything, they make greater returns in the harder-to-borrow targets (those with a low supply of lendable stock), though the differences are not statistically significant for any of our three measures of abnormal trading profits. In Panel C, the arbs make significantly greater profits in high-utilization stocks for two of the three measures.

Figure 18
Cumulative abnormal profits sorted by type of report

We obtain similar results when we sort on the supply of lendable stock available for borrowing or on the utilization rate. Again splitting the sample at the median, Panel B shows that the arbs make money, net of shorting fees, regardless of how tight the supply of lendable stock is. If anything, they make greater returns in the harder-to-borrow targets (those with a low supply of lendable stock), though the differences are not statistically significant for any of our three measures of abnormal trading profits. In Panel C, the arbs make significantly greater profits in high-utilization stocks for two of the three measures.
### Table 9: Abnormal returns and trading by arbitrage cost and firm size

<table>
<thead>
<tr>
<th>Panel A:</th>
<th>High Shorting Fee (N=51)</th>
<th>Low Shorting Fee (N=51)</th>
<th>Difference in Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal return on report date</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Based on four-factor CARs</td>
<td>−7.3***</td>
<td>−6.7***</td>
<td>−0.7</td>
</tr>
<tr>
<td>Based on DGTW-adjusted returns</td>
<td>−7.9***</td>
<td>−6.6***</td>
<td>−1.3</td>
</tr>
<tr>
<td>Based on calendar-time abnormal portfolio returns</td>
<td>−8.3***</td>
<td>−7.0***</td>
<td>−1.3</td>
</tr>
<tr>
<td>3-month abnormal borrow-and-hold shorting profit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Based on four-factor CARs</td>
<td>24.9***</td>
<td>22.9***</td>
<td>2.0</td>
</tr>
<tr>
<td>Based on DGTW-adjusted returns</td>
<td>24.1***</td>
<td>19.9***</td>
<td>4.2</td>
</tr>
<tr>
<td>Based on calendar-time abnormal portfolio returns</td>
<td>25.9***</td>
<td>19.0***</td>
<td>3.3</td>
</tr>
<tr>
<td>Abnormal turnover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1.49***</td>
<td>1.38***</td>
<td>0.110</td>
</tr>
<tr>
<td>Long side</td>
<td>1.88***</td>
<td>1.77***</td>
<td>0.110</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B:</th>
<th>Low Lendable (n=51)</th>
<th>High Lendable (n=51)</th>
<th>Difference in Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal return on report date</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Based on four-factor CARs</td>
<td>−7.8***</td>
<td>−6.2***</td>
<td>−1.6</td>
</tr>
<tr>
<td>Based on DGTW-adjusted returns</td>
<td>−8.4***</td>
<td>−6.0***</td>
<td>−2.4</td>
</tr>
<tr>
<td>Based on calendar-time abnormal portfolio returns</td>
<td>−8.3***</td>
<td>−5.9***</td>
<td>−2.4</td>
</tr>
<tr>
<td>3-month abnormal borrow-and-hold shorting profit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Based on four-factor CARs</td>
<td>28.9***</td>
<td>18.8***</td>
<td>10.1*</td>
</tr>
<tr>
<td>Based on DGTW-adjusted returns</td>
<td>27.0***</td>
<td>17.0***</td>
<td>10.0</td>
</tr>
<tr>
<td>Based on calendar-time abnormal portfolio returns</td>
<td>31.5***</td>
<td>15.0***</td>
<td>9.5</td>
</tr>
<tr>
<td>Abnormal turnover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1.636***</td>
<td>1.235***</td>
<td>0.401</td>
</tr>
<tr>
<td>Long side</td>
<td>1.845***</td>
<td>1.814***</td>
<td>0.031</td>
</tr>
</tbody>
</table>

(continued)

Pontiff (2006) argues that idiosyncratic volatility is a key measure of arbitrage holding costs. Panel D shows that idiosyncratic volatility does not prevent the arbs from making money. In fact, their trading profits net of shorting fees increase in idiosyncratic volatility, significantly so based on four-factor CARs: cumulative abnormal profits average 34.1% after 60 days for high-volatility stocks ($p<0.001$) versus 13.8% for low-volatility stocks ($p<0.001$).

Panel E, finally, splits the sample by the targets’ prereport market capitalization. While trading profits are larger in smaller target stocks, they are, perhaps remarkably large and statistically significant even for large targets: when targeting larger firms, the arbs make average trading profits of 20.9% relative to the four-factor model and 13.8% relative to characteristics-matched non-targets, net of shorting costs (both significant at the 0.001 level).

Table 9 further reveals that each subsample experiences similar spikes in turnover and in long trading when a report is released to the public, whether we sort on shorting fees, the supply of lendable stock, utilization rate, idiosyncratic volatility, or firm size. This finding is consistent with our proposed mechanism: if, as we propose, the price correction emanates not from the short side of the market but from long shareholders’ responses to the negative information...
Table 9 Continued

<table>
<thead>
<tr>
<th>Panel C</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Low</td>
<td>Difference</td>
</tr>
<tr>
<td></td>
<td>utilization</td>
<td>utilization</td>
<td>in means</td>
</tr>
<tr>
<td>Abnormal return on report date</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Based on four-factor CARs</td>
<td>−6.4***</td>
<td>−7.6***</td>
<td>1.2</td>
</tr>
<tr>
<td>Based on DGTW-adjusted returns</td>
<td>−7.5***</td>
<td>−7.7***</td>
<td>0.2</td>
</tr>
<tr>
<td>Based on calendar-time abnormal portfolio returns</td>
<td>−7.4***</td>
<td>−8.1***</td>
<td>0.7</td>
</tr>
<tr>
<td>3-month abnormal borrow-and-hold shorting profit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Based on four-factor CARs</td>
<td>19.4***</td>
<td>28.1***</td>
<td>−8.7</td>
</tr>
<tr>
<td>Based on DGTW-adjusted returns</td>
<td>29.7***</td>
<td>13.8***</td>
<td>15.9***</td>
</tr>
<tr>
<td>Based on calendar-time abnormal portfolio returns</td>
<td>40.2***</td>
<td>7.9</td>
<td>31.3***</td>
</tr>
</tbody>
</table>

Abnormal turnover
Total: 1.410*** 1.460*** −0.050
Long side: 1.822*** 1.841*** −0.020

<table>
<thead>
<tr>
<th>Panel D</th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High idiiosyncratic volatility</td>
<td>Low idiiosyncratic volatility</td>
<td>Difference in means</td>
</tr>
<tr>
<td>Abnormal return on report date</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Based on four-factor CARs</td>
<td>−9.0***</td>
<td>−6.2***</td>
<td>−2.8</td>
</tr>
<tr>
<td>Based on DGTW-adjusted returns</td>
<td>−9.0***</td>
<td>−6.3***</td>
<td>−2.7</td>
</tr>
<tr>
<td>Based on calendar-time abnormal portfolio returns</td>
<td>−8.9***</td>
<td>−6.1***</td>
<td>−1.6</td>
</tr>
<tr>
<td>3-month abnormal borrow-and-hold shorting profit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Based on four-factor CARs</td>
<td>34.1***</td>
<td>13.8***</td>
<td>20.3***</td>
</tr>
<tr>
<td>Based on DGTW-adjusted returns</td>
<td>25.7***</td>
<td>17.1***</td>
<td>8.0</td>
</tr>
<tr>
<td>Based on calendar-time abnormal portfolio returns</td>
<td>26.5***</td>
<td>15.3***</td>
<td>11.2***</td>
</tr>
</tbody>
</table>

Abnormal turnover
Total: 1.712*** 1.247*** 0.466*
Long side: 1.908*** 1.760*** 0.148

<table>
<thead>
<tr>
<th>Panel E</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small market capitalization</td>
<td>Large market capitalization</td>
<td>Difference in means</td>
</tr>
<tr>
<td>Abnormal return on report date</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Based on four-factor CARs</td>
<td>−7.5***</td>
<td>−7.5***</td>
<td>0.0</td>
</tr>
<tr>
<td>Based on DGTW-adjusted returns</td>
<td>−7.5***</td>
<td>−7.7***</td>
<td>0.2</td>
</tr>
<tr>
<td>Based on calendar-time abnormal portfolio returns</td>
<td>−7.4***</td>
<td>−8.1***</td>
<td>0.7</td>
</tr>
<tr>
<td>3-month abnormal borrow-and-hold shorting profit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Based on four-factor CARs</td>
<td>27.2***</td>
<td>20.9***</td>
<td>6.4</td>
</tr>
<tr>
<td>Based on DGTW-adjusted returns</td>
<td>29.7***</td>
<td>13.8***</td>
<td>15.9***</td>
</tr>
<tr>
<td>Based on calendar-time abnormal portfolio returns</td>
<td>40.2***</td>
<td>7.9</td>
<td>31.3***</td>
</tr>
</tbody>
</table>

Abnormal turnover
Total: 1.523*** 1.434*** 0.089
Long side: 1.782*** 1.900*** −0.118

Table 9 reports average abnormal returns, as well as shorting profits and trading statistics, on the first-report date in subsamples sorted by various measures of arbitrage costs: shorting fees (Panel A), the supply of lendable stock available for borrowing (Panel B), the utilization rate (Panel C), idiosyncratic volatility (Panel D), and the target’s market capitalization as of one month before a first-report date (Panel E). Panels A and B focus on the 102 targets for which data on shorting fees and the supply of lendable stock are available as of the baseline period (1 month before the release of the first report). In Panel D, we lose two observations with insufficient preevent trading data to compute idiosyncratic volatility. All returns and shorting profits are shown in percent. For variable definitions and details of their construction, see Appendix A. We use *** and ** to denote significance at the 1% and 5% level (two-tailed), respectively.

revealed in the reports, it should make no difference how severe a set of short-sale constraints a target company happens to have: after all, the longs are not constrained.
5.4 Informational spillovers

The short-and-disclose strategy appears well suited to instances in which hard information can be discovered, such as when a company is overvalued because of aggressive accounting or fraud. This is consistent with Kovbasyuk and Pagano’s (2014) model of traders who “advertise” arbitrage opportunities. In their model, advertising helps correct mispricing that is caused by limited investor attention: by focusing unconstrained investors’ attention on a mispriced stock, mispricing can be reduced. We argue that advertising, inadvertently, may also help prick bubbles: on the one-rotten-apple-spoils-the-barrel principle, investors may start to pay closer attention to similar companies when confronted with negative information about specific targets.

Chinese companies listed in the United States provide an opportunity to test for such informational spillovers. In 2010, Chinese stocks were in high demand in the United States. The number of Chinese companies with a listing in the United States increased from 401 to 462 and the Bloomberg China-U.S. index rose in value by 29%. Over the same period, Chinese companies were much less popular in China (the Shanghai SSE Composite index closed down 13%), as were U.S. firms in the United States (the S&P500 index closed up by only 13%).

During 2010, and especially 2011, many U.S.-listed Chinese companies were targeted by arbs. As the Online Appendix shows, these Chinese targets suffered substantial share price falls. We now examine whether the arbs’ reports may have changed sentiment about China stocks more generally. Figure 19 shows what happens to the stock prices of other Chinese firms listed in the United States (i.e., those not targeted by the short sellers) as reports are released. The graph shows 12-month alphas from calendar-time portfolios formed when the
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Figure 20
Average abnormal daily net sales of non-target Chinese stocks around first-report dates

The first nine reports appear not to have influenced investors’ views of China stocks in general. Starting with the 10th report, however, which came out on February 12, 2010, the prices of non-target China stocks started to be dragged down as well—and more so with every additional report that came out. This suggests that as a critical mass of negative reports about specific U.S.-listed Chinese companies accumulated, investors began to reevaluate U.S.-listed Chinese stocks in general. If so, we would expect institutional investors to sell non-target China stocks. Using ANcerno data, Figure 20 shows a clear and significant spike in net sales by institutional investors of non-target China stocks on the day an arb releases a report on a Chinese target.

6. Conclusions

Whether financial markets price securities efficiently depends on limits to arbitrage and on traders’ incentives to engage in costly information production. The former limit informed traders’ ability to correct mispricing ex post (Harrison and Kreps 1978). The latter affect whether mispricing is likely to be discovered ex ante (Nezafat and Wang 2014). Without limits to arbitrage, behavioral finance would not be possible (Brav, Heaton, and Rosenberg 2004).

In this study, we present evidence showing that even small arbitrageurs can help make prices efficient and that they can do so in situations characterized by what otherwise looks like formidable limits to arbitrage. To move prices in their favor despite their limited capital and the severe short-sale constraints
they face, they induce target-company shareholders to trade on their behalf. The
arbs do so by revealing their information. When the information is credible,
the unconstrained investors (i.e., the longs) sell, driving down the price. This
not only helps sidestep short-sale constraints but also accelerates the price
correction and thereby reduces the risk of noise traders moving prices even
further from fundamentals in the short-run, which might otherwise force the
arbs to liquidate their short positions at a loss.

Credibility is key: as our evidence shows, arbs who lack (or lose) a track
record of producing reliable evidence are ignored by investors and so cannot
move prices by publishing their reports. Producing evidence that is new also
is key: arbs who simply express the opinion that a stock is overvalued, based
purely on existing information, are similarly ignored by investors.

In principle, revealing the information creates the potential for coordinated
action by multiple arbitrageurs to overcome the synchronization problem
modeled in [Abreu and Brunnermeier, 2002]. But our results show that not even
that is enough, on its own, to correct mispricing in our setting. The reason is that
the arbs deliberately target companies with often-severe short-sale constraints,
limiting the scope for coordinated action by a group of short sellers.

The strategy we describe is reminiscent of large investors such as Carl Icahn,
George Soros, or Warren Buffett revealing their positions in certain companies,
a practice called “talking one’s book.” The difference is that the arbs in our
sample have limited capital, and so revealing their (necessarilly small) position
would, on its own, have no price impact. To be listened to, the arbs also have
to reveal their information. The effectiveness of their message thus depends
less on who they are or how much capital they have and more on their track
record and credibility. The main barrier to entry into informational arbitrage for
a small arbitrageur is thus not so much a lack of trading capital but the funding
required to produce credible information.

While the primary audience is the longs, without whom prices would not
adjust (or at least not sufficiently quickly), a reputation for credibly identifying
overvalued targets might eventually allow some arbs to raise funds from
institutional and other investors. This would help overcome the limit to arbitrage
identified by [Shleifer and Vishny, 1997]: the inability to persuade investors to
commit capital to an investment strategy aimed at correcting mispricing.

An important implication of our findings is that neither limited arbitrage
capital nor severe short-sale constraints need constrain informational arbitrage
in practice: as long as the mispricing is sufficiently large, these obstacles can
be overcome by the arbitrage mechanism we describe. It may even help prick
behavioral “bubbles,” by confronting overly optimistic investors with cold hard
facts that are difficult to ignore.

Our evidence also illustrates why financial markets need short sellers to
function well. We find no support for the widely held view that short sellers
are speculators who do little more than manipulate and destabilize share prices.
The fact that investors ignore reports that do not contain new, hard information

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suggests that it is quite difficult to manipulate share prices, at least in our setting. Instead, the short sellers in our sample are information producers who help correct mispricing and thereby help make markets more efficient. This is all the more remarkable given that many targets in our sample were held by highly sophisticated investors who apparently did not spot the mispricing until it was too late.

Appendix

A. Variable Definitions

A.1 Outcome Variables

A.1.1 Abnormal returns. CAR is the cumulative abnormal return over a specified event window. It is constructed using the Fama-French-Carhart benchmark. Factor loadings are estimated in a one-year preevent window ending 21 trading days before the report date. CARs for a given event window are then calculated as the difference between the realized return and the benchmark return computed using the estimated factor loadings. Standard errors are corrected for autocorrelation.

Characteristics-adjusted abnormal returns (DGTW returns) follow the methodology in Daniel and others (1997) and Wermers (2004). For each month, we sort firms into five size quintiles based on NYSE cutoffs. Within each size quintile, we then sort firms into five book-to-market quintiles based on data for the preceding December. Finally, we sort the firms in each of the 25 size/book-to-market portfolios into quintiles based on their monthly return. The resulting size, book-to-market, and momentum ranks for each stock are used in the following month to compute the DGTW-adjusted return by subtracting from a target’s daily return the value-weighted return of all non-target stocks with the same size, book-to-market, and momentum ranks. Because many of our targets are Chinese firms that are listed in the United States, we relax the sampling criterion of Daniel and others (1997) and Wermers (2004) that stocks must be U.S. firms (i.e., we do not require firms to have a CRSP share code of 10 or 11).

Calendar-time abnormal portfolio returns (alpha) are computed as follows. Assuming an equal initial dollar investment in the portfolio, the portfolio return on day \( t \) is given by

\[
\frac{\sum_{i=1}^{n_T} R_{it} x_{it}}{\sum_{i=1}^{n_T} x_{it}},
\]

where \( R_{it} \) is the day-\( t \) return on stock \( i \), \( n_T \) is the number of stocks in the portfolio at day \( t \), and \( x_{it} \) is the cumulative buy-and-hold return of stock \( i \) from the beginning of the date stock \( i \) enters the portfolio through the close of day \( t-1 \). (For a stock that enters the portfolio on day \( t \), \( x_{it} = 1 \).) The abnormal portfolio return (alpha) is the intercept from a weighted-least-squares regression of the daily portfolio return (in excess of the risk-free rate) on the daily Fama-French-momentum factors, using the number of stocks in the portfolio as weights (Fama 1998).

A.1.2 Abnormal profits. Cumulative abnormal profit measures the return to a borrow-and-hold strategy that goes short the stock on day \( t \), marks the position to market on a daily basis, and closes out the position on day \( T \). It is measured as the negative of the cumulative abnormal return (CAR)
net of the cumulative daily shorting fee (the daily cost of borrowing new shares from equity lenders according to DataExplorers).

**Characteristics-adjusted abnormal profit (DGTW profit)** measures the return to a borrow-and-hold strategy that goes short the stock on day \( t \), marks the position to market on a daily basis, and closes out the position on day \( T \). It is measured as the negative of the cumulative DGTW return net of the cumulative daily shorting fee (the daily cost of borrowing new shares from equity lenders according to DataExplorers).

**Calendar-time abnormal profit** measures the return to a borrow-and-hold strategy that goes short the stock on day \( t \), marks the position to market on a daily basis, and closes out the position on day \( T \). It is computed as follows. Each trading day \( t \), we measure the profit on target stock \( i \) as the negative of \( i \)'s return net of the daily shorting cost. Assuming an equal initial dollar investment in the portfolio, the portfolio profit on day \( t \) is \( \sum_{t=1}^{T} \pi_{it} x_{it} / \sum_{t=1}^{T} t_{it} \), where \( \pi_{it} \) is the day-\( t \) profit on stock \( i \), \( n_{i} \) is the number of stocks in the portfolio at day \( t \), and \( x_{it} \) is the cumulative buy-and-hold return of stock \( i \) from the beginning of the date stock \( i \) enters the portfolio through the close of day \( t-1 \). (For a stock that enters the portfolio on day \( t \), \( x_{it} = 1 \).) The abnormal portfolio profit is the intercept from a weighted-least-squares regression of the daily portfolio profit (in excess of the risk-free rate) on the daily Fama-French-momentum factors, using the number of stocks in the portfolio as weights \( \text{Fama, 1993} \).

### A.1.3 Daily trading and shorting variables.

**Turnover** is defined as the one-way number of shares traded in a day (CRSP variable \( \text{vol} \) divided by 2) divided by the number of shares outstanding (CRSP variable \( \text{shrout} \)).

**New shorts/shares outstanding** is the number of new shorts initiated (as proxied by the number of new shares on loan) on a given day divided by the number of shares outstanding (CRSP variable \( \text{shrout} \)). The number of daily new shares on loan is obtained from DataExplorers.

**Long trades/shares outstanding** is equal to the difference between one-way turnover and new shorts/shares outstanding (as defined above). In other words, it is the number of (one-way) traded shares on a given day that are not attributable to short sellers, divided by the total number of shares outstanding (CRSP variable \( \text{shrout} \)).

**Shorting fee** is the daily cost of initiating new short positions (i.e., the daily cost of borrowing new shares from equity lenders), using data obtained from DataExplorers.

**Supply of lendable stock** is defined as the number of shares available for borrowing on a given day divided by the number of shares outstanding (CRSP variable \( \text{shrout} \)). Data on shares available for borrowing are obtained from DataExplorers.

**Utilization** is defined as the number of shares out on loan divided by the number of shares available for borrowing on a given day. Data on shares available for borrowing are obtained from DataExplorers.

**Institutional sells/baseline turnover** measures the selling activity by ANcerno institutions at the daily level. Specifically, we follow [Goldstein, Irvine, and Puckett (2011)](https://academic.oup.com/rfs/article-abstract/29/8/1975/2583716) and [Puckett and Yan (2011)](https://academic.oup.com/rfs/article-abstract/29/8/1975/2583716) and aggregate sales in ANcerno to the daily level. We scale aggregate sales by the baseline trading volume, estimated as the average daily one-way CRSP trading volume in our baseline pre-event period (trading days \(-80 \) to \(-21 \)).

**Institutional buys/baseline turnover** measures the buying activity by ANcerno institutions at the daily level. Specifically, we follow [Goldstein, Irvine, and Puckett (2011)](https://academic.oup.com/rfs/article-abstract/29/8/1975/2583716) and [Puckett and Yan (2011)](https://academic.oup.com/rfs/article-abstract/29/8/1975/2583716) and aggregate purchases in ANcerno to the daily level. We scale aggregate purchases by...
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the baseline trading volume, estimated as the average daily one-way CRSP trading volume in our baseline pre-event period (trading days \(-80\) to \(-21\)).

*Institutional net sales/baseline turnover* is defined as the difference between *Institutional sells/baseline turnover* and *Institutional buys/baseline turnover*.

**A.1.4 Daily variables constructed using intraday data from TAQ.** *Amihud (2002) illiquidity measure* is defined as the average, over a day, of the absolute value of the 5-minute continuously compounded return multiplied by 1,000,000 which then is divided by the dollar trading volume within the same 5-minute interval. We compute the continuously compounded returns using TAQ prices sampled every 5 minutes. Results using quote prices are very similar. The variable is winsorized at the 1% and 99% levels to reduce the effect of outliers.

*Realized spreads* is a measure of the compensation liquidity providers require to cover their inventory and order processing costs. It is obtained from a spread decomposition. This requires estimates of the value of the stock before and after a given trade. We estimate these following [Huang and Stoll (1996)](#), who proxy for the pretrade value using the midpoint of the most recent bid-ask spread before the trade and for the posttrade value using the transaction price 5 minutes after the trade. The realized spread then is the difference between the current transaction price and the posttrade value.

**A.1.5 Daily options-related variables (from OptionMetrics).** *Put-call trading volume ratio* is constructed as follows. First, for each pair of traded put and call options with the same strike price (OptionMetrics variable `strike_price`) and exercise date (OptionMetrics variable `exdate`), we compute the put-call ratio of the daily trading volume (OptionMetrics variable `volume`). Second, we compute the weighted average of the daily trading volume ratios for all the put and call option pairs, weighted by open interest (OptionMetrics variable `open_interest`) on the corresponding put-call option pair for a given stock.

*Put option-implied volatility* is the weighted average of the implied volatility of all traded put options on a day for a given stock, weighted by open interest (OptionMetrics variable `open_interest`) on each of the traded put options for that stock. The implied volatility measure for each traded put option is obtained directly from OptionMetrics (variable `impl_volatility`).

*Put-call implied volatility ratio* is constructed as follows. First, for each pair of traded put and call options with the same strike price (OptionMetrics variable `strike_price`) and exercise date (OptionMetrics variable `exdate`), we compute the put-call ratio of the daily implied volatilities (OptionMetrics variable `impl_volatility`). Second, we compute the weighted average of the daily implied volatility ratios for all the put and call option pairs, weighted by open interest (OptionMetrics variable `open_interest`) on the corresponding put-call option pair for a given stock.

**A.1.6 Analyst recommendation variables (from I/B/E/S summary files).** *Mean (median) recommendation score* is defined as the average (median) of the recommendation scores on a target stock by sell-side analysts. A score of 1 equals a strong buy and a score of 5 equals a strong sell.

*Number of recommendations* is defined as the number of sell-side analyst recommendations on a target stock.

*% buy recommendation* is defined as the percentage of sell-side analyst recommendations that have a buy rating.
Table A1
Illustrations of report titles

1. “Credibility is like virginity; once you lose it, you can never get it back,” January 24, 2008 (Citron Research)
2. “Arthrocare—Something is rotten in the state of Denmark,” May 2, 2008 (Citron Research)
4. “Citron exposes Apollo’s big dirty secret – All new docs,” March 2, 2009 (Citron Research)
5. “AOB deal questionable even without undisclosed relationship between chairman and seller,” August 5, 2009 (Asensio & Co.)
6. “SinoCoking: Follow the money!” March 11, 2010 (Citron Research)
8. “China New Borun (BORN)—You are cold busted. Now it is time to come clean,” November 15, 2010 (Citron Research)
9. “A stock only a trading robot could love,” December 28, 2010 (Citron Research)
10. “Another stock only a computer could love: The sequel,” January 24, 2011 (Citron Research)
11. “CCME: The China reverse merger stock that is ‘too good to be true,’” January 30, 2011 (Citron Research)
12. “ChinaCast Education Corporation: Show me the money! Questions to management regarding acquisition #1,” February 16, 2011 (OLP Global)
14. “China Biotics: The best research you haven’t seen,” March 12, 2011 (Citron Research)
15. “DEER: Was the $22.3 million land use right certificate a forgery?” March 18, 2011 (Chimin Sang)
16. “Sino Clean Energy: Who lied about the weather?” May 12, 2011 (Chimin Sang)
17. “Gulf Resources: Financial claims are beyond reason,” May 19, 2011 (Kerrisdale Capital)
18. “ZAGG: Is it in the covers business, or covering up its real business?” July 13, 2011 (Citron Research)
19. “China Biotics: The best research you haven’t seen,” April 28, 2011 (Alfred Little)

Table A1 lists 20 examples of report titles used by sample arbitrageurs to attract attention to their reports.

% hold recommendation is defined as the percentage of sell-side analyst recommendations that have a hold rating.

% sell recommendation is defined as the percentage of sell-side analyst recommendations that have a sell rating.

A.2 Firm Characteristics (Measured as of the Most Recent Calendar Month-End before a First Report)
Market capitalization is defined as the product, reported in millions, of the end-of-month share price (CRSP variable prc) and the total number of shares outstanding (CRSP variable shrout).
Book/market ratio is measured as the ratio of a firm’s book value of equity (Compustat items seq + txditc – pstkrv) to its market value (Compustat item prcc multiplied by Compustat item csho).

Monthly idiosyncratic volatility is defined as the monthly average of the standard deviation of residuals from adjusted daily Fama-French regressions specified as in [Jiang, Xu, and Yao (2009)].

Monthly Amihud (2002) illiquidity measure is constructed as follows. We use daily CRSP data (CRSP items ret, prc, and vol) to calculate the ratio of absolute stock return (multiplied by 1,000,000) to dollar trading volume for each day, after which we average these daily ratios over a month.

A.3 Short-Seller Characteristics
Credible is defined as follows. We examine the arb’s prior record of accomplishment, on the assumption that arbs with a stronger record of accomplishment are more readily believed when they target a stock. We measure an arb’s record of accomplishment at time t as the rolling mean of the 3-month cumulative abnormal returns (CARs) of all her previous reports (issued at least 3 months before the report date).
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months before time $t$, to avoid look-ahead bias. We require each arb to have issued at least two reports before we compute a track record. A report issued at time $t$ is coded as more credible if the arb’s prior track record produced profits (a negative rolling mean CAR) and as less credible otherwise.

A.4 Portfolio Formation Strategy (Figure 19)

For each first report targeting a Chinese firm and released on day $t$, we estimate the abnormal return to a trading strategy that buys all non-target U.S.-listed Chinese firms when reports 1, 2, … $t$ are released and sells the Fama-French and momentum portfolios. Non-targets are firms that have not themselves been targeted by sample arbs through report $t$. Abnormal returns are obtained from monthly calendar-time portfolio regressions assuming a 12-month holding period.

References


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