The Role of Reputation in Financial Markets: The Impact of Broker Dark Pool Scandals on Institutional Order Routing*

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ABSTRACT

Utilizing commission data from a large sample of institutional investors, we examine investor reactions to scandals involving broker-operated dark pools. When a breach of trust becomes public, both mutual funds and pension funds react by reducing commissions routed to the affected broker. The response is strongest when the scandal results in large fines, when the broker offers only execution services, and when the institution and broker share a stronger prior relationship. Conversely, the reaction is muted for mutual funds likely to have internal monitoring capabilities. Together, our results suggest that institutional investors rely on trust when making order routing decisions.

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1. Introduction

Previous research suggests that reputational capital is embedded in multiple aspects of financial markets.[1] However, conclusions regarding the importance of reputation are often clouded by the difficulty in measuring reputation or its impact on financial market outcomes. In this paper, we isolate the importance of reputation by studying the reaction of institutional investors to a clear breach of trust by one or more of their brokers. Specifically, we test for changes in the order routing decisions of public pension funds and mutual funds following publicly revealed scandals involving broker-operated dark pools.[2]

Commissions from institutional investors are an important source of revenue for broker-dealers.[3] Although total dollar commissions have halved since their 2009 peak, Greenwich (2019) estimates that buy-side investment shops still spend $4.4 billion annually for brokerage services. Thus, there is a substantial payment pool for which brokers compete. This revenue is allocated among brokers via buy-side order routing decisions, which may be impacted by a number of factors, including broker reputation.

Broker-operated dark pools are one means of trading that many brokers provide to their institutional clients. Dark pools are a type of alternative trading system (ATS) through which certain investors are able to place orders and execute trades without revealing their trading intentions to the broader market. The anonymity provided by this lack of pre-trade transparency can be important to institutional traders, because their large orders could have a substantial market impact if other traders become aware of their existence.[4]

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[1] Examples include Beatty, Bunsis and Hand (1998), Fang (2005), Battalio, Ellul, and Jennings (2007), Fang and Yasuda (2009), and Atanasov, Ivanov and Litvak (2012). See Amiram, Bozanic, Cox, Dupont, Karpoff, and Sloan (2018) and Dupont and Karpoff (2020) for reviews of the theoretical and empirical literature related to the role of reputation in financial markets.

[2] Our approach is analogous to previous studies that identify a reputation-relevant event and examine either loss of business or loss of firm value subsequent to the event. Examples of this approach include Beatty and Ritter (1986), Karpoff, Lott, and Wehrly (2005), Karpoff, Lee, and Martin (2008), and Gopalan, Nanda, and Yerramilli (2011). Another common approach to study the impact of reputation is to utilize a proxy for reputation, such as size or market share (see, for example, Megginson and Weiss, 1991; Michaely and Shaw, 1994).

[3] Mutual funds and public pension funds are consequential institutional investors. Mackintosh (2021) reports that mutual funds own about 22% of public equity and account for 10-15% of daily two-sided liquidity, with pension funds accounting for another 11% and 4%, respectively.

[4] This anonymity feature appears to be valuable, as dark pools have become both an important source of liquidity for institutional investors and a significant source of revenue for the broker-dealers who operate them. Rosenblatt Securities (2020) indicates that daily dark pool volume accounted for between 12% and 16% of consolidated volume over the past decade and Mackintosh (2021) estimates that mutual funds and pension funds do about 30% of their trading in dark pools.

However, because the inner workings of dark pools have not historically been visible to outside clients, institutional investors are required to trust the claims of the broker with respect to how and against whom their orders are executed.[5] Thus, a trust-based reputation is vital to the viability of any dark pool and the success of a dark pool will reflect the broader level of trust developed between the broker and its clients.[6]

Between 2011 and 2018, the Securities and Exchange Commission (SEC), the Financial Industry Regulatory Authority (FINRA), and the New York Attorney General initiated actions charging several brokers with violations involving the operation of their dark pools. Alleged infractions typically involved misleading institutional traders about the participants in or the operation of the dark pool and sometimes included outright violations of security laws. In several cases, the dark pool operator is alleged to have provided confidential information to select pool participants regarding the identity or characteristics of buy-side customers and their orders, thus violating the promised anonymity. These enforcement actions were settled by fines and disgorgement totaling hundreds of millions of dollars, suggesting that the direct harm to customers and the related shocks to broker reputation were consequential.

This setting provides a useful framework for investigating the impact of reputation in financial markets for a number of reasons. First, the inability of institutional investors to observe the inner workings of dark pools leads to a substantial reliance on trust. Second, the breach of trust associated with these dark pool scandals is directly linked to the treatment of institutional order flow, which is likely to impact the broader relationship between the broker and its institutional clients. Lastly, our hand-collected data allow us to track relationships between funds and brokers over time and to directly measure the reaction of institutional investors toward the brokers impacted by these trust-based reputational shocks. Importantly,

[5] In 2018, the SEC passed new rules related to the regulation of alternative trading systems. These new rules require safeguards to protect subscribers' confidential trading information, as well as disclosures related to the dark pool's manner of operations and the dark-pool related activities of the broker-dealer operator and its affiliates (see SEC, 2018). While these new regulations do not stop brokers from misrepresenting what they are doing, the increased disclosures make it easier to identify and punish cases where broker actions deviate from their claims.

[6] Anecdotal evidence suggests that trust is particularly important in the financial market setting we study and that the implications of violating trust in this setting are substantial (see, for example, Cave, 2015). In her 2015 ruling against Barclays' request to dismiss a class action lawsuit, Justice Shirley Kornreich wrote that "traders are entitled to rely on material representations banks made about their dark pools" and "if such representations are untrue, the integrity of dark pools will be compromised and investor confidence in them will be shaken" (Stempel, 2015).

the significant number of mutual funds (652) and pension funds (77) in the sample allow us to examine several hypotheses related to the heterogeneity in effects across funds and across fund-broker pairs.

Given the importance of trust-based reputation to institutional trading and the fiduciary responsibilities that pension funds and mutual funds have to their clients, we expect the breaches of trust revealed through these dark pool scandals to result in a reallocation of commission dollars away from the affected brokers. Specifically, we hypothesize that institutional investors will reduce the commission dollars allocated to affected brokers following the public revelation of dark pool scandals. Importantly, while the violation of trust occurs within the dark pool, we expect the impact of the associated reputation shock to affect the broader trading relationship between the affected brokers and their institutional clients.[7]

It is possible that mutual funds and pension funds will react differently to dark pool scandals. On one hand, the reaction to a breach of trust may be weaker for pension funds than mutual funds if the enforcement of fiduciary duty within pension funds is hampered by the public oversight of the funds or if the effects of broker reputation are outweighed by other political factors.[8] Given evidence that pension fund flows are less sensitive to performance than mutual fund flows (Dahlquist and Martinez, 2015), pension funds may also be less incentivized to monitor broker performance and the related impact on trading costs. On the other hand, pension funds may react more strongly than mutual funds if their public nature makes them more sensitive to the appearance of a scandal.[9] Thus, the question of whether pension funds and mutual funds respond differently to breaches of trust remains an empirical one.

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[7] The decision to redirect commissions away from a particular broker could be made at the level of a particular fund manager or at a higher level, such as the fund family or the state or municipality operating the pension fund. The ability of trustees to dictate broker choice is illustrated by the aggressive order routing targets defined by the state of Illinois with respect to minority brokers. See, for example, Pensions & Investments (2006) and IMFR's Minority Broker/Dealer Goals (https://www.imrf.org/en/investments/minority-managers-and-brokers/minority-broker-and-dealer-goal).

[8] Etine (2006) hypothesizes that when the state acts as both a party to a legal obligation and its regulator/arbitrator, there is likely to be some slippage in the enforcement of fiduciary duty. He also notes that a breach of duty to a private trustee is considered a personal liability, while similar breaches by public trustees might not be. Rose (2018) makes similar arguments about the robustness of the enforcement for breaches by private and public funds and notes that public officials are frequently protected by sovereign immunity. A number of studies point to political influences on the investment choices of public pension funds, often with lower associated returns (e.g., Hochberg and Rauh, 2013; Andonov, Hochberg, and Rauh, 2018; Dyck, Manoel, and Morse, 2022).

[9] For example, Dyck, Manoel, and Morse (2022) document that public pension funds seem to avoid the appearance of a scandal by refusing to hire outside fund managers who are identified as highly compensated, even if the fund earns lower returns as a result.

The dark pool scandals we analyze are likely to differ along a number of dimensions, as reflected in the news announcements summarized in Internet Appendix Table IA.1. While we cannot capture all dimensions along which these scandals differ, we expect the magnitude of perceived wrongdoing and the related reputation shock to be closely correlated with the fines levied on the brokers. These fines vary significantly across the dark pool scandals we analyze, ranging from $800,000 for Goldman Sachs to $70 million for Barclays (plus a $27 million class action settlement). Thus, we hypothesize that the reaction of institutional investors to the public announcement of dark pool scandals will be most significant when the breaches of trust are most egregious, as proxied by the magnitude of resulting fines and disgorgement.[10]

The reaction of institutional investors to dark pool scandals will likely be impacted by the characteristics of the broker. The brokerage firms involved in these scandals vary widely in the services they offer to institutional clients. While some focus only on agency trading solutions, many are full-service global investment banks, providing access to security offerings, research, and capital, among other services (see, for example, Goldstein, Irvine, Kandel, and Wiener, 2009). If trade execution is the only service an institutional investor receives from a broker, then a breach of trust involving the broker's dark pool is likely to be associated with significant rerouting of commissions away from that broker. However, if the broker provides additional services, then the effects of a reputation shock on order routing decisions might be mitigated. We hypothesize that the reaction of pension funds and mutual funds to breaches of trust in dark pools will be more significant for execution-only brokers than for full-service brokers.

The reaction to dark pool scandals may also be impacted by institutional investor characteristics. Some institutional investors may be less reliant on trust and therefore less affected by shocks to broker reputation. In particular, some large institutional investors may have sufficient resources to perform their own internal monitoring of dark pool trading activity, allowing them to detect and react to dark pool abuses before they become known to the public.[11] If these monitoring institutions adjust their trading strategies

[10] We also include broker × fund fixed effects to control for unobserved, time-invariant heterogeneity at the level of the broker-fund pair.

[11] Patterson and Hope (2014) describe how some big trading firms identified issues with the execution quality of their orders in Barclay's dark pool months before allegations were raised by the New York attorney general. In response, at least two firms, including RBC Capital Markets and T. Rowe Price, altered their trading strategies involving

prior to the public revelation of a scandal, we would not expect to see a reaction in their order routing following the public announcement of the scandal. Specifically, we hypothesize that large institutional investors with internal monitoring capabilities will be less reliant on trust and therefore less sensitive to the public announcement of dark pool scandals.[12]

In addition to institutional investor and broker characteristics, the reaction to breaches of trust may be impacted by the nature of the pre-existing relationship between the institution and the broker. For example, Gennaioli, Shleifer, and Vishny (2015) develop a model in which clients prefer to work with the investment professionals, or 'money doctors,' with whom they have built familiarity and a trusted relationship. This suggests that stronger and longer-lasting relationships may be more reflective of trust, leading to more pronounced reactions to broker scandals. Alternatively, stronger pre-existing relationships could allow for more performance-based analysis and less reliance on trust. In this case, we would expect stronger relationships to be associated with weaker reactions to broker scandals.[13]

While the importance of reputation suggests that public pension funds and mutual funds will react strongly to breaches of trust in dark pools, it is not clear whether these effects will be permanent or temporary. It is possible that once a broker violates an institutional investor's trust, the institutional will permanently shift their business away from that broker. However, it is also possible that affected brokers

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Barclays. Similarly, Battalio, Hatch, and Saglam (2023) provide evidence suggesting that an institutional investor altered its order routing strategies in response to bad execution quality outcomes in a broker-operated dark pool.

[12] The level of monitoring ability required to identify broker malfeasance before it becomes public may not be achievable for most institutional investors. For example, Clive Williams, global head of equity trading at T. Rowe Price, is quoted in Henderson (2013) as stating that the "swathes of raw routing data that need to be analyzed before understanding brokers' smart order routing decisions makes meaningful analysis almost impossible for institutional investors."

[13] We also expect the reaction to dark pool scandals to be less pronounced if the relationship between the institutional investor and the broker involves a soft-dollar arrangement that is valuable for the investor. For example, Conrad et al. (2001) note that institutions often ask for and receive non-execution services, such as research, as a quid pro quo for directing trades to a particular broker and Gokkaya et al. (2023) find that mutual funds earn higher abnormal returns on stocks for which they obtain industry expertise through soft-dollar arrangements. Our data do not allow us to directly identify these types of soft-dollar arrangements between specific fund-broker pairs. However, we are able to identify mutual funds that utilize brokers for research and other non-trade services. We find no evidence that the reaction to broker scandals differs significantly between mutual funds that utilize brokers for these non-trade services and those that do not. On the contrary, we do find strong evidence that the reaction of institutional investors differs between scandals involving full-service brokers and brokers providing only execution services. Importantly, any variation in broker reaction driven by soft-dollar or other fund-broker relationships will be captured by the *Fund* × *Broker* fixed effects.

can credibly signal corrective actions they have taken and eventually rebuild their reputational capital. We follow order routing decisions for multiple years post-scandal to determine whether the reputational effects of dark pool scandals are permanent or temporary. We also examine the relative importance of downgrades vs. terminations to determine whether the effects are reflected at the intensive or extensive margins.

Consistent with our primary hypothesis, we find that both mutual funds and pension funds react to public announcements of dark pool scandals by reducing the commissions they route to the affected brokers. In particular, we find a significant reaction by institutional investors when the breach of trust is associated with an execution-only broker and when the perceived abuses by the broker are most egregious, as proxied by the magnitude of associated fines and disgorgement. These findings are robust to a variety of estimation methods and to controls for time, broker, and fund fixed effects. The results also suggest that the reaction of pension funds is more pronounced than that of mutual funds. When we separate broker downgrades from terminations, we find additional differences between mutual funds and pension funds. For mutual funds, reactions to broker scandals are evident at both the intensive and extensive margins. In contrast, the effects for pension funds appear to be driven by downgrades rather than terminations of the affected brokers.

The richness of the data allow us to explore the heterogeneity of investor reactions to breaches of trust and to rule out some potential alternative explanations. We find evidence that the reaction to broker scandals is less pronounced for those mutual funds most likely to have internal monitoring capabilities, especially for the most egregious scandals. This suggests that either these funds are less reliant on trust or they are better able to identify and react to dark pool abuses before they become public. We also find that the reaction to broker scandals is stronger in cases where the institutional investor and broker share a stronger pre-existing relationship, as measured by relationship length or the placement of the broker in the fund's commission league tables. This is consistent with the idea that stronger and longer lasting relationships reflect a buildup of trust that is more heavily damaged by the announcement of a broker scandal than shorter relationships.

If brokers change their pricing or services following dark pool scandals, our results could reflect a reaction to these changes rather than a shock to reputation. In addition, reputation-based downgrades by

some institutional investors may affect the decisions of other institutions if the broker's value is tied to its client network. To examine such alternative explanations, we extend our analysis to incorporate proxies for broker pricing, broker service offerings, and broker centrality. Our main results appear robust to these alternative explanations. This suggests that the broker downgrades we document reflect shocks to broker reputation, rather than changes in broker services or pricing.

Across all broker scandals in the sample, we estimate that the combined commissions paid to affected brokers by our sample funds are $72 million (7.4%) lower over the two years following scandals than had the guilty brokers maintained their pre-scandal share of total commission dollars. Moreover, the commission losses appear to continue for multiple years following the broker scandal announcements, suggesting that the impact of scandals is long-lasting. Because we study only a subsample of pension funds and mutual funds, these losses are likely to be significantly understated. Nonetheless, they are of the same order of magnitude as the fines imposed by regulators and represent a substantial additional penalty to the affected brokers. In sum, our evidence points to important reputational effects in the relationships between institutional investors and their brokers, with institutional investors reducing their use of brokers that violate their trust.

2. Data and descriptive statistics

2.1 Dark pool scandal events

To identify the sample of reputation shocks related to broker dark pools, we search the SEC's enforcement action website using the keyword "dark pool" combined with "SEC", "FINRA", or "New York Attorney General". For each identified event, we then conduct web searches for public media and regulatory announcements to identify the earliest announcement date associated with the event. Importantly, as data on broker commission spend for public pension funds (mutual funds) is available only on an annual (semi-annual) basis, we need only bracket the public announcement between two reporting dates. In some cases, the first news story we identify is the settlement announcement, while in others there is at least an indirect indication that a broker's dark pool is under investigation before the settlement is announced. We describe the identified sample of dark pool events in Table 1. More descriptive information

from public announcements of these events in provided in Internet Appendix Table IA.1.

[Insert Table 1 about here.]

Twelve of the 13 identified events involve regulatory actions against broker-operated dark pools. For example, regulators began scrutinizing the dark pools of Goldman Sachs, Credit Suisse, and Barclays in 2014 to determine whether these trading systems provided high-frequency traders unfair advantages over other investors. However, our search identified one additional event involving a significant trading error by Knight Capital Group.[14] Though this scandal is one of incompetence rather than breach of trust per se, the reputational shock associated with the event may have been significant and we include it in the sample. One of the identified events (Level in 2012) involves a broker that does not appear in either the pension fund or mutual fund data. This event is therefore dropped from the analysis.[15] The 12 remaining scandals reflect significant shocks to the reputations of the affected broker dealers and impact thousands of fund-broker relationships.[16]

As noted previously, we expect the sensitivity of routing decisions to reputation shocks to differ based on broker characteristics and the severity of the scandal. In particular, we expect the broker reaction following these shocks to be less severe for brokers offering services other than order execution and more severe for scandals resulting in larger fines. To test these hypotheses, we categorize the affected brokers into full-service (Barclays, Citigroup, Credit Suisse, Deutsche Bank, Goldman Sachs, and UBS) and execution-only brokers (ITG, KCG, Liquidnet, and Pipeline). We further distinguish between high-fine and

[14] On August 1, 2012, Knight Capital Group (KCG) introduced a new trading algorithm that contained a coding error. This led to KCG erroneously acquiring $7 billion of equities within an hour of the market open. Unwinding this position cost KCG $440 million. In discussing this event, Cheyenne Morgan of the Tabb Group stated, “This is a good opportunity to reiterate just how much reputation and trust plays into trading. Trust has always been the name of the game in trading and becomes even more critical when trading off-exchange." See *Wall Street Journal* (2012). While the KCG event is included in the analysis, the conclusions are unchanged if this event is excluded. This robustness check is provided in Internet Appendix Table IA.2.

[15] Pipeline goes out of business the year following the firm’s 2011 scandal. This illustrates the significant reputation shock associated with dark pool scandals and the difficulty associated with gaining back client trust following these events (see, for example, Traders Magazine, 2011). The failure of Pipeline suggests that our analysis of broker downgrades may understate the damages to brokers following dark pool scandals. While the Pipeline event is included in the analysis, the conclusions are unchanged if this event is excluded. This robustness check is provided in Internet Appendix Table IA.2.

[16] Given the large number of institutional investors in our sample, as described below, the identified broker scandals impact 1,850 broker-mutual fund relationships and 637 broker-pension fund relationships.

low-fine events, where high-fine events are those resulting in a fine of at least $40 million. Because we have only a small number of sample events for execution-only brokers, with a narrower range of resulting fines, we consider the high-fine and low-fine categorization only for full-service brokers. Thus, the high-fine full-service events are those involving Barclays (first announced 5/9/2014), Credit Suisse (5/9/2014), and Deutsche Bank (7/29/2014), and the low-fine full-service events are those involving Goldman Sachs (5/9/2014), Citigroup (7/25/2014 and 9/14/2018), and UBS (7/29/2014). The events associated with execution-only brokers include Pipeline (10/24/2011), Liquidnet (6/22/2012), KCG (8/1/2012), and ITG (7/29/2015 and 8/8/2018).

2.2 Mutual fund sample

Our mutual fund sample consists of U.S. actively managed open-end mutual funds. For the period from 2010 through 2018, we use NSAR filings to collect data related to the commissions these mutual funds paid to their brokers.[17] Like all investment companies during this period, mutual funds were required by the Investment Company Act of 1940 to file SEC Form NSAR semi-annually.[18] In addition to a broad range of financial and trading information, Form NSAR includes data on fund size, total trading commissions paid during the period, asset class (e.g., equity, fixed income, balanced), geography of investments (domestic vs. international), fund style (e.g., growth vs. income), and indicators for whether the fund is an open-end fund or index fund. Of particular interest to our research, Form NSAR also requires mutual funds to list their top ten brokers (ranked by commissions paid) and the total commissions paid to each.[19]

Importantly, Form NSAR is filed at the CIK (Central Index Key) level, rather than the investment company or fund level. A single investment company or fund family may have multiple CIKs registered with the SEC, sometimes with different fiscal years, and each CIK can have multiple mutual funds assigned

[17] We select 2010 as the starting date as it precedes the first dark pool scandal and allows analysis of brokerage commissions in both the mutual fund and pension fund samples. While mutual funds and some public pension funds report commission data earlier than 2010, not all pension funds do so consistently.

[18] Form NSAR-A includes data for the first half of the fiscal year and Form NSAR-B includes data for the entire fiscal year. Form NSAR fully replaced Form N-1R in November 1995 and was itself phased out in 2018 and replaced with Form NCEN. Because investment companies are permitted to use either Form NSAR or Form NCEN through June 2019, NSAR data during this phase-out period captures only a subset of mutual funds. For 2018-2020, we supplement the NSAR data with NCEN data, as described below.

[19] See Han, Kim, and Nanda (2019) for a more complete description of data reported via Form NSAR.

to it. While the NSAR filing for a CIK that includes multiple funds will report a number of data items at the individual fund level, including fund name and fund characteristics, commission data for the top 10 brokers are aggregated across all funds included under the CIK. Thus, in the case of an investment company that has multiple CIKs, with each CIK including multiple funds, the commission data we collect will represent the commissions at the CIK level, rather than either the investment company or fund level. This is further complicated by the fact that the funds reported under a particular CIK can change over time. To ensure that the commission data and broker rankings we analyze are comparable across time, we follow Edelen, Evans, and Kadlec (2012) in restricting our analysis to the subset of CIKs that include only a single mutual fund. The impact of this restriction is described in more detail below.

To construct our database, we begin by downloading all annual NSAR filings (Form NSAR-B) available in the SEC's EDGAR database. We then use an algorithm to parse the filings and extract the relevant information. After restricting the sample to open-end mutual fund companies and eliminating NSAR filings with no broker commission data[20], this process results in a sample of 107,553 broker observations across 1,657 CIKs and 10,247 CIK-years.

Some observations are missing management company and fund characteristic information. Where possible, we fill in this missing data based on observations in preceding and subsequent years with the same CIK and fund name. In some cases, NSAR reports are amended after the original filing. Where multiple NSAR reports with the same report date (fiscal year end) exist for a given CIK, we keep only the most recently updated NSAR data. We also eliminate a small number of CIKs with multiple report dates in the same calendar year. Finally, we examine the broker commission data for outliers. Where obvious errors cannot be corrected manually, we eliminate the observations.[21] After applying these restrictions, the NSAR sample consists of 69,982 broker observations across 1,573 CIKs and 8,993 CIK-years.

[20] This screen primarily eliminates fixed income funds, as investors pay mark-ups rather than commissions to trade in the fixed income market.

[21] Specifically, we search for large outliers in broker or total commissions, cases where the sum of the individual broker commissions exceeds the total commissions figure, and cases where broker or total commissions change significantly across years for the same CIK. In some cases, it is clear that the commission data are incorrect by orders of magnitude. In cases where the difference is clearly driven by an error in reporting units (e.g., dollars versus thousands of dollars) we correct the outlier entry. If the correction is not obvious, we delete the observation.

Because the broker names reported in the NSAR data are not standardized, they require substantial cleaning before any analysis can be performed. Some brokers are also absorbed over time through mergers with other brokers. The process used to clean broker names and adjust for broker mergers is described in Appendix I. Before name consolidation, the final sample of NSAR data include 5,017 unique broker name variations. These broker names are consolidated into 724 'master' broker names (referred to henceforth as 'broker'). To the extent that the name consolidation process results in multiple occurrences of the same broker name in the same fund-year, we aggregate all commissions paid to the broker and recalculate broker ranks for that fund-year. This cleaning and aggregation process results in a sample of 69,424 observations across 1,573 CIKs and 8,993 CIK-years.

As noted above, to allow comparison of broker commissions and rankings across time, we restrict our analysis to those CIKs that report data for only a single mutual fund. After applying this restriction, the NSAR sample consists of 25,443 broker observations across 652 CIKs and 3,502 CIK-years.[22] Given this restriction, any references to fund or CIK are interchangeable throughout the rest of the paper.

Because Form NSAR was phased out beginning in 2018, we supplement the NSAR data with NCEN data to extend the sample through 2020. Like Form NSAR, Form NCEN provides data on a number of fund characteristics, as well as the identification of and commissions paid to the top ten brokers used by the fund during the period. Unlike Form NSAR, Form NCEN is filed only annually and is filed at the fund rather than the CIK level.

To supplement the NSAR data, we begin by downloading all annual NCEN filings available in the SEC's EDGAR database through 2020. We then match these data to the CIKs in the final NSAR sample and use an algorithm to parse the filings and extract the relevant information. Of the 652 single-fund CIKs in the final NSAR sample, we are able to identify NCEN data for 389. This includes 358 (90.4%) of the 396 single-fund CIKs that report NSAR data in either 2017 or 2018. We clean the NCEN data in the same manner as the NSAR data, eliminating observations replaced by an amended filing, correcting or

[22] The single-fund CIK sample (652 CIKs) accounts for 23.1% of total mutual fund commissions in the cleaned NSAR data (1,573 CIKs).

eliminating outliers, and cleaning/adjusting broker names. When combined, the NSAR and NCEN data result in a final sample of 32,525 broker observations across 652 single-fund CIKs and 4,401 CIK-years. These data include 544 different brokers.

Summary statistics related to the mutual funds in our sample and related brokerage commissions are described in Panel A of Tables 2 and 3. In total, the sample mutual funds report $8.39 billion in commissions during the period with the top five funds accounting for 27% of the total. The mean fund pays $1.4 million in average annual commissions and $12.9 million during the sample period.[23] The highest total commissions during the sample period were paid by American Funds Europacific Growth Fund, with total commissions of $740.7 million.

[Insert Tables 2 and 3 about here.]

The sample brokers account for $5.44 billion in commissions or approximately 65% of total commissions paid by the sample mutual funds during the period.[24] The top broker across the sample funds is Morgan Stanley, earning $618.18 million in total commissions during the sample period. The mean (median) commissions paid to a single broker in a fund-year is $167,255 ($30,000) with a maximum of $19.91 million paid by the Fidelity Commodity Strategy Central Fund to Morgan Stanley in 2014.

Across time, the aggregate commission spend for the sample mutual funds decreases from $930.5 million in 2010 to $576.2 million in 2020. While this pattern is consistent with the broader industry trends described in Greenwich (2019), it appears to reflect a decrease in sample funds over time rather than a decrease in commissions per fund. Across sample funds, the mean value of annual commissions increases from $1.86 million in 2010 to $1.98 million in 2020.

[23] The average (median) mutual fund appears in the sample 6.75 (7) years, with 243 funds (37.3%) listed in at least 10 sample years and 87 (13.3%) listed in just one sample year. The 243 funds with at least 10 years of commission data account for 79.7% of the total commissions paid by our sample mutual funds during the period. Roughly half of the sample mutual funds have reporting years ending in either October (19.3%) or December (29.3%). The reporting of the remaining funds is spread across the year, though relatively few funds report in January through March.

[24] The mean (median) number of observations per broker across all fund-years is 59.8 (4) with a maximum of 2,617 (JP Morgan/JP Morgan Chase). The average (median) broker appears in the sample 4.14 (3) years, with 71 brokers (13.0%) listed in at least 10 sample years and 175 (32.1%) listed in just one sample year. The 71 brokers with at least 10 years of commission data account for 61.4% of the total commissions paid by our sample mutual funds during the period and 94.7% of commissions paid to the sample of listed brokers.

2.3 Pension fund sample

Our pension fund sample includes all state and local pensions for which we could identify detailed broker commission data. For the period from 2010 through 2020, we use Comprehensive Annual Financial Reports (CAFRs) to hand collect data related to the commissions these pension funds paid to their brokers. In addition to a broad range of financial and other information, the typical CAFR reports commissions paid to at least a subset of brokers and total commissions across all brokers. While some pension funds categorize commissions by security type (i.e., equity vs. fixed income) or geography (i.e., domestic vs. international), the typical fund aggregates domestic and international commissions into one "global" category.

We begin our data collection by searching for CAFRs for each of the 210 public pension funds listed on the website *publicplansdata.org*. We then perform additional searches for all states for which we do not have the primary state employees' or teachers' retirement plans and for the 100 largest U.S. cities. This search resulted in at least one published CAFR containing detailed commission information for 77 public pension funds.[25] For these sample pension funds, we collect information on equity commission spend for all listed brokers. For those pensions providing multiple categories of equity commissions, we aggregate the data into a single "global" commission category to allow consistency across funds.

Summary statistics for the pension fund sample and related brokerage commissions are provided in Panel B of Tables 2 and 3, with a more detailed list of the sample pension funds provided in Internet Appendix Table IA.3. While some pension funds report commission data for all brokers utilized during the year, the majority report data for only the top brokers utilized. These latter funds often set a minimum dollar amount of commissions a given broker must be paid in order to be reported (common cutoffs are $5,000 or $10,000).

The sample includes at least one pension fund from 37 different states. Of the states represented, 25 have only one pension fund in the data. In contrast, nine of the sample funds are from Illinois and 11 are

[25] Two additional pensions were eliminated due to non-standard reporting of commission data. These two pensions, the Employees and Uniformed Employees Retirement Systems for Fairfax County, Virginia, report only a subset of brokers ranked by commissions per share (rather than total commissions). Because we cannot verify that the data for these funds include the brokers receiving the highest dollar commissions, we eliminate them from consideration.

from California. The sample funds include 51 state-level funds, with the remaining funds being at the city or county level. Of the 51 state-level funds, 34 are state employee funds, nine are state teachers or university employee funds, and the remaining eight are state-level funds related to public safety, municipal, or county employees. Of the funds in the final sample, 71 have data for all eleven years, while four are missing one year of data and two are missing two years of data.[26]

We clean broker names and adjust for broker mergers in the same manner used for the mutual fund data (see Appendix I). Before name consolidation, the pension data include 48,304 observations and 9,039 unique broker name variations. These broker names are consolidated into 1,093 'master' broker names (referred to henceforth as 'broker'). To the extent that the name consolidation process results in multiple occurrences of the same broker name in the same pension-year, we aggregate all commissions paid to the broker and recalculate broker ranks for that pension-year. This aggregation process results in a final sample of 34,348 observations, reflecting 1,093 brokers, 77 pension funds, and 839 pension-years.

The mean (median) number of reported brokers per pension-year is 40.9 (24) and the number of brokers in a pension-year ranges from one (Houston Police Officers Pension in 2018) to 329 (CIF Connecticut in 2010).[27] For the median fund, the minimum number of brokers reported across all sample years is 16. In total, the sample pension funds report $4.59 billion in commissions during the sample period with the top five funds accounting for 47% of the total (led by TRS-Texas paying $647 million during the sample period). The sample brokers account for $3.89 billion or approximately 85% of total reported commissions.[28] The mean (median) commissions paid to a single broker in a single pension-year is $113,109 ($16,940) with a maximum of $9.58 million paid by TRS-Texas to Barclays in 2010. The mean

[26] Most sample pension funds have fiscal years that end in June (54). December is the next most common fiscal year end (16), with the remainder of the sample funds having fiscal year ends in March (1), August (2), and September (4).
[27] The mean (median) number of observations per broker across all pension-years is 31.4 (4) with a maximum of 795 (Bank of America). The average (median) broker appears in the sample 4.47 (3) years, with 160 brokers (14.6%) listed in all 11 sample years and 347 (31.6%) listed in just one sample year. The 160 brokers with commission data in all years account for about 89.5% of the total commissions paid by our sample pension funds during the sample period.
[28] Four pension funds fail to report total commissions and instead report only the commissions paid to the brokers listed in the CAFR. In these cases, we use the sum of the commissions paid to the listed brokers as the total commission spend for the year. These pensions are not included in subsequent tests that apply a restriction on the proportion of total commissions received by reported brokers.

(median) annual total commissions paid by the sample funds is $5.47 ($2.06) million with a maximum of $66.7 million paid by TRS-Texas in 2010.

Across the sample period, aggregate commissions for the sample funds decrease from $584.2 million in 2010 to $306.1 million in 2020 and the mean commission spend per fund falls from $7.89 million in 2010 to $4.03 million in 2020. These patterns are consistent with Greenwich (2019), who notes that commissions fell by about 50% from 2009 to 2018.

2.4 Commonality in broker usage

To investigate the commonality in broker usage between pension funds and mutual funds, we examine the top 25 brokers used in each of the samples based on total commissions earned during the sample period. These brokers are listed in Table 4, along with the proportion of fund-years in which they are ranked #1, top 5, or top 10 by sample funds. As an example, Morgan Stanley is the top broker in terms of dollar commissions earned in the mutual fund sample. Morgan Stanley receives the top rank in 8.3% of mutual fund-years (fourth most among brokers in the mutual fund data) and is ranked in the top 10 in 50.5% of mutual fund-years (fourth most). In comparison, Morgan Stanley is the fifth-ranked broker in terms of dollar commissions earned in the pension fund sample, receives the top rank in 7.4% of pension fund-years (fourth most among brokers in the pension fund data), and is ranked in the top 10 in 70.2% of pension fund-years (fourth most).

Of the 25 brokers receiving the highest total commissions in the mutual fund sample, 20 are also in the top 25 for pension funds. The remaining five are ranked 26, 30, 32, 33, and 38 in the pension fund sample. The five brokers ranked in the top 25 for pension funds but not mutual funds receive ranks of 26, 33, 43, 79, and 289 in the mutual fund sample. While there is significant overlap in broker usage between mutual funds and pension funds, these rankings illustrate some notable differences. Perhaps the most striking differences are those related to the usage of minority-owned brokers (e.g., CAPIS and Loop Capital Markets), which tend to be ranked much higher among pension funds than mutual funds. For example, Loop is ranked 24th among brokers in the pension fund data based on total commissions received and is among the top five brokers based on proportion of fund-years ranked number one. In contrast, Loop is

ranked outside the top 100 (289 and 156, respectively) in each of these categories in the mutual fund data.

[Insert Table 4 about here.]

In addition to utilizing similar brokers, pension funds and mutual funds tend to use these brokers in roughly similar rank orders. For example, of the top five brokers showing up in the number one rank for mutual funds, three are also in the top five of brokers ranked number one by pension funds. Similar results are evident for the brokers most frequently appearing in the top five and the top 10 of pension and mutual fund rankings.

Although rankings of top brokers appear to be similar between pension funds and mutual funds, concentration of broker usage appears higher among pension funds. For example, while 191 different brokers are reported as the top-ranked broker by at least one mutual fund, only 54 different brokers earn the top spot among pension funds. JP Morgan is the most frequent top-ranked broker in the mutual fund data, while Bank of America is the most frequent top-ranked broker in the pension fund data. Similarly, 545 different brokers show up in the top 10 among our sample mutual funds, while only 193 brokers appear in the top ten for pension funds. While some of the observed differences may be driven by the truncation of broker lists in the data and the smaller sample of pension funds relative to mutual funds, these factors seem unlikely to completely explain the differences.

2.5 Broker Ranking Changes

For each fund and each reporting period, brokers are ranked beginning with the broker receiving the most dollar commissions during the period. However, the list of utilized brokers is truncated throughout the mutual fund data and for many fund-years in the pension data. This truncation makes it infeasible to use continuous measures of broker choice (e.g., share of total commissions paid) or even ordinal measures of change in broker rank, because we cannot determine either the rank or commissions received by a broker that drops off the reported list. As a result, we focus our primary analysis on directional rank changes, with a broker that is ranked higher (lower) in a particular fund's league table this period compared to last categorized as rising (falling) in rank. Likewise, if a broker appears (does not appear) in a fund's league table in a given reporting period, but does not appear (does appear) in the prior reporting period, the broker

is categorized as rising (falling) in rank.[29]

In Table 5, we document the overall (i.e., "unconditional") rank transition frequencies for brokers used by mutual funds and pension funds. The mutual fund (pension fund) sample includes 34,908 (35,568) fund-broker-year observations for which change in broker rank can be defined.[30] Panel A summarizes broker rank changes from year-to-year. The unconditional probability of a downgrade is 44% in the mutual fund sample and 47% in the pension fund sample. For both types of funds, the probability of downgrade is generally higher than the probability of upgrade. The top ranking is quite sticky, with a nearly 50% chance that the number one broker in a given year remains the number one broker in the following year. However, the probability of staying at the same rank drops as the initial rank in year *t*-1 decreases. At the same time, the likelihood of improving rank increases as the initial rank goes from 2 to 9. Panel B provides more detail for brokers ranked in the Top 5. In both the mutual fund and pension fund samples, the chance of the top-ranked broker in one year falling out of the top 10 the following year is only 11%. This likelihood increase to 27% (23%) for the fifth ranked broker in the mutual fund (pension fund) sample. Overall, the unconditional transition matrices for mutual funds and pension funds look quite similar.

3. Institutional investor response to broker reputation shocks

If broker reputation is an important consideration in the order routing decisions of pension funds and mutual funds, we expect these institutions to reduce the commissions routed to affected brokers after public announcements of scandals. As noted previously, we expect this response to differ based on the magnitude of the resulting fines, as well as the characteristics of the broker, the institutional investor, and the relationship between the two. We examine these hypotheses below.

Although dark pool trading is one channel through which institutional investors may respond to the

[29] A broker is considered eligible for league table ranking in a given year if it appeared in at least one fund's league table during that year. Thus, for brokers that either fall out of or newly appear in the league table of a particular fund, rank changes are calculated only if the broker appeared in at least one other fund's rankings during that year. Brokers are not considered in the analysis for a fund-year if they fail to appear in at least one fund's commission league table in that year or if they fail to appear in the fund's league table for both that year and the prior year.

[30] For mutual funds, this includes 32,525 observations with commission data plus 2,383 observations where the broker appears in the prior year ranking, but not the current year. For pension funds, this includes 34,348 observations with commission data plus 1,220 observations where the broker appears in the prior year ranking, but not the current year.

scandal announcements, we expect the reputational effects of these violations of trust to impact the broader trading relationship between the broker and its clients. Effects may also be difficult to detect within the dark pool for a number of reasons. First, available dark pool data is limited and aggregated, such that we cannot test whether specific institutions reduce their use of a dark pool. Second, any effects within the dark pool may be muted because brokers have some control over the orders routed to their own dark pool and some institutions may choose not to use dark pools at all. Finally, dark pool volume will also be affected if HFT participation is reduced following the scandals. For these reasons, we focus our analysis on the overall commissions routed to brokers around dark pool scandals.[31]

3.1. Univariate analysis for broker rank changes

We begin by performing an event study of broker rank changes in the mutual fund and pension fund data around dark pool scandal events. For each year relative to the event, we calculate the proportion of mutual funds and pension funds ranking the affected broker in the top 10 of their commission league table, as well as the proportion of funds for which the affected broker's rank is downgraded, upgraded, or unchanged. Table 6 reports the mean proportions across all events, and for the subsamples of high-fine full-service events (Panel B), low-fine full-service events (Panel C), and execution-only events (Panel D).

For each broker event, the event year (year 0) is defined as the year during which the broker scandal was announced. However, because reporting dates differ across funds, the commission data for each fund is assigned to event years based on a comparison of the event date to the fund's reporting date. Specifically, the commission data assigned to year 0 are from the first report year with a report date at least two months after the announcement date of the broker event.[32]

[Insert Table 6 about here.]

[31] An illustrative analysis of monthly dark pool volume around the scandal events is provided in Internet Appendix Figure IA.1.

[32] As an example, the 2014 (2015) data for a fund reporting on June 30th would be assigned to year -1 (0) for the Citigroup event on July 25, 2014. To increase the likelihood that any reaction by institutional investors is observable during year zero, we require the report year assigned to year zero to include at least two months of data subsequent to the broker event date. If the report date is less than two months after the event date, the subsequent report year is assigned to year zero. The results are not sensitive to this requirement. In particular, the primary conclusions are similar if no lag is used or if the event year is based on a simple calendar year definition with no comparison of event dates to report dates.

In Panel A, we report event study results across all broker scandal events. For pension funds, there is a noticeable increase in the percentage of funds that downgrade the affected broker starting in year zero. The proportion of funds that downgrade a particular broker increases from a mean of 46.5% in the year prior to the scandal to 55.4% in the year of the scandal. This is accompanied by a noticeable decrease in the percentage of funds reporting the broker in the top ten and in the percentage of funds that upgrade the broker or leave the broker's rank unchanged. From the year prior to the scandal to the scandal year, the proportion of funds reporting the broker in the top ten drops from 47.2% to 43.4% and the proportion of funds upgrading the broker drops from 42.1% to 35.5%. The changes in broker routing appear to continue through at least year +2. These results are consistent with our hypothesis that pension funds respond to reputation shock events by routing commissions away from the affected brokers. The results for mutual funds also point to an increased likelihood of downgrades and decreased likelihood of upgrades following broker reputation shocks. However, the results are less pronounced than in the pension fund sample and appear more concentrated in year zero. This suggests that pension funds may react more strongly than mutual funds to broker scandals.

In Panels B, C, and D, we provide separate results for the subcategories of broker scandals. For the high-fine full-service broker events reported in Panel B (Barclays, Credit Suisse, and Deutsche Bank), the results are consistent with those in Panel A. For these events, the proportion of pension funds downgrading the broker increases from a mean of 48.0% in year -1 to 57.2% in the event year. At the same time, the proportion of pension funds ranking the broker in the top ten drops from a mean of 64.9% before the scandal to 53.5% after. As was the case in the full sample results, mutual funds appear to exhibit a similar, but less pronounced reaction to broker scandal events.

Panel C reports the results for the subsample of low-fine full-service broker events (Goldman Sachs, Citigroup, and UBS). These results provide little evidence of a strong reaction to the broker scandals by either pension funds or mutual funds. Combined with Panel B, these results are consistent with our hypothesis that institutional investors react most strongly to the broker scandals involving the largest reputation shocks, as proxied by magnitude of fines.

In Panel D, we report results for the scandals involving execution-only brokers (Pipeline, Liquidnet, KCG, and ITG). Like Panels A and B, the results point to a significant reaction to broker scandals by institutional investors. For pension funds, the proportion of funds downgrading the broker increases from a mean of 44.2% in the year prior to the scandal to 62.7% in the year of the scandal, while the proportion of funds upgrading the broker drops from a mean of 47.5% to 32.8%. For mutual funds, the proportion of funds downgrading the broker increases from a mean of 38.2% in year -1 to 51.6% in the event year, while the proportion of funds upgrading the broker drops from a mean of 47.4% to 35.0%. Again, the reactions appear both more pronounced and more long-lasting among pension funds than mutual funds. These results suggest that institutional investors react more strongly to broker scandals involving execution-only brokers than to those involving low-fine full-service brokers.

Overall, the results in Table 6 are consistent with our hypotheses. Both pension funds and mutual funds appear to respond to reputation shocks by routing commissions away from the affected brokers. Further, both types of institutional investors appear to react more strongly when the affected broker offers only execution services and when the broker malfeasance is more severe, as proxied by resulting fines. Interestingly, the reaction of pension funds appears to be stronger than that of mutual funds. This suggests that either pension funds are more sensitive to reputation shock events or mutual funds are less reliant on broker reputation when making routing decisions, perhaps because some mutual funds have the resources and expertise to identify and react to broker malfeasance before it becomes public.

3.2. Regression analysis of broker downgrades

To provide a more formal analysis of the impact of broker scandals on order routing by mutual funds and pension funds, we estimate a linear probability model for the likelihood of a broker ranking downgrade.[33] The model is estimated separately for mutual funds and pension funds, with the baseline specification described as follows:

[33] The main results are robust to alternative specifications, including the use of logistic regressions rather than linear probability models. Detailed definitions of all variables are provided in Appendix II.

$$Downgrade_{ijt} = \beta_1\left(Post_{itj}\right) + \beta_2\left(Post_{ijt} \times High\ Fine_i\right) + \beta_3\left(Post_{ijt} \times Execution\ Only_i\right) + \beta_4\left(High\ Fine_i\right) + \beta_5\left(Execution\ Only_i\right) + Z + \varepsilon_{ijt}\ , \quad (1)$$

where the dependent variable, $Downgrade_{ijt}$, is a binary variable that takes a value of one if broker *i* is downgraded by fund *j* at year *t* and zero otherwise; $Post_{ijt}$ is a binary variable that takes a value of one for all post-event fund-years when broker *i* is involved in a scandal event and zero otherwise (and zero for all fund-years involving brokers not impacted by scandal); $High\text{-}Fine_i$ is a binary variable that takes a value of one for full-service brokers involved in high-fine scandals and zero otherwise; and $Execution\text{-}Only_i$ is a binary variable that takes a value of one for all execution-only brokers involved in scandals and zero otherwise. We also include a set of fixed effects (*Z*). We include *Broker-by-Fund* fixed effects to control for unobserved, time-invariant heterogeneity at the level of the broker-fund pair and *Fund-by-Year* fixed effects to account for unobserved, time-varying heterogeneity across funds. Because the likelihood of downgrade is affected by prior-period rank, we include *Broker Rank* fixed effects. Finally, robust standard errors are clustered at the broker and fund levels.[34] The analysis includes the 32,956 mutual fund observations and 34,518 pension fund observations for which broker rank changes can be defined and for which fixed effects can be estimated.[35]

The regression results are presented in Table 7, with mutual funds in panel A and pension funds in panel B. Our initial hypothesis related to the effects of broker scandals on order routing is reflected in columns (1) and (2), including only the *Post* dummy variable. The coefficient on *Post* is insignificant when only *Broker Rank* and *Fund×Year* fixed effects are included, but positive and marginally significant for both types of institutional investors when *Broker×Fund* fixed effects are included. This latter result is consistent with the hypothesis that institutional investors respond to broker scandals by routing

[34] Our treatment is assigned at the level of the fund-broker pair and our data has a panel structure. Moreover, residuals may present time-series dependence. Therefore, following Abadie et al. (2023) and Pedersen (2009), we cluster standard errors at fund and broker level.

[35] The mutual fund sample includes 32,525 observations with commissions data in year *t* plus 2,383 observations with commissions in year *t*-1 but not year *t*. The pension fund sample includes 34,348 observations with commissions data in year *t* plus 1,220 observations with commissions in year *t*-1 but not year *t*. We eliminate 1,952 observations in the mutual fund sample and 1,050 observations in the pension fund sample due to single observations involving the various fixed effects.

commissions away from the affected brokers.

[Insert Table 7 about here.]

In columns (3) through (6), we add interactions between *Post* and both *High-Fine* and *Execution-Only* dummy variables. As expected, we find that high-fine broker scandals lead to a significant increase in the likelihood of downgrade. In the mutual fund sample (Panel A), the coefficients on the *Post*×*High-Fine* interaction point to an increase in downgrade likelihood of between 8.3% and 10.5%. This change is economically large relative to the unconditional likelihood of downgrade for mutual funds of 43.7%. The results for pension funds (Panel B) point to an even stronger reaction to high-fine scandals. Here, the coefficients on the *Post*×*High-Fine* interaction point to an increase in downgrade likelihood of between 14.6% and 22.3%. Again, this change is economically large relative to the unconditional likelihood of downgrade for pension funds of 46.6%.

The last two columns of Table 7 provide results related to scandals involving execution-only brokers. In the mutual fund sample (Panel A), the coefficient on the *Post*×*Execution-Only* interaction is statistically insignificant in column (5). However, the coefficient is large and marginally significant in column (6), where we include the full set of fixed effects. This coefficient reflects an increase in downgrade likelihood of 12.1%, which is economically large relative to the unconditional likelihood of downgrade. As is the case for the *High-Fine* interaction, the results for *Execution-Only* brokers are stronger in the pension fund sample (Panel B). Here, the coefficients on the *Post*×*Execution-Only* interaction point to an increase in downgrade likelihood of between 17.2% and 19.9%, which is economically large relative to the unconditional likelihood of downgrade.

The reaction of institutional investors to low-fine events involving full-service brokers is reflected in the coefficient on the *Post* dummy variable. In contrast to the interaction terms discussed above, the results for the *Post* coefficient are mixed. This suggests that institutional investors do not react to low-fine scandals involving full-service brokers in the same manner they react to high-fine events or events involving execution-only brokers.

Taken together, the results in Table 7 suggest that both mutual funds and pension funds react to

public announcements of broker scandals by reallocating commission dollars away from the offending brokers.[36] For both types of institutional investors, the reaction to broker reputation shocks appears to be concentrated within events that are considered more egregious, as proxied by fines, and for brokers who provide only execution services. Thus, our subsequent tests will focus primarily on the reaction of institutional investors to these categories of broker scandals.

3.3. Heterogeneous reactions to broker reputation shocks

The results described above suggest that the reaction of institutional investors to broker reputation shocks is affected by the types of services offered by the broker (i.e., full-service vs. execution-only). As noted previously, we also expect the reactions of institutional investors to be affected by the characteristics of the institution and the relationship between the institution and the broker. In particular, we expect that some institutional investors may have the resources necessary to identify and react to broker malfeasance before it becomes public, leading to reduced reaction at the announcement date. The impact of fund-broker relationships could go in either direction. If stronger prior relationships between institutions and brokers reflect a buildup of trust, these relationships could lead to a more pronounced reaction to reputation shocks. Alternatively, if stronger pre-existing relationships allow for more performance-based analysis and less reliance on trust, we would expect these relationships to be associated with weaker reactions to broker scandals. To examine these heterogeneous effects, we exploit the richness of the data to define proxies for investor monitoring ability and fund-broker relationships. We then test whether the reaction to broker scandals differs based on these characteristics.

While there is no single identifier that captures an institutional investor's monitoring ability, we assume that the funds that execute the most shares have the most to gain by carefully monitoring and/or managing trading costs.[37] As a result, these funds are also more likely to develop the internal resources and

[36] To examine whether any single event has an outsized influence on the results, we repeat the regression from column (6) of Table 7 excluding one scandal broker at a time. The results, provided in Internet Appendix Table IA.2, show that our main results are robust to the exclusion of each individual scandal broker. Thus our conclusions do not appear to be driven by any particular scandal event.

[37] This is similar in spirit to the model of Gârleanu and Pedersen (2018), in which large, sophisticated investors have search costs that are low relative to their assets and, therefore, benefit from searching for informed active managers.

capabilities necessary to perform this monitoring. Because trading volume is unavailable for many pension funds, we instead proxy for total trading activity using commission spending. In particular, we define *Monitoring* (*Non-Monitoring*) mutual funds as those with total commission spending above (below) the median mutual fund for a given year. *Monitoring* (*Non-Monitoring*) pension funds are defined similarly. We expect the impact of *Post*×*High-Fine* and *Post*×*Execution-Only* to be muted for *Monitoring* funds relative to *Non-Monitoring* funds.

We construct two proxies for the strength of pre-existing fund-broker relationships. One important indicator of relationship strength is whether a broker is among the top brokers utilized by an institutional investor. To capture this aspect of relationships, we define a broker as *Top 5* (*Non-Top 5*) for a particular fund in year *t* if it is among the top 5 brokers reported by the fund based on total commissions in year *t*-1. To define relationship length, we require information on relationships from prior to our sample period. We therefore limit our focus to the mutual fund sample and collect all NSAR filings for our sample mutual funds beginning in 1995. For each fund-broker pair, *Relationship Length* in year *t* is then defined as the number of years from 1995 through year *t*-1 that the broker was one of the top ten brokers reported by the mutual fund, as listed in the annual NSAR filing. *Long* (*Short*) *Relationships* are then defined as those above (below) the median in a given year.

To analyze these heterogeneous effects, we repeat our regression analysis of downgrade probability, adding interactions between the variables described above and the previously defined *Post*×*High-Fine* and *Post*×*Execution-Only* interaction effects. We then test for differences in the reaction to high-fine broker scandals and scandals involving execution-only brokers across these various characteristics. The results are provided in Table 8, with mutual fund results in columns (1) through (3) and pension fund results in columns (4) and (5). As in the full specification presented in Table 7, the regressions include *Broker Rank*, *Fund*×*Year*, and *Broker*×*Fund* fixed effects and standard errors are clustered at the broker and fund levels.

[Insert Table 8 about here.]

In the mutual fund sample, the results are generally consistent with a stronger reaction to broker

reputation shocks by non-monitoring funds and when pre-existing fund-broker relationships are stronger. Column 1 includes the interactions related to monitoring and non-monitoring mutual funds. The coefficients for the high-fine interactions imply an increase in downgrade probability of 13.4% for non-monitoring funds, compared to 8.4% for monitoring funds. This difference is both statistically significant and economically large relative to the unconditional average downgrade probability of 43.7%. The results for execution-only events lead to similar conclusions in terms of economic magnitudes, with downgrade probability increasing by 16.4% for non-monitoring funds, compared to 9.7% for monitoring funds. However, this difference is not statistically significant. Overall, we interpret these results as consistent with a muted reaction by monitoring mutual funds, suggesting that some funds may be able to detect and react to broker misconduct before it becomes public.[38]

Columns 2 and 3 of Table 8 provide results related to the strength of fund-broker relationships in the mutual fund sample. For both measures of relationship strength, the coefficients from the high-fine interactions point to a more pronounced reaction to high-fine broker scandals when fund-broker relationships are stronger. In particular, the coefficients for high-fine events imply an increase in downgrade probability of 13.3% for top 5 brokers compared to 7.0% for non-top 5 brokers. The comparable magnitudes for long vs. short relationships are 10.9% and 4.7%. For both relationship proxies, the differences in reactions to high-fine events are both statistically significant and economically large relative to the unconditional average probability of downgrade. The impact of relationship strength following execution-only events in the mutual fund sample is less clear. While the coefficient estimates suggest a more pronounced reaction to execution-only events for both top 5 brokers and longer pre-existing relationships, these differences are not statistically significant.

The results related to heterogenous reactions in the pension fund sample are mixed. While the

[38] The richness of the mutual fund NSAR data allow us to define additional proxies for fund monitoring ability. In particular, the NSAR data allow us to define monitoring ability based on total trading volume, defined as the sum of annual purchases (NSAR question 71A) and sales (NSAR question 71B) and based on total assets under management (NSAR question 75B). Both alternative proxies suggest that the reaction of non-monitoring mutual funds is economically larger than that of monitoring mutual funds, with the difference being statistically significant following execution-only broker scandals.

effects for Top 5 Brokers are consistent with those in the mutual fund sample, the interactions involving our measure of investor monitoring ability lead to inconsistent results. This suggests that either the commission-based proxy fails to capture pension fund monitoring ability or monitoring ability is less important in the pension fund sample than in the mutual fund sample. Given that flows into pension funds are less tied to performance, one possible explanation for this result is that pension funds have less incentive than mutual funds to conduct the costly analysis necessary to identify problem brokers.

Overall, the results in Table 8 suggest that the reaction of institutional investors to broker scandals is affected by the characteristics of the fund, as well as the relationship between the fund and the broker.[39] In particular, the results point to a less pronounced reaction to high-fine scandals for monitoring mutual funds and a more pronounced reaction for both pension funds and mutual funds in the presence of stronger pre-existing relationships. Importantly, regardless of the heterogeneity effect being considered, the overall results throughout Table 8 remain consistent with our main findings and point to significant increases in broker downgrades following high-fine scandals and scandals involving execution-only brokers.

3.4. Alternative explanations

A potential concern is that the observed increase in broker downgrades following dark pool scandals may reflect something other than a shock to broker reputation. In particular, if brokers alter their services or pricing following scandals, these changes could drive increased broker downgrades even in the absence of reputational effects. Reputation-based downgrades by some institutional investors may also affect the decisions of other institutions if the broker's value is tied to its client network. To ensure that our results are robust to these alternative explanations, we repeat our analysis after controlling for several measures of broker services and pricing.

[39] The reaction to dark pool scandals may also be less pronounced if the relationship between the institution and the broker involves a soft-dollar arrangement. While our data do not allow us to directly identify these types of soft-dollar arrangements between specific fund-broker pairs, we are able to identify institutions that utilize the types of services associated with soft-dollar arrangements in the course of their business. In particular, each mutual fund indicates through NSAR question 26 whether it utilizes any of its brokers to (1) sell fund shares, (2) obtain investment research and/or statistical information, (3) compute portfolio valuations, (4) obtain telephone line and wire services, or (5) arrange to return or credit commissions in a given year. We find little evidence that institutions utilizing brokers for these additional services have a less pronounced reaction to broker scandals. This lack of evidence may reflect our inability to identify soft-dollar arrangements at the fund-broker level.

For many of the sample pension funds, the CAFR includes data on both commissions paid to brokers and the number of shares routed to those brokers. To estimate broker pricing, we first calculate the average commissions per share for each broker reported by these pension funds in each available sample year. To reduce the effects of potential data errors, we then eliminate observations outside the 5th and 95th percentiles. Finally, for each broker in each year, we define *Broker Pricing* as the median value of commissions per share across the broker's pension fund clients in year *t*-1. Although *Broker Pricing* is calculated based on pension fund data, we match the resulting measures to brokers in the mutual fund data under the assumption that a broker's pricing will be generally consistent across pension funds and mutual funds. Holding all else constant, we expect an increase in broker pricing to be associated with an increase in the likelihood of broker downgrade.

To measure broker service offerings, we utilize data from mutual fund NSAR filings. For each year, a broker is assumed to provide services as an investment adviser, administrator, underwriter, servicing agent, custodian, or dealer, if any mutual fund identifies the broker as providing that service, as reported in NSAR questions 8, 10, 11, 12, 15, and 22, respectively. We then define the number of service offerings as a count from 1 to 6 based on these identified services. Finally, for each broker in each year, we define *Change in Broker Services* as the change in the number of services offered by a broker to its mutual fund clients in year *t* relative to year *t*-1. Although broker services are defined based on mutual fund data, we match the resulting measures to brokers in the pension fund data under the assumption that a broker's services will be generally consistent across pension funds and mutual funds. Holding all else constant, we expect a decrease in services to be associated with an increase in the likelihood of broker downgrade.

As a final measure of broker services, we estimate the centrality of each broker within the network of fund-broker relations. Di Maggio, Franzoni, Kermani, Sommavilla (2019) find evidence that central brokers (e.g., those that are focal in the network of trading relations of institutional investors) gain valuable information through the execution of large informed trades and share this information with their best clients. To the extent that more central brokers provide value to their institutional investor clients, we expect a reduction in broker centrality to be associated with an increase in the likelihood of broker downgrades. We

calculate the eigenvector centrality of each broker following Di Maggio et al. (2019) and Han, Kim and Nanda (2020). We begin by mapping the trading network between brokers and their institutional clients using annual brokerage commission data, with networks analyzed separately in the mutual fund and pension fund datasets. As described in Han et al. (2024), these networks can be represented by means of weighted bi-partite graphs, and a bi-partite graph is represented in our setting by an adjacency matrix in which rows index funds and columns index brokers. Each element of the adjacency matrix, a_{ij}, represents the strength of the connection between fund *i* and broker *j*, which we define as commissions paid by fund *i* to broker *j* divided by the norm of the vector of commissions paid by all funds to broker *j*. *Broker Centrality* is then defined for each year *t* as the principal eigenvector of the adjacency matrix defining the broker-fund network in year *t*-1. This measure of centrality will decrease for a given broker if some set of institutions choose to reduce or terminate the commissions routed to that broker.

Panels A and C of Table 9 provide summary statistics for *Broker Pricing*, *Broker Centrality*, and *Change in Broker Services* in the mutual fund and pension fund samples, respectively. The analysis includes all observations from Table 7 for which these broker characteristics can be calculated.[40] *Broker Pricing* has a mean (median) value of 1.64 (1.34) ¢/shr in the mutual fund sample and 2.12 (1.98) ¢/shr in the pension fund sample. The mean (median) value of *Broker Centrality* is 5.19% (3.80%) in the mutual fund sample and 4.55% (5.00%) in the pension fund sample. Finally, *Change in Broker Services* has a mean (median) of 0.02 (0.00), with a range from -3 to +2 in both samples.[41]

[Insert Table 9 about here.]

To examine whether the observed increase in broker downgrades following dark pool scandals is driven by changes in broker services or pricing, we repeat our regression analysis including *Broker Pricing*, *Broker Centrality*, and C*hange in Broker Services*, as well as interactions between these variables and the

[40] *Broker Pricing* is missing for 4,462 observations in the mutual fund data and 5,178 observations in the pension fund data. In addition, we eliminate 2,303 observations in the mutual fund regressions and 1,473 observations in the pension fund regressions due to single observations involving the various fixed effects.

[41] We find little evidence that the affected brokers systematically alter their pricing or services following the public announcement of scandals. For both high-fine full-service brokers and execution-only brokers, univariate tests fail to reject equality of pre-event and post-event means for each of the pricing and service variables.

previously defined *Post* dummy variable. As in prior specifications, the regressions include *Broker Rank*, *Fund×Year*, and *Broker×Fund* fixed effects, and standard errors are clustered at the broker and fund levels. The results for mutual funds and pension funds are provided in Panels B and D of Table 9, respectively.

Both *Broker Pricing* and the interaction of *Post* with *Broker Pricing* are positive and significant in the mutual fund sample (columns 1 and 4 of panel B). These results suggest that higher commission rates are associated with an increased likelihood of broker downgrade. Both *Broker Centrality* and the related interaction term have negative coefficients in the mutual fund sample (columns 2 and 4 of panel B). While these results are consistent with the expected negative relation between broker centrality and likelihood of downgrade, the coefficients are not statistically significant. Surprisingly, the coefficient on *Change in Broker Services* is positive and significant. However, when interacted with *Post* (column 4), the resulting coefficient is negative and marginally significant, suggesting that reduced services after scandals lead to an increased likelihood of downgrade.

While the results in Table 9 suggest that broker pricing and services may have an impact on the likelihood of broker downgrades, our main findings are robust to these effects. Across all mutual fund specifications, the coefficients on the *Post×High-Fine* and *Post×Execution-Only* interaction terms remain positive and statistically significant. The coefficients suggest an increase in downgrade likelihood of between 6.4% and 9.0% following high-fine broker scandals and between 8.8% and 12.6% following execution-only scandals. These changes are economically large relative to the unconditional likelihood of downgrade in this subsample (43.9%) and are of similar magnitude to the results presented in Table 7.

Like the mutual fund results, the results for the pension funds confirm that our main findings are robust to controls for broker pricing and services. While *Broker Pricing* and *Change in Broker Services* are insignificant throughout Panel D, the negative and significant coefficients on the *Broker Centrality* interaction term suggest that lower broker centrality leads to an increased likelihood of downgrade. Across all pension fund specifications, the coefficients on the *Post×High-Fine* and *Post×Execution-Only* interaction terms remain positive and statistically significant after controlling for broker pricing and services. The coefficients suggest an increase in downgrade likelihood of between 19.4% and 21.3%

following high-fine broker scandals and between 16.5% and 18.4% following execution-only scandals. As was the case for mutual funds, the results are of similar magnitude to those presented in Table 7 and are economically large relative to the unconditional likelihood of downgrade in this subsample (46.1%).

Together, the results in Table 9 provide support for the interpretation that dark pool scandals lead to significant reputation shocks, even after controlling for several alternative explanations. In particular, while broker pricing and services appear to have some effect on broker downgrades, these factors do not alter our main findings. Both mutual funds and pension funds appear to respond to reputation shocks by downgrading the affected brokers in their commission league tables and these findings do not appear to be driven by changes in broker services or pricing.

3.5. Intensive vs. Extensive Margins

The results above suggest that institutional investors route commissions away from brokers that violate their trust. However, these results do not address whether institutions end their relationships with these brokers completely or simply reduce the commissions they route to these brokers. To analyze the impact of broker scandals at the intensive vs. extensive margins, we repeat our analysis with modified definitions of *Downgrade*. To address the extensive margin, we estimate regressions following the previous specification, but defining a broker as downgraded only if it is completely eliminated from a fund's commission league table. To address the intensive margin, we estimate regressions using our original definition of *Downgrade*, but excluding those observations for which the broker is completely eliminated from the fund's league table. To ensure our definition of broker termination is not driven by truncation of reported broker lists, we limit these tests to the subsample of pension fund and mutual fund observations for which reported brokers account for at least 90% of total commissions in both year *t* and year *t*-1. Results for mutual funds (pension funds) are provided in columns 1 through 4 (5 through 8) of Table 10, with separate results for downgrades with termination and downgrades without termination.

[Insert Table 10 about here.]

The results point to significant reactions to broker scandals at both the intensive and extensive margins. For mutual funds, both the *Post*×*High-Fine* and *Post*×*Execution-Only* interaction terms are

economically and statistically significant when *Downgrade* is defined as termination. The coefficients point to an increase in termination likelihood of between 11.9% and 14.0% following high-fine broker scandals and between 11.4% and 13.0% following scandals involving execution-only brokers. While the *Post×High-Fine* interaction remains significant for mutual funds when *Downgrade* is defined to exclude terminations, the *Post×Execution-Only* interaction is insignificant in this specification. Excluding terminations, the coefficients point to an increase in downgrade likelihood of between 5.8% and 16.4% following high-fine broker scandals.

Interestingly, the results for pension funds appear to be driven by downgrades rather than broker termination. When *Downgrade* is defined as termination in the pension fund sample, the *Post×High-Fine* interaction is statistically insignificant and the *Post×Execution-Only* interaction is at best marginally significant. Focusing on economic magnitudes, the interaction term coefficients point to an increase in termination likelihood of between 1.4% and 2.8% following high-fine broker scandals and between 2.8% and 5.5% following scandals involving execution-only brokers. In contrast, when terminations are excluded, the coefficients on both the *Post×High-Fine* and *Post×Execution-Only* interactions are economically large and statistically significant. The coefficients point to an increase in downgrade likelihood of between 19.7% and 24.7% following high-fine broker scandals and between 16.4% and 18.7% following scandals involving execution-only brokers. Taken together, we interpret these results as evidence that institutional investors respond to broker reputation shocks at both the intensive and extensive margins. The difference in results across samples suggests that pension funds are less likely than mutual funds to completely terminate a broker.

4. Lost commissions

Our analyses suggest that broker scandals are associated with reduced broker use by at least some institutional investors. In this section, we estimate the impact on the affected brokers in terms of 'lost' commissions. When combined with fines and disgorgement, these losses can be used to better understand

the total losses to brokers resulting from a breach of trust.[42] To compute lost commissions, we must develop an estimate of expected commissions. We take as a benchmark the fraction of total pension fund or mutual fund commissions a given broker received during the year prior to the scandal. We assume the broker would have received this same fraction of commissions in subsequent years absent the scandal. Expected commissions for each post-event year are then estimated by multiplying the total commissions paid by pension funds or mutual funds in that year by the broker's commission percentage from the year prior to the scandal. Finally, lost commissions are estimated as the difference between actual commissions in a year and excepted commissions, as defined above.

Our estimates of lost commissions are summarized in Table 11, with results for pension funds and mutual funds reported separately. The table lists results for each individual broker scandal, as well as aggregate totals across all events and across subsamples of events by type. To understand the longer-term impacts of broker reputation shocks, we report lost commissions for both the two-year period starting in the event year and the four-year period starting in the event year.

[Insert Table 11 about here.]

The results in Table 11 are consistent with our earlier results. Over the two years following the events, the three high-fine full-service broker scandals are associated with lost mutual fund commissions of $13.9 million (6.4% of expected commissions) and lost pension fund commissions of $23 million (18.6% of expected commissions). These estimated losses more than double if the four years after the event are included, suggesting that the effects of broker reputation shocks are long lasting. Estimated commission losses are also significant following the six events involving execution-only brokers. Over two post-event years, these events are associated with lost mutual fund commissions of $2.7 million (9.4% of expected commissions) and lost pension fund commissions of $5.9 million (10.9% of expected commissions). Again, these estimated losses increase significantly if four post-event years are considered.

[42] Because some pension fund and most of the mutual fund data include only truncated lists of brokers, our estimates for commissions received by a particular broker in any particular year are likely to be underestimated. For this reason, the lost commission estimates provided here are only suggestive. We note that this problem may be attenuated by the fact that the brokers involved in the scandals we study are some of the most frequently used brokers in the sample.

As was the case in our multivariate analyses, the reactions of institutional investors to low-fine events involving full-service brokers appear muted. These scandals are associated with lost pension fund commissions of only $1.9 million (1.1% of expected commissions) over two post-event years and $1.3 million over four post-event years. Interestingly, these events are associated with larger commission losses in the mutual fund sample. For these events, lost mutual fund commissions over two post-event years total $24.2 million (6.6% of expected commissions).[43]

The analysis of lost commissions confirms both the reaction of institutional investors to broker reputation shocks and the more pronounced reaction of these investors to high-fine events and events involving execution-only brokers. Despite including only a subsample of mutual funds and pension funds, our estimates of lost commission are of the same order of magnitude as the fines imposed on the brokers by regulators. Thus, these commission losses reflect a substantial additional penalty imposed on the brokers through institutional investor routing decisions.[44]

5. Conclusion

Trust and reputation are important factors in the success of many types of financial transactions. This is particularly true in the dark pools operated by broker-dealers, as the inner workings of these trading facilities have not historically been visible to outside clients, requiring these clients to rely on the broker's claims with respect to how and against whom orders are executed. The public announcements of scandals related to the operation of these dark pools provide a useful experimental setting for analyzing the importance of trust-based reputation in financial markets.

[43] Of the four low-fine full-service events, only the Goldman Sachs event appears to be followed by higher than expected commissions. This likely reflects the nature of the Goldman Sachs violation, which involved Regulation NMS trade reporting rules, rather than more significant misrepresentations about dark pool operations. The investigation of Goldman Sachs was settled quickly and resulted in relatively low levels of fines and disgorgement.

[44] The truncation of reported broker lists requires us to focus our primary analysis on broker rank changes. However, we also performed robustness tests on continuous measures of broker market share using the subsample of pension funds that report nearly complete broker lists. Specifically, we focus on the subsample of 14 pension funds for which reported brokers account for at least 90% of total commissions in each year of the sample period. In broker-level regressions, we find that high-fine broker scandals are associated with a 2.2% reduction in market share. This reduction is both statistically significant and economically large relative to the average pre-scandal market share of high-fine brokers. These results are consistent with both our primary tests related to broker downgrades and the estimates of lost commissions described above.

Using a hand-collected sample of annual broker commission league tables, we examine whether pension funds and mutual funds redirect business away from brokers found to have made misrepresentations regarding the operations of their dark pools. Specifically, we expect these institutional investors to reduce the commissions routed to affected brokers. We further expect the reaction of pension funds and mutual funds to be stronger when the scandal is more egregious, as proxied by the fines imposed on the broker, and when the broker offers no other services beyond order execution. We also expect the reaction to broker scandals to be affected by the characteristics of the institutional investor, as well as the relationship between the institution and the broker.

Our results suggest that both pension funds and mutual funds reduce the commissions they route to brokers affected by negative reputational shocks. This reduction in commissions appears to last for several years following broker scandals. The results are most pronounced following high-fine broker scandals and scandals involving execution-only brokers. We find some evidence that the reaction of pension funds is stronger than that of mutual funds. The more pronounced reaction of pension funds suggests that either these funds are more sensitive to broker scandals or they are more reliant on broker reputation when making order routing decisions. The results also suggest that the reaction to broker scandals is muted for monitoring mutual funds (as proxied by total commission spend) and more pronounced for both pension funds and mutual funds when the fund and broker share a stronger pre-existing relationship. The former result suggests that some mutual funds may possess the capabilities necessary to detect and react to broker issues before they become public. The latter result is consistent with the hypothesis that stronger pre-existing relationships reflect a build up of trust that is damaged following a broker scandal.

Together, our results suggest that institutional investors rely on reputation when making order routing decisions and they reduce commissions to affected brokers following the revelation of a violation of trust. These findings highlight the importance of trust in determining financial market outcomes and facilitating efficient contracting, as suggested by Amiram et al. (2018).

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Table 1: Dark Pool Enforcement and Trading Error Events, 2010-2020

The table lists the sample of events involving dark pool operators as identified through the SEC's enforcement action website. We identify settlement dates and settlement-related penalties through the SEC's website. For each enforcement action, we identify the earliest public announcement of the misconduct using web searches. Internet Appendix Table IA.1 provides excerpts from articles used to identify the announcement date for each enforcement action. Broker Type distinguishes between brokers that offer only execution services and those that offer a full range of financial services, including access to securities offerings and capital. The last two columns describe the number of sample pension funds and mutual funds that list the identified broker in their annual commission rankings at least once during the sample period.

Broker	Announcement Date	Settlement Date	Settlement-Related Penalties	Broker Type	N Mutual Funds Using	N Pension Funds Using
Pipeline	20111024	20111024	$1m fine	Execution-only	13	18
Liquidnet	20120622	20140606	$2m fine	Execution-only	151	68
Knight Capital Group	20120801	20120801	$440m trading loss	Execution-only	114	54
Level (eBX)	20121003	20121003	$0.8m fine	Execution-only	0	0
Barclays	20140509	20160131	$70m fine	Full-service	362	75
Credit Suisse	20140509	20160131	$60m fine + $24.3m disg.	Full-service	376	76
Goldman Sachs	20140509	20140701	$0.8m fine	Full-service	413	77
Citigroup (Lavaflow)	20140725	20140725	$2.85m fine + $1.8m disg.	Full-service	384	77
UBS	20140729	20150615	$14.4m fine	Full-service	367	76
Deutsche Bank	20140729	20161216	$40.25m fine	Full-service	341	76
ITG	20150729	20150812	$20.3m fine	Execution-only	131	74
ITG	20180808	20181107	$12m fine	Execution-only	131	74
Citigroup (CORE)	20180914	20180914	$7.5m fine + $5.4m disg.	Full-service	384	77

Table 2: Summary Statistics for Pension Fund and Mutual Fund Samples

The table provides fund and broker-level summary statistics for the mutual fund sample (Panel A) and the pension fund sample (Panel B). Commission data are collected for mutual funds from annual NSAR and NCEN filings and for pension funds from Comprehensive Annual Financial Reports (CAFRs). The mutual fund sample includes 652 funds and 32,525 fund-broker-year observations. The pension fund sample includes 77 funds and 34,348 fund-broker-year observations. The full list of sample pension funds is provided in Internet Appendix Table IA.3.

Panel A – Mutual Fund Sample					
	N	Mean	Min	Median	Max
Fund Characteristics:					
Years in Data	652	6.75	1.00	7.00	11.00
Min Brokers Reported	652	5.70	1.00	6.00	10.00
Max Brokers Reported	652	7.35	1.00	10.00	10.00
Avg. Annual Commissions – Reported Brokers	652	0.92	<0.01	0.11	41.42
Avg. Annual Commissions – Total ($m)	652	1.39	<0.01	0.12	67.34
Full Sample Commissions – Reported Brokers	652	8.34	<0.01	0.60	455.57
Full Sample Commissions – Total ($m)	652	12.87	<0.01	0.72	740.71
Broker Characteristics:					
Years in Data	544	4.14	1.00	3.00	11.00
Fund-Year Observations	544	59.80	1.00	4.00	2,617.00
Avg. Annual Commissions – Total ($m)	544	0.96	<0.01	0.03	56.20
Full Sample Commissions – Total ($m)	544	10.00	<0.01	0.07	618.18
Panel B – Pension Fund Sample					
	N	Mean	Min	Median	Max
Fund Characteristics:					
Years in Data	77	10.90	9.00	11.00	11.00
Min Brokers Reported	77	25.87	1.00	16.00	204.00
Max Brokers Reported	77	59.35	5.00	33.00	329.00
Avg. Annual Commissions – Reported Brokers	77	4.61	0.04	1.58	49.60
Avg. Annual Commissions – Total ($m)	77	5.45	0.05	1.88	58.81
Full Sample Commissions – Reported Brokers	77	50.46	0.37	15.93	545.59
Full Sample Commissions – Total ($m)	77	59.65	0.51	20.68	646.89
Broker Characteristics:					
Years in Data	1,093	4.47	1.00	3.00	11.00
Fund-Year Observations	1,093	31.42	1.00	4.00	795.00
Avg. Annual Commissions – Total ($m)	1,093	0.35	<0.01	0.01	27.44
Full Sample Commissions – Total ($m)	1,093	3.55	<0.01	0.03	301.89

Table 3: Commissions Paid to the Top 25 Brokers Used by Sample Pension Funds and Mutual Funds

The table describes the annual and aggregate commissions received by the top 25 brokers utilized in the mutual fund sample (Panel A) and the pension fund sample (panel B), where brokers are ranked based on the total commissions received during the full sample period. Commission data are collected for mutual funds from annual NSAR and NCEN filings and for pension funds from Comprehensive Annual Financial Reports (CAFRs). The mutual fund sample includes 652 funds and 32,525 fund-broker-year observations. The pension fund sample includes 77 funds and 34,348 fund-broker-year observations. The full list of sample pension funds is provided in Internet Appendix Table IA.3.

Panel A – Mutual Fund Sample

Broker	Commission Dollars (millions)											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Morgan Stanley	57.21	64.47	51.08	58.57	80.60	59.00	63.83	49.61	44.75	38.92	50.15	618.18
Goldman Sachs	57.82	64.98	54.83	52.19	58.48	58.37	51.88	44.50	43.76	36.00	46.63	569.45
JP Morgan Chase	60.74	58.43	49.36	55.64	56.23	55.44	53.04	51.67	40.88	42.51	41.70	565.65
Bank of America	59.21	59.74	52.75	60.73	60.33	65.51	55.68	44.04	29.12	20.97	27.07	535.16
Citigroup	57.58	60.54	51.48	59.20	59.79	52.57	45.44	42.08	33.10	22.69	22.79	507.25
Credit Suisse	62.40	64.01	48.50	43.75	41.17	37.69	29.79	31.27	20.33	23.18	30.14	432.23
UBS	50.55	51.32	36.62	35.46	30.14	30.41	27.88	27.56	26.69	20.93	29.22	366.78
Deutsche Bank	30.08	36.05	22.26	32.76	27.51	36.76	23.56	22.70	19.43	2.04	0.01	253.16
Barclays	27.28	29.56	24.20	29.15	28.80	31.72	22.88	17.09	11.21	3.80	5.19	230.87
Jefferies	4.71	5.33	4.70	4.99	12.86	16.51	23.23	14.54	18.42	16.74	25.98	148.01
Alliance Bernstein	10.17	7.51	7.02	11.21	11.16	18.94	21.42	17.87	14.38	7.81	6.86	134.36
RBC Dominion	6.97	9.54	12.22	14.30	10.17	11.21	18.01	11.62	11.51	12.13	12.69	130.37
Liquidnet	6.76	6.09	3.09	3.41	3.70	3.79	3.16	15.32	22.39	12.90	13.33	93.92
Macquarie	9.67	11.90	8.79	5.85	8.36	4.30	8.49	5.49	1.25	6.36	6.55	76.99
Nomura	6.00	17.64	10.15	3.74	4.77	3.64	4.62	3.16	3.47	2.99	3.56	63.75
CITIC	-	-	-	1.77	6.10	6.10	8.80	11.32	11.59	6.22	8.04	59.93
Credit Agricole	13.63	11.54	9.95	9.68	1.06	0.99	0.58	0.25	0.56	0.13	0.10	48.46
Cowen Group	1.66	0.63	1.52	1.28	1.15	0.92	1.74	2.68	11.28	10.25	10.91	44.02
Wells Fargo	1.50	1.72	2.46	3.09	2.07	4.04	4.58	3.09	1.97	1.42	2.85	28.79
BNY	4.97	5.49	4.49	3.28	2.52	1.65	2.65	0.92	0.86	0.44	1.14	28.40
Stifel Financial	2.34	2.19	3.07	2.55	4.06	2.71	3.19	2.19	1.76	1.12	0.95	26.13
ITG	5.05	3.30	2.78	1.78	2.53	1.87	1.48	1.86	3.82	-	-	24.47
KCG	3.04	3.59	3.33	3.35	3.35	3.09	2.02	0.31	-	-	-	22.08
Raymond James	0.74	0.98	3.05	3.92	2.99	2.76	2.33	1.24	1.13	1.15	1.26	21.54
HSBC	2.05	1.18	0.87	1.30	1.81	1.92	1.68	2.65	4.20	1.87	1.98	21.50
Top 25 Brokers	542.14	577.74	468.56	502.95	521.68	511.91	481.95	425.01	377.85	292.59	349.06	5,051.43
All Reported Brokers	593.41	624.86	509.03	537.75	561.70	543.19	515.30	451.96	409.30	317.07	376.41	5,439.96
All Brokers	930.47	971.52	786.93	820.30	856.43	832.65	773.42	709.00	649.80	485.73	576.21	8,392.47
Number of Funds	499	457	431	413	420	419	414	390	356	311	291	652
Number of Brokers	253	235	228	198	212	189	198	185	203	175	175	544

Table 3– Continued

Broker	Panel B – Pension Fund Sample											
	Commission Dollars (millions)											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Bank of America	34.63	30.35	23.44	27.32	28.40	25.75	28.63	26.21	30.53	24.31	22.21	301.89
Goldman Sachs	35.79	34.67	26.92	25.47	24.01	25.95	21.75	26.80	27.64	26.30	25.00	300.32
Credit Suisse	45.16	40.27	34.19	28.70	25.13	21.20	18.85	17.42	17.50	16.42	18.17	283.00
JP Morgan Chase	34.81	32.57	30.83	29.49	24.27	23.02	20.91	19.62	23.09	19.93	21.26	279.81
Morgan Stanley	33.29	28.39	27.28	23.39	22.25	22.40	20.00	20.94	23.23	20.62	18.76	260.55
Citigroup	28.78	26.74	25.46	23.77	21.20	21.09	20.36	21.75	23.74	19.80	16.17	248.85
UBS	26.88	26.30	21.91	21.86	19.89	20.00	19.07	19.20	19.73	15.82	15.44	222.61
Nomura	24.45	24.82	22.10	17.62	18.16	18.91	17.59	19.96	21.21	15.28	13.90	214.02
Deutsche Bank	20.85	21.82	20.38	17.37	16.31	14.75	11.79	9.29	9.34	4.27	0.18	146.34
Barclays	24.33	17.92	19.47	18.41	14.06	9.32	9.41	8.43	10.15	7.78	5.19	144.48
ITG	16.16	13.29	10.15	10.59	10.69	10.79	6.88	6.68	7.59	-	-	92.81
Jefferies	10.05	8.01	6.47	5.63	7.11	7.05	7.74	5.09	5.54	5.57	7.95	76.22
Alliance Bernstein	6.84	6.25	7.55	6.74	6.68	5.55	5.18	4.91	4.74	3.75	3.25	61.45
BNY	10.36	9.49	5.78	5.55	4.12	5.81	3.06	3.62	4.66	3.49	4.61	60.55
Macquarie	9.33	8.02	5.38	5.16	5.65	5.58	3.33	5.53	4.04	3.38	4.39	59.80
HSBC	4.28	4.02	3.80	5.28	6.36	5.60	3.85	3.15	4.60	5.20	6.38	52.52
Liquidnet	8.27	7.50	5.55	4.56	4.61	3.23	4.68	2.88	3.62	3.38	3.48	51.77
CAPIS	3.83	5.33	5.37	5.63	5.73	5.98	5.19	3.80	3.60	4.40	2.06	50.93
State Street	5.58	5.90	8.80	4.34	4.38	5.86	4.95	6.72	1.11	0.73	0.36	48.74
Societe Generale	4.42	3.63	3.54	2.98	3.59	3.63	3.55	4.98	4.63	3.32	2.35	40.63
Credit Agricole	7.78	7.81	6.08	3.67	2.45	2.64	1.71	1.76	2.17	2.17	1.42	39.64
Cowen Group	3.98	2.47	2.26	2.04	3.31	2.32	1.53	5.35	5.06	5.79	4.84	38.95
RBC Dominion	3.05	3.91	4.45	3.71	3.66	3.61	3.01	3.86	2.96	3.19	3.33	38.43
Loop Capital Mkts.	3.01	3.03	3.70	3.06	3.21	3.27	3.14	3.35	3.22	2.81	3.34	35.13
Weeden & Co.	5.72	4.69	3.85	3.15	2.72	2.46	1.85	1.66	1.82	1.67	-	29.59
Top 25 Brokers	411.63	377.22	334.40	305.50	287.94	275.76	248.01	250.98	263.72	219.40	204.17	3,178.73
All Reported Brokers	505.99	465.04	408.72	370.07	359.21	342.15	301.93	301.90	307.85	268.88	253.34	3,885.08
All Brokers	584.17	539.40	471.30	426.27	418.40	400.01	375.39	371.15	375.11	325.58	306.08	4,592.86
Number of Funds	74	74	77	77	76	77	77	77	77	77	76	77
Number of Brokers	637	569	532	493	443	450	381	368	356	337	325	1,093

Table 4: Commonality in Broker Usage Between Pension Funds and Mutual Funds

The table lists the set of brokers that rank in the top 25 brokers for either pension funds or mutual funds based on aggregate commissions received during the full sample period (Overall Rank). In addition to the overall rank, the table lists the proportion of fund-years in each sample for which the broker is ranked first, in the top five, or in the top 10, respectively, along with their associated rankings based on these proportions. Commission data are collected for mutual funds from annual NSAR and NCEN filings and for pension funds from Comprehensive Annual Financial Reports (CAFRs). The mutual fund sample includes 652 funds and 32,525 fund-broker-year observations. The pension fund sample includes 77 funds and 34,348 fund-broker-year observations.

	Mutual Funds				Pension Funds			
	Overall Rank	% Top 1 (Rank)	% Top 5 (Rank)	% Top 10 (Rank)	Overall Rank	% Top 1 (Rank)	% Top 5 (Rank)	% Top 10 (Rank)
Morgan Stanley	1	8.3 (4)	34.2 (4)	50.5 (4)	5	7.4 (4)	37.7 (5)	70.2 (4)
Goldman Sachs	2	10.5 (3)	37.7 (4)	53.0 (3)	2	12.0 (2)	40.4 (4)	68.3 (6)
JP Morgan Chase	3	14.1 (1)	44.2 (1)	59.5 (1)	4	4.8 (8)	44.8 (2)	74.3 (3)
Bank of America	4	11.0 (2)	38.7 (2)	54.3 (2)	1	13.9 (1)	59.0 (1)	84.4 (1)
Citigroup	5	6.1 (5)	30.4 (5)	48.2 (5)	6	4.8 (8)	26.7 (8)	61.3 (7)
Credit Suisse	6	5.6 (6)	29.0 (6)	46.4 (6)	3	7.7 (3)	43.1 (3)	76.5 (2)
UBS	7	3.3 (9)	22.2 (7)	39.7 (7)	7	5.8 (6)	35.4 (6)	68.8 (5)
Deutsche Bank	8	1.6 (16)	11.6 (9)	30.2 (9)	9	1.2 (22)	11.7 (10)	39.1 (9)
Barclays	9	4.2 (7)	18.2 (8)	34.8 (8)	10	0.7 (28)	10.3 (11)	33.4 (10)
Jefferies	10	1.5 (17)	9.1 (13)	19.3 (12)	12	1.1 (25)	8.8 (13)	24.6 (12)
Alliance Bernstein	11	1.4 (20)	9.7 (11)	22.3 (10)	13	0.1 (50)	4.5 (23)	15.3 (15)
RBC	12	2.0 (13)	9.6 (12)	21.9 (11)	23	0.2 (41)	3.5 (25)	9.2 (24)
Liquidnet	13	1.0 (22)	5.9 (15)	11.6 (15)	17	1.7 (17)	8.6 (14)	19.4 (13)
Macquarie	14	0.3 (54)	2.8 (26)	8.8 (20)	15	0.2 (41)	1.4 (45)	7.7 (26)
Nomura	15	4.2 (8)	9.9 (10)	15.2 (13)	8	5.7 (7)	28.1 (7)	52.7 (8)
CITIC	16	0.2 (66)	1.5 (42)	4.7 (31)	38	0.1 (44)	1.3 (58)	5.2 (34)
Credit Agricole	17	0.4 (42)	2.1 (35)	5.5 (27)	21	0.0 (na)	0.6 (73)	2.6 (50)
Cowen Group	18	0.6 (31)	4.8 (19)	9.6 (17)	22	1.1 (25)	6.4 (18)	11.6 (18)
Wells Fargo	19	1.0 (21)	4.4 (21)	9.3 (18)	32	0.1 (50)	2.7 (33)	5.7 (32)
BNY	20	2.2 (11)	5.3 (17)	7.4 (23)	14	2.0 (15)	9.2 (12)	16.3 (14)
Stifel Financial	21	0.5 (37)	3.6 (23)	8.5 (22)	26	0.1 (50)	2.7 (33)	9.8 (22)
ITG	22	0.8 (24)	5.3 (18)	9.0 (19)	11	2.6 (13)	15.7 (9)	31.3 (11)
KCG	23	1.9 (14)	5.8 (16)	8.5 (21)	30	0.5 (32)	3.1 (27)	7.6 (27)
Raymond James	24	0.4 (42)	2.6 (27)	5.7 (26)	33	0.2 (41)	1.4 (45)	3.6 (43)
HSBC	25	0.7 (26)	2.4 (29)	5.0 (30)	16	0.1 (50)	1.8 (40)	6.1 (31)
CAPIS	43	0.9 (23)	1.8 (37)	2.4 (41)	18	2.7 (12)	8.1 (16)	13.8 (16)
State Street	79	0.2 (79)	0.7 (72)	1.3 (63)	19	3.9 (10)	6.3 (19)	10.1 (21)
Societe Generale	33	0.3 (54)	1.8 (37)	3.2 (37)	20	0.2 (41)	1.9 (39)	6.2 (30)
Loop Capital Mkts	289	0.1 (156)	0.3 (160)	0.5 (153)	24	6.5 (5)	8.5 (15)	11.3 (19)
Weeden & Co.	26	0.4 (41)	3.8 (20)	7.2 (22)	25	0.3 (39)	3.0 (28)	8.9 (25)
# Brokers Utilized	545	191	396	545	1,096	54	124	193

Table 5: Transition Matrices for Broker Ranks in the Mutual Fund and Pension Fund Data

The table describes transition matrices comparing broker rank in year *t*-1 and year *t*, where broker ranks are based on total commissions earned during the year. Commission league tables are collected for mutual funds from annual NSAR and NCEN filings and for pension funds from Comprehensive Annual Financial Reports (CAFRs). The mutual fund sample includes 652 funds and 34,908 fund-broker-year observations for which change in broker rank could be defined. The pension fund sample includes 77 funds and 35,568 fund-broker-year observations for which change in broker rank could be defined.

Panel A – Directional Rank Changes for Brokers in the Mutual Fund and Pension Fund Samples

Broker's time *t* rank	Mutual Funds			Pension Funds		
	Broker's time *t+1* rank			Broker's time *t+1* rank		
	Higher than	Same as time	Lower than	Higher than	Same as	Lower than
1	n.a.	47%	53%	n.a.	46%	54%
2	18%	22%	60%	16%	24%	60%
3	26%	16%	59%	25%	16%	60%
4	28%	13%	59%	29%	13%	58%
5	32%	11%	57%	30%	13%	57%
6	36%	10%	53%	33%	11%	55%
7	38%	8%	54%	37%	10%	53%
8	40%	8%	52%	39%	9%	51%
9	40%	8%	52%	43%	10%	47%
10	38%	7%	55%	41%	10%	50%
Top 10	27%	17%	56%	29%	16%	55%
Any	43%	13%	44%	47%	6%	47%

Panel B – Detailed Rank Changes Brokers in the Mutual Fund Sample

Broker's time *t* rank	Time *t+1* rank										
	1	2	3	4	5	6	7	8	9	10	>10
1	47%	15%	9%	6%	4%	3%	2%	2%	1%	1%	11%
2	18%	22%	14%	10%	6%	5%	4%	3%	2%	1%	17%
3	11%	15%	16%	11%	8%	7%	5%	4%	2%	2%	19%
4	7%	10%	12%	13%	10%	8%	5%	5%	4%	2%	24%
5	6%	7%	9%	10%	11%	9%	7%	6%	5%	3%	27%

Panel C – Detailed Rank Changes for Brokers in the Pension Fund Sample

Broker's time *t* rank	Time *t+1* rank										
	1	2	3	4	5	6	7	8	9	10	>10
1	46%	17%	8%	4%	4%	3%	3%	2%	1%	1%	11%
2	16%	24%	14%	11%	6%	6%	3%	2%	3%	2%	14%
3	9%	16%	16%	12%	9%	6%	6%	4%	4%	2%	17%
4	6%	9%	13%	13%	12%	9%	6%	7%	3%	3%	17%
5	4%	6%	10%	10%	13%	10%	11%	5%	4%	4%	23%

Table 6: Event Study of Broker Use Around Reputation Shocks

The table describes mean values of several broker usage statistics around dark pool reputation shocks. The first column reports the proportion of funds for which the affected broker is included among the fund's top 10 brokers based on commissions earned. The remaining columns describe the proportion of funds for which the affected broker's rank was downgraded, upgraded, or unchanged. Means are calculated across all relevant events, with all events included in Panel A and subsamples of events in Panels B, C, and D. Subsamples are defined based on whether the affected broker is a full-service broker (Barclays, Credit Suisse, Deutsche Bank, Goldman Sachs, Citigroup, and UBS) vs. execution-only broker (ITG, Liquidnet, and Knight Capital Group) and based on whether the dark pool scandal resulted in a fine greater than $40 million. Commission league tables are collected for mutual funds from annual NSAR and NCEN filings and for pension funds from Comprehensive Annual Financial Reports (CAFRs). The samples include all fund-broker-year observations involving scandal brokers and for which change in broker rank could be defined.

Panel A: All Events

	Mutual Funds				Pension Funds			
Event Year	% of Funds with Broker Ranked in Top 10	% of Funds with Broker Rank Downgrade	% of Funds with No Change in Broker Rank	% of Funds with Broker Rank Upgrade	% of Funds with Broker Ranked in Top 10	% of Funds with Broker Rank Downgrade	% of Funds with No Change in Broker Rank	% of Funds with Broker Rank Upgrade
- 2	32.19	44.98	11.36	43.66	45.47	40.31	11.30	48.40
- 1	31.44	42.90	13.23	43.87	47.20	46.50	11.44	42.06
0	29.68	47.94	13.93	38.11	43.37	55.35	9.15	35.50
+ 1	30.68	42.82	13.54	43.64	39.03	53.24	9.49	37.27
+ 2	30.15	43.76	13.53	42.72	38.45	52.37	6.48	41.15

Panel B: High-fine Full-service Broker Events

	Mutual Funds				Pension Funds			
Event Year	% of Funds with Broker Ranked in Top 10	% of Funds with Broker Rank Downgrade	% of Funds with No Change in Broker Rank	% of Funds with Broker Rank Upgrade	% of Funds with Broker Ranked in Top 10	% of Funds with Broker Rank Downgrade	% of Funds with No Change in Broker Rank	% of Funds with Broker Rank Upgrade
- 2	42.87	42.15	12.89	44.96	62.34	38.12	11.78	50.10
- 1	42.02	43.08	11.73	45.19	64.94	47.99	12.53	39.48
0	39.06	50.48	11.80	37.72	53.51	57.19	8.60	34.21
+ 1	39.51	42.34	14.06	43.61	45.89	53.21	7.34	39.45
+ 2	35.34	51.40	12.47	36.13	43.29	52.69	8.78	38.53

Table 6 – Continued

Panel C: Low-fine Full-service Broker Events								
	Mutual Funds				Pension Funds			
Event Year	% of Funds with Broker Ranked in Top 10	% of Funds with Broker Rank Downgrade	% of Funds with No Change in Broker Rank	% of Funds with Broker Rank Upgrade	% of Funds with Broker Ranked in Top 10	% of Funds with Broker Rank Downgrade	% of Funds with No Change in Broker Rank	% of Funds with Broker Rank Upgrade
- 2	47.01	44.38	14.10	41.53	64.61	37.19	12.41	50.40
- 1	44.76	47.51	13.17	39.32	66.23	39.70	16.57	43.73
0	43.32	42.41	16.05	41.54	68.55	40.80	16.48	42.73
+ 1	45.71	42.53	15.40	42.07	67.37	42.94	14.18	42.88
+ 2	46.86	40.76	14.23	45.01	61.26	48.34	8.93	42.72
Panel D: Execution-Only Broker Events								
	Mutual Funds				Pension Funds			
Event Year	% of Funds with Broker Ranked in Top 10	% of Funds with Broker Rank Downgrade	% of Funds with No Change in Broker Rank	% of Funds with Broker Rank Upgrade	% of Funds with Broker Ranked in Top 10	% of Funds with Broker Rank Downgrade	% of Funds with No Change in Broker Rank	% of Funds with Broker Rank Upgrade
- 2	9.35	47.71	7.48	44.81	24.90	45.06	9.83	45.12
- 1	10.20	38.16	14.42	47.42	26.65	44.18	8.36	47.47
0	9.00	51.63	13.40	34.97	21.43	62.71	4.53	32.76
+ 1	9.03	43.47	11.28	45.25	15.30	51.87	8.78	39.35
+ 2	9.55	41.03	13.62	45.36	12.01	56.17	2.29	41.55

Table 7: Reputation Shocks and the Likelihood of Broker Downgrades

The table provides results from a linear probability model for the likelihood of downgrade. Results for mutual funds are reported in Panel A and results for pension funds are reported in Panel B. The dependent variable, *Downgrade*, is a binary variable that takes a value of one if the broker is lower on the league table of a fund in a given year than in the previous year and zero otherwise. *Post* is a binary variable that takes a value of one for all post-event years of a fund-broker pair when the broker is involved in a scandal event and zero otherwise. *Post* is equal to zero for all unaffected fund-broker pairs. *High-Fine* is a binary variable that takes a value of one for all brokers involved in reputation shock events that led to fines and disgorgement of more than $40 million and zero otherwise. *Execution-Only* is a binary variable that takes a value of one for execution-only brokers involved in reputation shock events and zero otherwise. Fixed effects are included as reported. *t*-statistics based on standard errors clustered at the broker and fund levels are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. Commission league tables are collected for mutual funds from annual NSAR and NCEN filings and for pension funds from Comprehensive Annual Financial Reports (CAFRs). The samples include all fund-broker-year observations for which change in broker rank could be defined and fixed effects could be estimated. Detailed definitions of all variables are provided in Appendix II.

Panel A: Mutual Funds						
	(1)	(2)	(3)	(4)	(5)	(6)
Post × High-Fine	-	-	0.095***	0.083***	0.105***	0.095***
			(3.11)	(3.15)	(3.35)	(3.83)
Post × Execution-Only	-	-	-	-	0.058	0.121*
					(1.22)	(1.89)
High-Fine	-	-	-0.018	-	-0.017	-
			(-0.79)		(-0.73)	
Execution-Only	-	-	-	-	0.008	-
					(0.20)	
Post	-0.008	0.055*	-0.038	0.019	-0.051*	0.004
	(-0.27)	(1.81)	(-1.43)	(0.63)	(-1.80)	(0.13)
Broker Rank FE	Yes	Yes	Yes	Yes	Yes	Yes
Fund × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Broker × Fund FE	No	Yes	No	Yes	No	Yes
Observations	32,956	32,956	32,956	32,956	32,956	32,956
Adjusted R^2	0.203	0.255	0.205	0.256	0.205	0.256
Panel B: Pension Funds						
	(1)	(2)	(3)	(4)	(5)	(6)
Post × High-Fine	-	-	0.165***	0.146**	0.223***	0.203***
			(2.78)	(2.60)	(3.72)	(4.21)
Post × Execution-Only	-	-	-	-	0.199***	0.172***
					(4.71)	(4.16)
High-Fine	-	-	-0.076***	-	-0.079***	-
			(-3.00)		(-3.02)	
Execution-Only	-	-	-	-	-0.058**	-
					(-2.19)	
Post	-0.031	0.068*	-0.064**	0.013	-0.123***	-0.047
	(-1.00)	(1.68)	(-2.02)	(0.32)	(-4.15)	(-1.65)
Broker Rank FE	Yes	Yes	Yes	Yes	Yes	Yes
Fund × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Broker × Fund FE	No	Yes	No	Yes	No	Yes
Observations	34,518	34,518	34,518	34,518	34,518	34,518
Adjusted R^2	0.168	0.202	0.170	0.203	0.171	0.204

Table 8: Heterogeneity in the Effect of Reputation Shocks on Broker Downgrades

The table provides results from a linear probability model for the probability of downgrade, with heterogeneous effects related to investor monitoring ability and fund-broker relationships. Columns (1) through (3) provide results for mutual funds, while columns (4) and (5) provide results for pension funds. The dependent variable, *Downgrade*, is a binary variable that takes a value of one if the broker is lower on the league table of a fund in a given year than in the previous year and zero otherwise. *Post* is a binary variable that takes a value of one for all post-event years of a fund-broker pair when the broker is involved in a scandal event and zero otherwise. *Post* is equal to zero for all unaffected fund-broker pairs. *High-Fine* is a binary variable that takes a value of one for all brokers involved in reputation shock events that led to fines and disgorgement of more than $40 million and zero otherwise. *Execution-Only* is a binary variable that takes a value of one for execution-only brokers involved in reputation shock events and zero otherwise. Fixed effects are included as reported. *Monitoring* (*Non-Monitoring*) funds are those with total commissions above (below) the median across all funds in the prior year. *Top 5 Brokers* (*Non-Top 5*) *Brokers* are those ranked (not ranked) among the top 5 brokers reported by the fund in the prior year. We define a mutual fund-broker pair as having a *Long* (*Short*) *Relationships* if the number of years the broker is reported in the fund's top 10 between 1995 and event year *t*-1 is above (below) the median. Fixed effects are included as reported. *t*-statistics based on standard errors clustered at the broker and fund levels are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. Commission league tables are collected for mutual funds from annual NSAR and NCEN filings and for pension funds from Comprehensive Annual Financial Reports (CAFRs). The samples include all fund-broker-year observations for which change in broker rank could be defined and fixed effects could be estimated. Detailed definitions of all variables are provided in Appendix II.

Table 8 - Continued

	Mutual Funds			Pension Funds	
	(1)	(2)	(3)	(4)	(5)
Post × High-Fine × Monitoring Fund	0.084***	-	-	0.241***	-
	(3.22)			(3.94)	
Post × High-Fine × Non-Monitoring Fund	0.134***	-	-	0.162***	-
	(4.42)			(4.93)	
Post × Execution-Only × Monitoring Fund	0.097	-	-	0.145***	-
	(1.28)			(3.92)	
Post × Execution-Only × Non-Monitoring Fund	0.164***	-	-	0.202***	-
	(3.44)			(5.16)	
Post × High-Fine × Non-Top 5 Broker	-	0.070***	-	-	0.181***
		(2.92)			(3.11)
Post × High-Fine × Top 5 Broker	-	0.133***	-	-	0.272***
		(4.39)			(7.32)
Post × Execution-Only × Non-Top 5 Broker	-	0.115	-	-	0.167***
		(1.53)			(4.74)
Post × Execution-Only × Top 5 Broker	-	0.127**	-	-	0.196***
		(2.23)			(5.58)
Post × High-Fine × Short Relationship	-	-	0.047	-	-
			(1.30)		
Post × High-Fine × Long Relationship	-	-	0.109***	-	-
			(4.22)		
Post × Execution-Only × Short Relationship	-	-	0.115*	-	-
			(1.68)		
Post × Execution-Only × Long Relationship	-	-	0.155	-	-
			(1.49)		
Post	0.004	0.003	0.004	-0.047**	-0.047**
	(0.13)	(0.11)	(0.14)	(-2.00)	(-1.97)
Difference in High-Fine Coefficients	0.050*	0.063***	0.063*	-0.079**	0.091*
	(1.95)	(4.18)	(1.91)	(-2.01)	(1.93)
Difference in Execution-Only Coefficients	0.067	0.012	0.040	0.057	0.029
	(1.62)	(0.32)	(0.42)	(1.56)	(0.74)
Broker Rank FE	Yes	Yes	Yes	Yes	Yes
Fund × Year FE	Yes	Yes	Yes	Yes	Yes
Broker × Fund FE	Yes	Yes	Yes	Yes	Yes
Observations	32,956	32,956	32,956	34,518	34,518
Adjusted R^2	0.256	0.256	0.256	0.204	0.204

Table 9: Alternative Explanations for Broker Downgrades

The table provides results from a linear probability model for the likelihood of downgrade. Results for mutual funds are reported in Panel A and results for pension funds are reported in Panel B. The dependent variable, *Downgrade*, is a binary variable that takes a value of one if the broker is lower on the league table of a fund in a given year than in the previous year and zero otherwise. *Post* is a binary variable that takes a value of one for all post-event years of a fund-broker pair when the broker is involved in a scandal event and zero otherwise. *Post* is equal to zero for all unaffected fund-broker pairs. *High-Fine* is a binary variable that takes a value of one for all brokers involved in reputation shock events that led to fines and disgorgement of more than $40 million and zero otherwise. *Execution-Only* is a binary variable that takes a value of one for execution-only brokers involved in reputation shock events and zero otherwise. *Broker Pricing* is defined based on the pension fund data as the median commissions per share paid by the broker's pension fund clients during a given year. *Broker Centrality* is measured as the eigenvector centrality of a broker in the network of trading relations between brokers and funds. *Change in Broker Services* is defined based on the mutual fund data as the number of new services offered by the broker in a given year, as reported by the broker's mutual fund clients. Fixed effects are included as reported. Fixed effects are included as reported. *t*-statistics based on standard errors clustered at the broker and fund levels are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. Commission league tables are collected for mutual funds from annual NSAR and NCEN filings and for pension funds from Comprehensive Annual Financial Reports (CAFRs). The samples include all fund-broker-year observations for which change in broker rank and explanatory variables could be defined and fixed effects could be estimated. Detailed definitions of all variables are provided in Appendix II.

Panel A – Summary Statistics for Mutual Funds					
	N	Mean	Min	Median	Max
Broker Pricing (¢/shr)	28,143	1.64	0.20	1.34	4.85
Broker Centrality (%)	28,143	5.19	0.10	3.80	18.40
Change in Broker Services	28,143	0.02	-3.00	0.00	2.00
Panel B – Regression Results for Mutual Funds					
	(1)	(2)	(3)	(4)	
Post × High-Fine	0.070***	0.090***	0.087***	0.064***	
	(2.90)	(4.10)	(3.90)	(2.97)	
Post × Execution-Only	0.088*	0.126**	0.124**	0.094*	
	(1.80)	(2.07)	(2.17)	(1.94)	
Post × Broker Pricing	0.085***	-	-	0.088***	
	(2.98)			(3.33)	
Post × Broker Centrality	-	-0.075	-	-0.064	
		(-0.24)		(-0.24)	
Post × Chg in Broker Services	-	-	-0.025	-0.024*	
			(-1.64)	(-1.80)	
Broker Pricing	0.035**	-	-	0.035**	
	(2.28)			(2.32)	
Broker Centrality	-	-0.093	-	-0.114	
		(-1.07)		(-1.28)	
Chg in Broker Services	-	-	0.022*	0.024**	
			(1.86)	(2.13)	
Post	-0.098*	0.003	0.003	-0.101**	
	(-1.93)	(0.11)	(0.11)	(-2.44)	
Broker Rank FE	Yes	Yes	Yes	Yes	
Fund × Year FE	Yes	Yes	Yes	Yes	
Broker × Fund FE	Yes	Yes	Yes	Yes	
Observations	28,143	28,143	28,143	28,143	
Adjusted R^2	0.257	0.256	0.257	0.258	

Table 9 - Continued

Panel C – Summary Statistics for Pension Funds					
	N	Mean	Min	Median	Max
Broker Pricing (¢/shr)	28,917	2.12	0.20	1.98	4.97
Broker Centrality (%)	28,917	4.55	0.10	5.00	6.50
Change in Broker Services	28,917	0.02	-3.00	0.00	2.00

Panel D – Regression Results for Pension Funds				
	(1)	(2)	(3)	(4)
Post × High-Fine	0.213***	0.194***	0.207***	0.199***
	(6.83)	(4.75)	(6.26)	(5.88)
Post × Execution-Only	0.184***	0.165***	0.175***	0.172***
	(5.26)	(4.16)	(4.76)	(5.09)
Post × Broker Pricing	-0.012	-	-	-0.034
	(-0.60)			(-1.35)
Post × Broker Centrality	-	-2.199**	-	-2.300**
		(-2.09)		(-2.10)
Post × Chg in Broker Services	-	-	-0.011	-0.008
			(-0.80)	(-0.55)
Broker Pricing	0.014	-	-	0.014
	(1.32)			(1.36)
Broker Centrality	-	0.167	-	0.176
		(0.58)		(0.60)
Chg in Broker Services	-	-	-0.006	-0.007
			(-0.69)	(-0.75)
Post	-0.048	0.056	-0.054**	0.099
	(-1.36)	(0.99)	(-2.13)	(1.24)
Broker Rank FE	Yes	Yes	Yes	Yes
Fund × Year FE	Yes	Yes	Yes	Yes
Broker × Fund FE	Yes	Yes	Yes	Yes
Observations	28,917	28,917	28,917	28,917
Adjusted R^2	0.197	0.197	0.196	0.197

Table 10: Broker Downgrade vs. Broker Termination

The table provides results from a linear probability model for the likelihood of downgrade. To isolate the effects of termination vs. downgrade, the analysis is limited to the subsample of fund-years for which reported brokers account for at least 90% of the fund's total commissions in years *t* and *t*-1. The samples then include all fund-broker-year observations for which change in broker rank could be defined and fixed effects could be estimated. Results for mutual funds are reported in columns 1 through 4 and results for pension funds are reported in columns 5 through 8. In columns 1, 2, 5, and 6, the dependent variable, *Downgrade with Termination*, is a binary variable that takes a value of one if the broker was reported in the league table of a given fund in the previous year, but is not reported by the fund in the current year, and zero otherwise. In columns 3, 4, 7, and 8, the dependent variable, *Downgrade without Termination*, is a binary variable that takes a value of one if the broker is reported in the league table of a given fund in both the current and the previous years, but is ranked lower in the current year. For this specification, observations for which *Downgrade with Termination* equals one are eliminated. *Post* is a binary variable that takes a value of one for all post-event years of a fund-broker pair when the broker is involved in a scandal event and zero otherwise. *Post* is equal to zero for all unaffected fund-broker pairs. *High-Fine* is a binary variable that takes a value of one for all brokers involved in reputation shock events that led to fines and disgorgement of more than $40 million and zero otherwise. *Execution-Only* is a binary variable that takes a value of one for execution-only brokers involved in reputation shock events and zero otherwise. Fixed effects are included as reported. *t*-statistics based on standard errors clustered at the broker and fund levels are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. Commission league tables are collected for mutual funds from annual NSAR and NCEN filings and for pension funds from Comprehensive Annual Financial Reports (CAFRs). Detailed definitions of all variables are provided in Appendix II.

	Mutual Funds				Pension Funds			
	Downgrade with Termination		Downgrade w/o Termination		Downgrade with Termination		Downgrade w/o Termination	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post × High-Fine	0.119***	0.140**	0.058**	0.164**	0.028	0.014	0.247***	0.197***
	(3.10)	(2.47)	(1.99)	(2.07)	(0.74)	(0.42)	(3.73)	(4.55)
Post × Execution-Only	0.114***	0.130***	-0.042	0.020	0.028	0.055*	0.187***	0.164***
	(3.99)	(3.73)	(-1.25)	(0.29)	(1.01)	(1.98)	(4.87)	(3.20)
High-Fine	-0.006	-	-0.031	-	-0.011	-	-0.090***	-
	(-0.24)		(-0.73)		(-0.87)		(-3.46)	
Execution-Only	-0.043*	-	0.089***	-	-0.013	-	-0.062*	-
	(-1.72)		(4.34)		(-1.67)		(-1.81)	
Post	-0.057***	-0.021	-0.013	-0.024	-0.055**	-0.085***	-0.107***	0.034
	(-2.93)	(-0.51)	(-0.88)	(-0.43)	(-2.55)	(-3.14)	(-3.25)	(1.07)
Broker Rank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Broker × Fund FE	No	Yes	No	Yes	No	Yes	No	Yes
Observations	7,764	7,764	6,110	6,110	22,089	22,089	19,300	19,300
Adjusted R^2	0.226	0.248	0.216	0.193	0.167	0.276	0.148	0.155

Table 11: Lost Commissions Following Reputation Shocks

The table describes estimates of lost brokerage commissions resulting from broker reputation shocks. Commission data are collected for mutual funds from annual NSAR and NCEN filings and for pension funds from Comprehensive Annual Financial Reports (CAFRs). Year *t* is defined as the year of the broker scandal. Expected commissions in years *t* through *t*+3 are estimated by multiplying the total commissions available in that year by the percentage of total commissions the broker earned in the year prior to the scandal (year *t*-1). Lost commissions are then estimated by comparing expected commissions to actual commissions earned in years *t* through *t*+3. Lost commission totals include only three years for the 2018 events (Citigroup and ITG) and only two years for Pipeline, which went out of business in 2012. Subsamples are defined based on whether the affected broker is a full-service broker (Barclays, Credit Suisse, Deutsche Bank, Goldman Sachs, Citigroup, and UBS) vs. execution-only broker (ITG, Liquidnet, and Knight Capital Group) and based on whether the dark pool scandal resulted in a fine greater than $40 million.

	Mutual Funds ($m)				Pension Funds ($m)			
Type of Scandal Broker	Expected Commissions *t* to *t*+1	Actual Commissions *t* to *t*+1	Lost Commissions *t* to *t*+1	Lost Commissions *t* to *t*+3	Expected Commissions *t* to *t*+1	Actual Commissions *t* to *t*+1	Lost Commissions *t* to *t*+1	Lost Commissions *t* to *t*+3
High-fine full-service Events:								
Barclays – 2014	60.02	60.52	0.50	-12.20	35.35	23.38	-11.97	-26.36
Credit Suisse – 2014	90.09	78.86	-11.24	-29.25	55.10	46.33	-8.78	-22.78
Deutsche Bank – 2014	67.46	64.27	-3.19	-16.14	33.35	31.06	-2.30	-11.64
Event Type Aggregate	217.57	203.65	-13.92	-57.59	123.80	100.76	-23.04	-60.78
Low-fine full-service Events:								
Goldman Sachs – 2014	107.46	116.85	9.38	11.45	48.91	49.96	1.05	4.99
Citigroup – 2014	121.91	112.36	-9.55	-29.02	45.64	42.29	-3.36	-2.88
UBS – 2014	73.02	60.55	-12.47	-21.11	41.97	39.89	-2.08	-4.10
Citigroup – 2018	67.39	55.79	-11.60	-23.00	41.07	43.54	2.47	0.70
Event Type Aggregate	369.78	345.54	-24.23	-61.69	177.59	175.68	-1.91	-1.29
Execution-Only Events:								
Pipeline – 2011	5.06	0.91	-4.15	-4.15	3.56	0.70	-2.86	-2.86
Liquidnet – 2012	10.08	6.50	-3.58	-6.68	12.48	10.11	-2.38	-5.92
KCG – 2012	5.94	6.68	0.74	0.93	5.94	6.03	0.09	-1.24
ITG – 2015	4.74	3.36	-1.39	0.27	19.80	17.67	-2.13	-6.93
ITG – 2018	2.98	8.65	5.67	5.75	12.60	13.96	1.35	-0.37
Event Type Aggregate	28.80	26.09	-2.71	-3.89	54.39	48.46	-5.94	-17.33
Combined Aggregate	616.15	575.28	-40.87	-123.17	355.79	324.90	-30.89	-79.40

Appendix I: Broker Name Consolidation Process

As noted in Section 2, the broker names reported in the pension fund CAFRs and the mutual fund NSAR/NCEN filings are not standardized and require substantial cleaning before any analysis can be performed. This appendix describes the process used to clean and consolidate broker names within the data.

A number of issues make it difficult to match the raw data to specific brokers. First, the same broker may be referenced with different name variations or different combinations of upper- and lower-case letters across funds, or even across years by the same fund. For example, UBS is listed in the pension fund data as UBS, UBS AG, UBS Ag, Ubs Ag, Union Bank of Switzerland, Union Bank Switzerland, etc. The data may also include separate units of the same broker, as defined by geography (e.g., UBS London, UBS Stamford), division (e.g., UBS Equities, UBS Financial Services, UBS Securities), etc. Using a manual verification process, we combine all name variations of the same broker and all units of the same parent broker under a single "master" broker name. For the examples above, all name variations are combined under the single name 'UBS'.

A number of the sample brokers are also impacted by mergers either before or during the sample period. In cases where the data do not properly reflect the merger of two sample brokers prior to the start of our sample period, we adjust the broker names manually. For example, the raw pension data reference both Warburg and Dillon Read despite the fact that both firms merged with UBS prior to the start of our sample period. In such a case, we manually replace all occurrences of the predecessor broker names and all related names (e.g., SBC Warburg, UBS Warburg, Warburg Dillon Read) with the new parent name (which in this case is 'UBS'). For broker mergers that occur during the sample period, all post-merger occurrences of the affected broker names are manually adjusted to reflect the merger. As an example, Wunderlich Investment Company was acquired by B. Riley Financial in July of 2017. To account for this merger, we treat these brokers as separate entities prior to the merger date, and manually replace any occurrences of the Wunderlich name after July 2017 with the name B. Riley Financial. When both subsidiaries and parent appear in the data, subsidiaries are aggregated with the parent. This ensures consistent treatment across brokers and funds, as well as across time.

Appendix II: Variable definitions

Variable	Description
Downgrade	A binary variable that takes a value of one if the broker is lower on the league table of a fund in a given year than in the previous year or drops out of the league table after appearing the previous year, and zero otherwise.
Post	A binary variable that takes a value of one for all post-event years of a fund-broker pair when the broker is involved in a scandal event and zero otherwise. *Post* is equal to zero for all fund-broker pairs unaffected by a broker dark pool scandal.
High-Fine	A binary variable that takes a value of one for all brokers involved in a dark pool scandal that led to fines and disgorgement of more than $40 million and zero otherwise.
Execution-Only	A binary variable that takes a value of one for execution-only brokers involved in dark pool scandals and zero otherwise.
Monitoring	A binary variable that takes a value of one in year *t* if total commissions for a mutual fund or pension fund in year *t*-1 are above the median in that year and zero otherwise. Funds with total commissions below the median are defined as non-monitoring.
Top 5 Broker	A binary variable that takes a value of one for a fund-broker pair in year *t* if the broker is one of the top five brokers reported by the fund in year *t*-1 and zero otherwise.
Long (Short) Relationship	A binary variable that takes a value of one for a mutual fund-broker pair in year *t* if the length of the prior relationship between the broker and the mutual fund is above (below) the median across all broker-fund pairs in the same year and zero otherwise. In each year *t*, the length of the prior relationship between a mutual fund and a broker is defined as the number of years between 1995 and year *t*-1 that the broker is one of the top ten brokers reported by the mutual fund.
Broker Pricing	The median commission per share for a broker across pension funds reporting both commissions and shares traded for that broker in that year. For each broker in each available fund-year, commissions per share is calculated by dividing commissions for the broker by the shares routed to the broker, as reported in the Comprehensive Annual Financial Report (CAFR). *Broker Pricing* for each year *t* is then defined as the median of commissions per share in year *t*-1. To reduce the effects of possible data errors, the median is computed after eliminating observations outside the 5^{th} and 95^{th} percentiles.
Broker Centrality	The eigenvector centrality of a broker in the network of fund-broker relations. In each year, we use brokerage commission payments to map the network of funds with their institutional clients, with networks analyzed separately for mutual funds and pension funds. As described in Han et al. (2024), these networks can be represented by means of weighted bi-partite graphs, and a bi-partite graph is represented in our setting by an adjacency matrix in which rows index funds and columns index brokers. Each element of the adjacency matrix, a_{ij}, represents the strength of the connection between fund *i* and broker *j*, which we define as commissions paid by fund *i* to broker *j* divided by the norm of the vector of commissions paid by all funds to broker *j*. *Broker Centrality* is then defined for each year *t* as the principal eigenvector of the adjacency matrix in year *t*-1.
Chg in Broker Services	The change in the number of services offered by a broker to its institutional clients in year *t* relative to year *t*-1. For each year, a broker is assumed to provide services as an investment adviser, administrator, underwriter, servicing agent, custodian, or dealer, if any mutual fund identifies the broker as providing that service, as reported in NSAR questions 8, 10, 11, 12, 15, and 22, respectively.

Internet Appendix for

"The Role of Reputation in Financial Markets: The Impact of Broker Dark Pool Scandals on Institutional Order Routing"

Robert Battalio, Shane Corwin, Robert Jennings, Emanuele Rizzo, and Rafael Zambrana

This appendix provides additional analysis to support the main text. The contents include the following:

Internet Appendix Table IA.1: Identification of Dark Pool Event Announcement Dates

This tables provides excerpts from the earliest article found related to each dark pool event in the sample. These articles are used to identify the announcement date associated with each event.

Pipeline – October 24, 2011

Nature of Violation: Failed to disclose role of affiliate in trading

Reuters.com on October 24, 2011: "Pipeline Settles SEC Case." By Sarah Lynch.

"SEC charges Pipeline with misleading investors. Pipeline to pay $1 million to settle charges. Pipeline executives to pay $100,000 each. This marks first-ever SEC case against a dark pool."

"Pipeline, unlike many of the other successful U.S. dark pools, is not run by a larger bank. It competes with Investment Technology Group's Posit and Liquidnet and others for larger blocks of stock traded by institutions looking to hide their intentions from the wider marketplace, where far smaller-sized trades are done."

Traders Magazine on December 1, 2011: "Pipeline Fine Shocks Trading World." By Editorial Staff.

"Traders were shocked this year when Pipeline Trading Systems agreed to pay $1 million to settle charges brought by the Securities and Exchange Commission. Regulators alleged the company failed to disclose that, at times, more than 97 percent of the orders in its dark pool were filled by a trading operation affiliated with the firm."

"People were using that pool with an expectation that it was natural liquidity," said one veteran broker. "Maybe Pipeline thought what they were doing was fair, but it's disappointing."

Liquidnet – June 22, 2012.

Nature of Violation: Failed to protect customer trade information

Law306.com on June 22, 2012: "Liquidnet Says Dark Pool Disclosures Drew SEC Reproach." By Max Stendahl.

"Liquidnet Holdings Inc., the operator of a so-called dark pool stock trading network, revealed Friday that the U.S. Securities and Exchange Commission had faulted it for disclosing information about the trading habits of its members. The SEC recently inspected Liquidnet and determined it had improperly provided "descriptive characteristics" about member clients to corporations that use the trading platform to sell and buy back their shares, company spokeswoman Melissa Kanter said. She said the inspection was not related to Liquidnet's core trading business."

Knight Capital Group – August 2, 2012

Nature of Violation: Trading error

New York Times on August 2, 2012: "Knight Capital Says Trading Glitch Cost it $440 Million." By Nathaniel Popper

"The Knight Capital Group announced on Thursday that it lost $440 million when it sold all the stocks it accidentally bought Wednesday morning because a computer glitch. The losses are threatening the stability of the firm, which is based in Jersey City. In its statement, Knight Capital said its capital base, the money it uses to conduct its business, had been "severely impacted" by the event and that it was "actively pursuing its strategic and financing alternatives." The losses are greater than the company's revenue in the second quarter of this year, when it brought in $289 million. "With the events of yesterday, you have to question if this is the beginning of the end for Knight," said Christopher Nagy, founder of the consulting firm KOR Trading."

Internet Appendix Table IA.1 – Continued

Level (eBX) – October 3, 2012

Nature of Violation: Failed to protect customer trade information

Traders Magazine on October 3, 2012: "LeveL ATS Failed to Protect Info on Unexecuted Orders, SEC Says." By Editorial Staff.

The Securities and Exchange Commission charged Wednesday that the operator of the Level ATS failed to protect information about unexecuted orders in its dark pool. The regulator said eBX LLC, which operates the LeveL alternate trading system, did not "protect the confidential trading information of its subscribers," allowing an outside technology firm to use information about LeveL subscribers' unexecuted orders, for its own "business purposes."

Barclays – May 9, 2014.

Nature of Violation: Misled investors about the role of HFTs in trading

WSJ on May 9, 2014: "Goldman, Barclays, Credit Suisse Draw High-Speed Trading Scrutiny: Banks Have Received Requests for Information from N.Y. Attorney General." By Justin Baer and Scott Patterson.

"New York's attorney general is scrutinizing the private stock-trading venues run by Goldman Sachs Group Inc., Barclays PLC, Credit Suisse Group AG and others as part of a probe into whether high-frequency-trading firms have enjoyed unfair advantages over other investors, people familiar with the matter said. The banks have received requests for information from New York Attorney General Eric Schneiderman's office, which is investigating whether high-speed firms made secret arrangements with exchanges and other venues that allow them to gain an edge, the people said."

WSJ on June 25, 2014: "New York Attorney General Sues Barclays Over Stock-Trading Business." By Scott Patterson and Andrew R. Johnson

"New York Attorney General Eric Schneiderman sued British banking giant Barclays for allegedly lying about how it favors high-frequency players in the firm's stock-trading business. The civil suit filed Wednesday alleged that Barclays engaged in fraudulent activity related to a trading venue known as a "dark pool," in which buy and sell orders aren't reported to the public, allowing investors to hide their trading interest and evade faster-moving firms."

Credit Suisse – May 9, 2014.

Nature of Violation: Misled investors about the role of HFTs in trading

WSJ on May 9, 2014: "Goldman, Barclays, Credit Suisse Draw High-Speed Trading Scrutiny: Banks Have Received Requests for Information from N.Y. Attorney General." By Justin Baer and Scott Patterson.

"New York's attorney general is scrutinizing the private stock-trading venues run by Goldman Sachs Group Inc., Barclays PLC, Credit Suisse Group AG and others as part of a probe into whether high-frequency-trading firms have enjoyed unfair advantages over other investors, people familiar with the matter said. The banks have received requests for information from New York Attorney General Eric Schneiderman's office, which is investigating whether high-speed firms made secret arrangements with exchanges and other venues that allow them to gain an edge, the people said."

Internet Appendix Table IA.1 – Continued

Goldman Sachs – May 9, 2014

Nature of Violation: Violation of trade pricing rules

WSJ on May 9, 2014: "Goldman, Barclays, Credit Suisse Draw High-Speed Trading Scrutiny: Banks Have Received Requests for Information from N.Y. Attorney General." By Justin Baer and Scott Patterson.

"New York's attorney general is scrutinizing the private stock-trading venues run by Goldman Sachs Group Inc., Barclays PLC, Credit Suisse Group AG and others as part of a probe into whether high-frequency-trading firms have enjoyed unfair advantages over other investors, people familiar with the matter said. The banks have received requests for information from New York Attorney General Eric Schneiderman's office, which is investigating whether high-speed firms made secret arrangements with exchanges and other venues that allow them to gain an edge, the people said."

Citigroup (Lavaflow) – July 25, 2014

Nature of Violation: Failed to protect customer trade information

New York Times on July 25, 2014: "S.E.C. Says Citigroup Unit Failed to Protect Customer Trading Data." By William Alden

"LavaFlow, a unit of Citigroup that operates an alternative stock trading venue, agreed to pay $5 million to settle charges that it failed to protect the confidential trading data of its customers, the Securities and Exchange Commission said on Friday. The payment includes a $2.85 million penalty that the S.E.C. said was the largest it had levied against an alternative trading system."

UBS – July 29, 2014

Nature of Violation: Misled investors about the role of HFTs in trading

Money.cnn.com on July 29, 2014: "More Banks Caught up in 'Dark Pools' Probe." By Alanna Petroff.

"UBS said Tuesday it is being probed over its alternative off-exchange marketplace, where orders are not made public until they are completed. The Swiss bank said it was cooperating with the U.S. Securities and Exchange Commission, the New York Attorney General and the Financial Industry Regulatory Authority in their investigations. The SEC began investigating UBS in early 2012, focusing on some order types and disclosure practices that the bank says it discontinued around the time the probe began. In addition, UBS noted it was among "dozens of defendants, including broker dealers, trading exchanges, high frequency trading firms, and dark pool sponsors" that could be facing a class action suit filed by traders in a New York federal court."

Deutsche Bank – July 29, 2014

Nature of Violation: Failed to disclose information about dark pool routing

New York Times on July 29, 2014: "UBS and Deutsche Bank Disclose New Inquiries Over 'Dark Pools.'" By Chad Bray

"The long reach of the New York attorney general's office appears to be stretching further into Europe. On Tuesday, the Swiss bank UBS and Deutsche Bank of Germany became the latest banks to disclose that they were facing inquiries from regulators after Attorney General Eric T. Schneiderman of New York sued the British bank Barclays last month over its private stock trading platform, known as a dark pool."

Internet Appendix Table IA.1 – Continued

ITG – July 29, 2015

Nature of Violation: Failed to disclose role of subsidiary in trading

Reuters.com on July 29, 2015. "ITG Sets Aside $20.3 Million Related to Dark Pool Investigation." By John McCrank

"Broker dealer Investment Technology Group said on Wednesday it set aside $20.3 million for a probable settlement with the U.S. Securities and Exchange Commission over rule violations related to its private stock trading venue. The settlement would be a record amount handed out by the SEC related to the operation of a private stock trading platform, or "dark pool." ITG said the SEC was investigating a test program one of the firm's subsidiaries ran from 2010 until mid-2011 that involved proprietary trading inside of ITG's POSIT dark pool against some of its broker clients that the firm did not disclose."

Yahoo.com on July 30, 2015. "ITG Shares Plunge on Likely Dark Pool Settlement with Regulators." By Staff

"Shares of brokerage Investment Technology Group (ITG.N) were down more than 20 percent on Thursday after the company said it had set aside $20.3 million for a probable settlement with regulators related to how it ran its 'dark pool.' ITG disclosed late on Wednesday that the U.S. Securities and Exchange Commission was investigating the lack of disclosure by the firm to its clients that a subsidiary of the agency broker was trading against client orders within ITG's private stock trading venue, or 'dark pool.'"

ITG – August 8, 2018

Nature of Violation: Failed to protect customer trade information

Reuters.com on August 8, 2018. "ITG sets aside $12 million for SEC probe into its U.S. dark pool." By John McCrank

"Agency brokerage Investment Technology Group Inc. ITG.N said on Wednesday it had set aside $12 million for a probable settlement related to a regulatory probe into its U.S. "dark pool," or private stock trading venue. The settlement would be the company's second in recent years with the U.S. Securities and Exchange Commission involving its U.S. POSIT dark pool, following a $20.3 million charge in August 2015. Dark pools allow institutional investors to anonymously trade large blocks of shares without the market moving against them. Over the years the trading venues have evolved to cater to other types of investors and regulatory scrutiny has increased as volumes have grown. The current SEC probe into ITG is focused on several alleged regulatory violations related to disclosures on how its dark pool operated, the underlying technology, and how its data was used, the New York-based company said in a statement."

Citigroup (CORE) – September 14, 2018

Nature of Violation: Misled investors about the role of HFTs in trading

New York Times on September 14, 2018: "Citigroup to Pay $12 Million Over Accusations It Misled Trading Customers." By Emily Flitter.

"Citigroup agreed to pay more than $12 million to settle a regulator's claims that it misled investors who thought they were paying a premium to keep their trading activity shielded from interference by high-frequency traders, the Securities and Exchange Commission has announced. In a civil action filed Friday, the S.E.C. said Citigroup had let two high-frequency trading entities have access to a trading venue called Citi Match, which it had billed as a safe space free of rapid-fire, computer-driven traders. The agency said the presence of the high-frequency traders might have translated into higher prices paid by its other customers. The S.E.C. said Citigroup had failed to tell its customers about the high-frequency traders and, for more than two years, had sometimes routed their trades to venues other than Citi Match without notifying them."

Internet Appendix Table IA.2: Primary Regression Results Excluding Individual Dark Pool Brokers

The table provides results from a linear probability model for the likelihood of downgrade. In each column, we repeat the primary regression results in column (6) of Table 7, excluding one of the sample brokers involved in a dark pool scandal. Results for mutual funds are reported in Panel A and results for pension funds are reported in Panel B. The dependent variable, *Downgrade*, is a binary variable that takes a value of one if the broker is lower on the league table of a fund in a given year than in the previous year and zero otherwise. *Post* is a binary variable that takes a value of one for all post-event years of a fund-broker pair when the broker is involved in a scandal event and zero otherwise. *Post* is equal to zero for all unaffected fund-broker pairs. *High-Fine* is a binary variable that takes a value of one for all brokers involved in reputation shock events that led to fines and disgorgement of more than $40 million and zero otherwise. *Execution-Only* is a binary variable that takes a value of one for execution-only brokers involved in reputation shock events and zero otherwise. Fixed effects are included as reported. *t*-statistics based on standard errors clustered at the broker and fund levels are reported in parentheses. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. Commission league tables are collected for mutual funds from annual NSAR and NCEN filings and for pension funds from Comprehensive Annual Financial Reports (CAFRs). The samples include all fund-broker-year observations for which change in broker rank could be defined and fixed effects could be estimated. Detailed definitions of all variables are provided in Appendix II of the paper.

Panel A: Mutual Funds										
Excluding	Barclays	Citigroup	Credit Suisse	Deutsche Bank	Goldman Sachs	UBS	ITG	KCG	Liquidnet	Pipeline
	(1)	(2)	(3)	(4)	(5)	(10)	(6)	(7)	(8)	(9)
Post × High-Fine	0.079***	0.116***	0.108***	0.100***	0.088**	0.080***	0.096***	0.095***	0.095***	0.095***
	(3.63)	(6.09)	(4.11)	(3.49)	(2.58)	(2.96)	(3.82)	(3.90)	(3.77)	(3.83)
Post × Execution-Only	0.119*	0.141**	0.119*	0.120*	0.120	0.107*	0.198***	0.052	0.134	0.116*
	(1.85)	(2.17)	(1.95)	(1.94)	(1.65)	(1.75)	(2.94)	(1.36)	(1.43)	(1.81)
Post	0.006	-0.019	0.002	0.003	0.009	0.020	0.004	0.006	0.002	0.004
	(0.21)	(-0.67)	(0.08)	(0.10)	(0.24)	(0.63)	(0.14)	(0.18)	(0.05)	(0.13)
Broker Rank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Broker × Fund FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31,273	30,830	30,947	31,433	30,720	31,201	32,514	32,635	32,439	32,948
Adjusted R^2	0.254	0.259	0.259	0.253	0.262	0.257	0.256	0.256	0.257	0.256

Internet Appendix Table IA.2 - Continued

Panel B: Pension Funds										
Excluding	Barclay	Citigroup	Credit Suisse	Deutsche Bank	Goldman Sachs	UBS	ITG	KCG	Liquidnet	Pipeline
	(1)	(2)	(3)	(4)	(5)	(10)	(6)	(7)	(8)	(9)
Post × High-Fine	0.210***	0.210***	0.239***	0.156***	0.172***	0.221***	0.204***	0.202***	0.204***	0.203***
	(3.34)	(3.90)	(5.23)	(4.52)	(4.30)	(4.35)	(4.25)	(4.21)	(4.26)	(4.21)
Post × Execution-Only	0.170***	0.178***	0.171***	0.169***	0.142***	0.190***	0.136***	0.190***	0.177***	0.171***
	(4.15)	(3.87)	(4.17)	(4.04)	(4.07)	(4.28)	(2.77)	(5.30)	(4.12)	(4.12)
Post	-0.049*	-0.055	-0.047	-0.046	-0.018	-0.063*	-0.048*	-0.048	-0.049*	-0.047
	(-1.70)	(-1.55)	(-1.65)	(-1.62)	(-1.23)	(-1.94)	(-1.67)	(-1.66)	(-1.71)	(-1.65)
Broker Rank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Broker × Fund FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	33,888	33,814	33,794	33,861	33,799	33,805	33,959	34,269	34,023	34,496
Adjusted R^2	0.205	0.205	0.206	0.205	0.206	0.205	0.205	0.204	0.205	0.203

Internet Appendix Table IA.3: Description of Sample Pension Funds

The table describes the 77 pension funds in the final sample. Commission data for these funds are collected from the Comprehensive Annual Financial Report (CAFR). The number of brokers reported in the table is after aggregation of broker names.

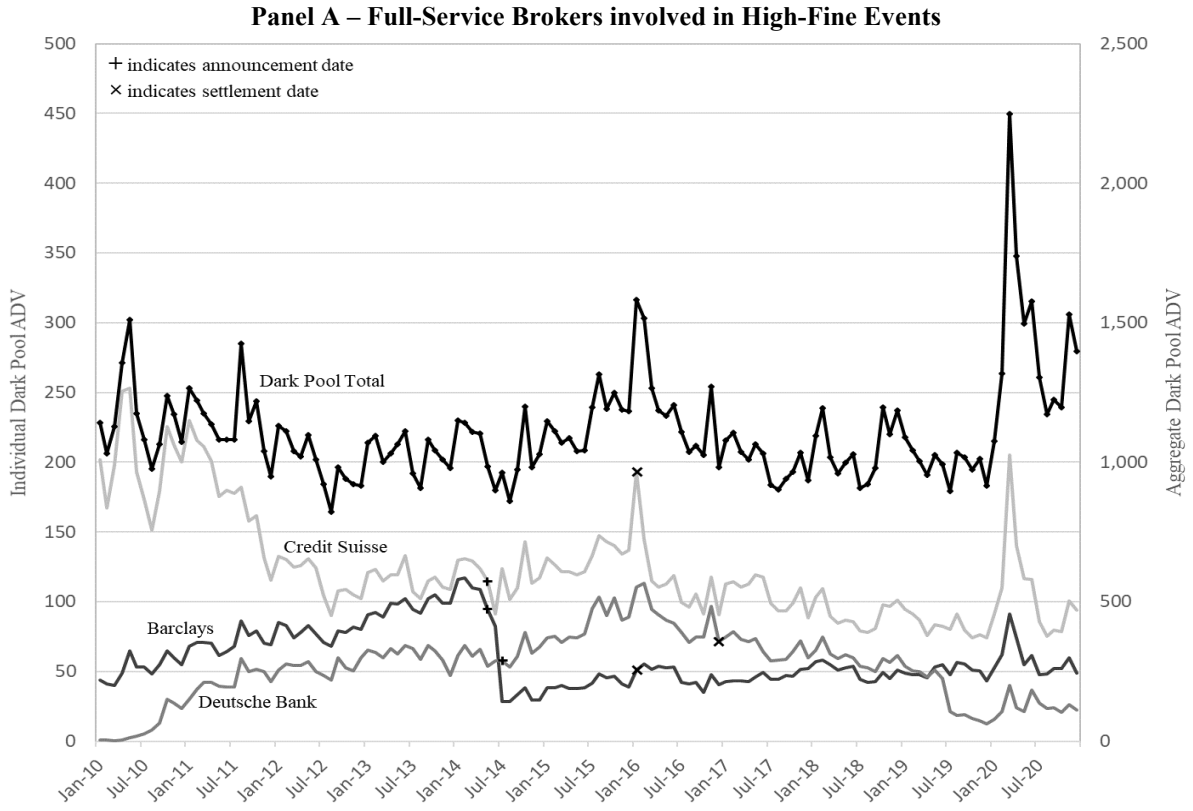
State	Fund Name	Reporting Month	Years in Data	Min # brokers	Max # brokers	Min Annual Commission ($millions)	Max Annual Commission ($millions)
Alabama	Retirement Systems of Alabama	9	11	24	39	0.20	7.62
Arizona	Arizona Public Safety Personnel Retirement System	6	11	17	100	0.09	0.95
	Arizona State Retirement System	6	11	16	60	1.35	6.65
	City of Phoenix, Arizona Employees Retirement Plan	6	11	3	25	0.16	0.70
	Tucson Supplemental Retirement System	6	11	15	36	0.07	0.44
Arkansas	Arkansas Public Employees Retirement System	6	11	20	25	2.00	4.79
California	California Public Employees Retirement System (CALPERS)	6	11	44	158	28.37	50.43
	California State Teachers Retirement System (CALSTERS)	6	11	10	10	19.37	35.45
	Alameda County Employees' Retirement Association	12	11	18	20	1.00	2.88
	City of Fresno Employees Retirement System	6	11	7	10	0.26	0.81
	City of San Jose Federated City Employees Retirement System	6	11	66	128	0.13	1.24
	Los Angeles City Employees Retirement System (LACERS)	6	11	7	10	3.16	6.26
	Orange County Employees Retirement System	12	11	16	37	0.33	1.95
	Sacramento County Employees Retirement System	6	11	13	22	0.67	2.45
	San Bernardino County Employees Retirement Association	6	9	2	9	0.00	1.47
	San Diego City Employees Retirement System	6	11	23	25	0.30	5.58
	San Diego County Employees Retirement Association	6	11	8	18	0.30	4.62
Colorado	Fire & Police Association of Colorado	12	11	26	49	0.43	1.17
	Denver Employees Retirement Plan	12	11	24	69	0.12	0.53
Connecticut	Connecticut Combined Investment Funds	6	11	160	329	5.31	14.39
Delaware	Delaware Public Employees Retirement System	6	11	13	34	0.59	2.23
Hawaii	Employees Retirement System of the State of Hawaii	6	11	22	139	2.18	5.20
Idaho	Public Employee Retirement System of Idaho	6	11	14	25	2.37	5.49
Illinois	Illinois Municipal Retirement Fund	12	11	32	46	6.03	11.92
	Illinois State Board of Investment	6	11	13	64	0.24	3.92
	State Universities Retirement System of Illinois	6	11	57	267	2.94	5.12
	Teachers Retirement System of the State of Illinois	6	11	47	50	5.55	23.16
	Chicago Teachers Pension Fund	6	11	44	68	2.40	7.49
	County Empl. and Officers Annuity & Benefit Fund of Cook Co.	12	11	19	36	1.52	3.19
	Forest Preserve District Empl. Annuity & Benefit Fund of Cook Co.	12	10	14	22	0.03	0.09
	Municipal Employees Annuity and Benefit Fund of Chicago	12	11	18	71	0.77	1.96
	Policemen’s Annuity and Benefit Fund of Chicago	12	11	22	40	0.65	2.08

Internet Appendix Table IA.3 – Continued

State	Fund Name	Reporting Month	Years in Data	Min # brokers	Max # brokers	Min Annual Commission ($millions)	Max Annual Commission ($millions)
Indiana	Indiana Public Retirement System	6	11	8	11	3.46	6.48
Iowa	Iowa Public Employees Retirement System	6	11	22	25	2.88	6.36
Kansas	Kansas Public Employees Retirement System	6	11	11	31	0.40	3.13
	Wichita Retirement Systems	12	11	16	64	0.32	0.50
Kentucky	Teachers Retirement System of the State of Kentucky	6	11	56	94	1.27	3.22
Louisiana	Louisiana State Employees' Retirement System	6	11	24	70	0.92	2.72
Maine	Maine Public Employees Retirement System	6	11	9	14	0.03	1.90
Maryland	Maryland State Retirement and Pension System	6	11	13	29	5.39	16.40
	Baltimore Fire and Police Employees Retirement System	6	11	26	30	0.48	1.07
	Montgomery County Employee Retirement Plans	6	11	8	12	0.24	0.86
Massachusetts	Massachusetts Pension Reserve Investment Trust	6	11	23	25	5.81	11.43
Michigan	Michigan Public School Employees Retirement System	9	11	13	29	1.64	8.41
	Michigan State Employees Retirement System	9	11	13	29	0.43	2.07
Minnesota	Minnesota State Board of Investment	6	11	155	309	7.09	24.61
Mississippi	Public Employees Retirement System of Mississippi	6	11	19	31	4.23	10.45
Missouri	Missouri Dept. of Transportation & Patrol Employees Retirement Syst.	6	11	21	35	0.11	0.26
	Missouri Local Government Employee Retirement System	6	10	13	39	0.99	3.17
	Missouri Public School & Education Employee Retirement Systems	6	11	13	21	5.07	13.91
Nevada	Public Employees Retirement System of Nevada	6	11	24	83	0.18	4.24
New Hampshire	New Hampshire Retirement System	6	11	16	19	1.38	2.34
New Jersey	New Jersey Division of Pensions and Benefits	6	11	10	53	3.57	20.74
New York	New York State and Local Retirement System	3	11	204	245	18.07	29.30
North Dakota	North Dakota Retirement and Investment	6	11	6	10	0.73	1.54
Ohio	Ohio Police & Fire Pension Funds	12	10	18	33	1.80	4.00
	Ohio Public Employees Retirement System	12	11	33	75	6.23	31.92
	School Employees Retirement System of Ohio	6	11	40	49	0.53	2.38
Oklahoma	Oklahoma Police Pension and Retirement System	6	11	16	79	0.14	1.17
	Oklahoma Public Employees Retirement System	6	11	15	20	1.17	1.73
	Oklahoma City Employees Retirement System	6	11	14	21	0.05	1.98
	Tulsa County Employees Retirement System	6	11	4	5	0.04	0.13
Oregon	Oregon Public Employee Retirement System	6	11	18	20	6.99	20.73
Pennsylvania	Pennsylvania Public Employee Retirement System	12	11	21	39	1.90	5.10
	Pennsylvania State Employee Retirement System	6	11	13	26	4.00	17.70
South Carolina	South Carolina Public Employee Retirement System	6	11	9	20	4.26	7.07

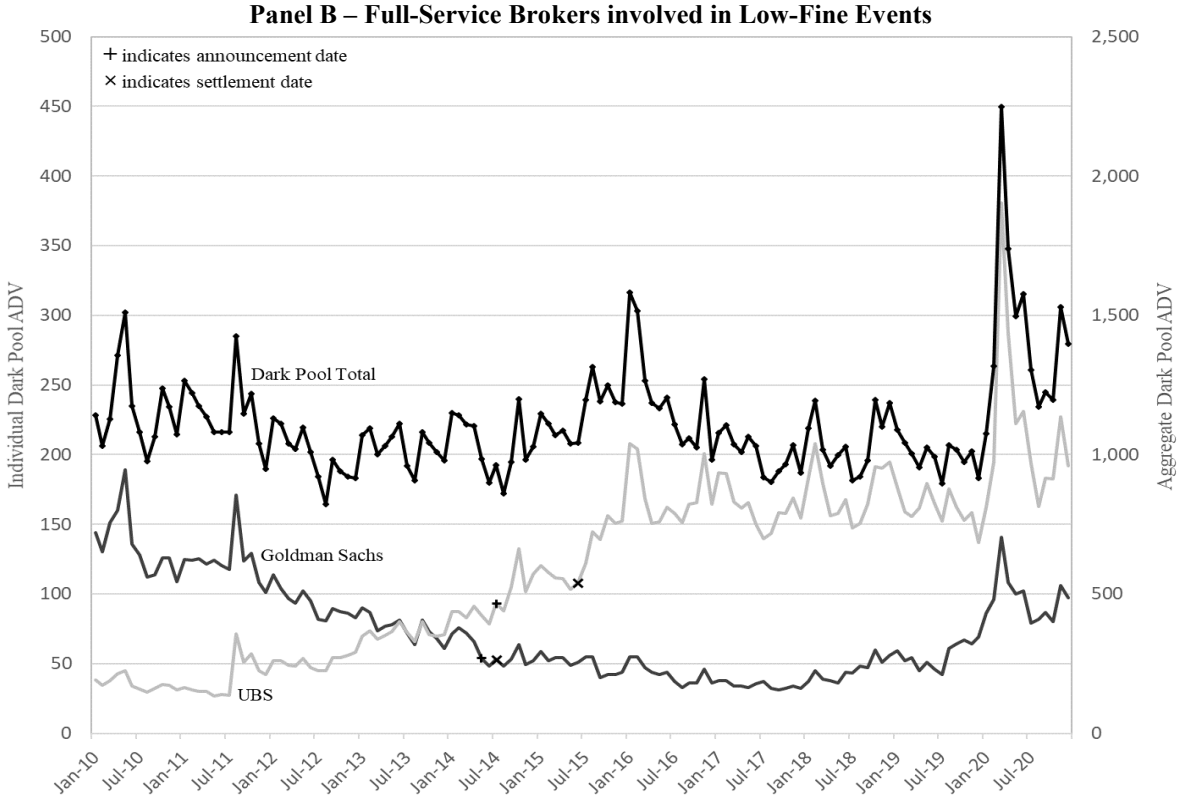
Internet Appendix Table IA.3 – Continued

State	Fund Name	Reporting Month	Years in Data	Min # brokers	Max # brokers	Min Annual Commission ($millions)	Max Annual Commission ($millions)
Tennessee	Tennessee Consolidated Retirement System	6	11	18	26	10.24	18.46
Texas	Texas County and District Retirement System	12	11	10	16	0.75	1.69
	Texas Teachers Retirement System	8	11	10	312	50.27	66.70
	Austin Employee Retirement System	12	11	9	27	0.16	0.97
	Fort Worth Employees Retirement Fund	9	11	34	71	0.27	0.79
	Houston Municipal Employees Pension System	6	11	34	66	0.33	1.12
	Houston Police Officers Pension System	6	10	1	16	0.00	0.59
	Texas Employee Retirement System	8	9	45	55	5.62	11.18
Utah	Utah Public Employee Retirement System	12	11	9	22	2.45	5.79
Virginia	Virginia Retirement System	6	11	8	21	7.01	21.93
Washington	Washington State Department of Retirement Systems	6	11	56	203	4.25	11.79

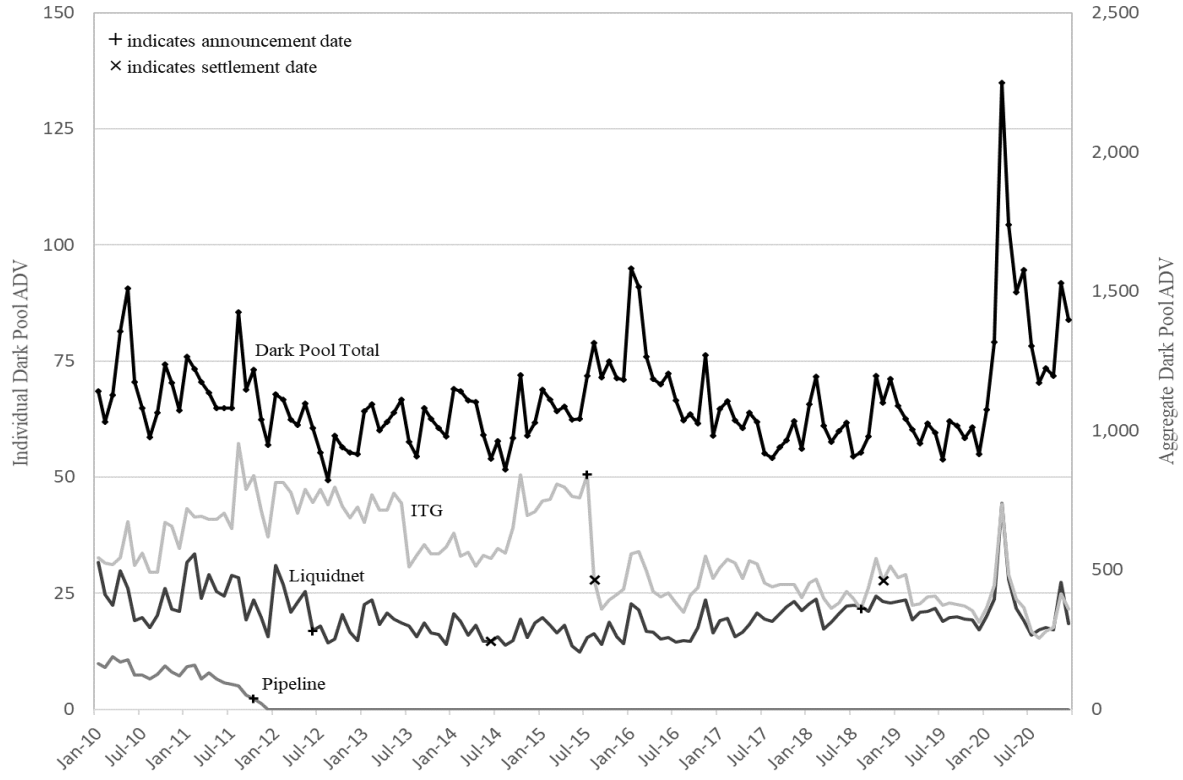


Internet Appendix Figure IA.1 – Monthly Dark Pool Volume around Broker Scandals
The figure plots average daily volume (ADV) by month for broker dark pools affected by scandals (left-hand axis), as well as across all dark pools (right-hand axis). Volumes are in millions of shares. For dark pools operated by full-service brokers, results are provided separately for high-fine events (Panel A) and low-fine events (Panel B), where high-fine events are those resulting in penalties of at least $40 million. Results for dark pools operated by execution-only brokers are provided in Panel C. In addition, the graph indicates the announcement date (+) and settlement date (×) associated with each dark pool scandal. Event descriptions and broker classifications are provided in Table 1 of the paper and additional information on the determination of announcement dates is provided in Internet Appendix Table IA.1. The monthly data are provided by Rosenblatt Securities. KCG and Citigroup dark pools are omitted due lack of available data.

Panel B – Full-Service Brokers involved in Low-Fine Events



Panel C – Execution-Only Brokers



Internet Appendix Figure IA.1 – Continued