The Transformation of Corporate Bond Investors and Fragility: Evidence on Mutual Funds and ETFs

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Investment vehicles offering daily and intraday liquidity now have assets equivalent to traditional long-term investors in the corporate bond market. We examine if this transformation is a potential source of market fragility. Using an idiosyncratic shock caused by monetary policy, we test the impact of unexpected outflows to various investment vehicles on corporate bond yields. Relying on within issuer variation, we find that active and index mutual fund outflows have no effect on asset prices. However ETF outflows lead to flow-driven pressure with the yields of exposed bonds increasing significantly before reverting seven months later. We attribute the differential effect to reduced cash buffers and to greater investment by short-term positive feedback traders in ETFs. Arbitrage is found to be one mechanism by which the risks created by these features are propagated to the underlying market.

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1. Introduction

Fragility resulting from the unintended consequences of financial innovation is a recurring theme in market history (Gennaioli, Shleifer, and Vishny, 2012).[1] Following the most recent financial crisis, there has been heightened academic and regulatory interest in the vulnerabilities created by various non-bank financial institutions. Schmidt, Timmermann, and Wermers (2016) observe that pooled vehicles for which the liquidity mismatch becomes magnified during times of turmoil are especially susceptible to run-like behavior and its consequences. In the years since, the systemically important corporate bond market has seen the assets of nontraditional investors, open end mutual funds and exchange traded funds (ETFs), more than double to nearly match the levels of traditional bond investors, insurance companies. Despite providing diversified exposure to the difficult to access underlying market, the emergence of these investment vehicles has raised historically familiar concerns among market participants due to the daily and intraday liquidity they provide relative to illiquid corporate bonds, a transformation that is anecdotally referred to as the liquidity illusion. For instance, the 2015 Financial Stability Oversight Council annual report lists the expansion of these vehicles as a potential emerging systematic threat and Bill Gross expressed concern regarding an exodus from ETFs.[2] Conversely, the Investment Company Institute argues that asset managers are well aware of their liquidity risks and can manage a buffer to prevent impacting the underlying asset prices and major ETF sponsors deem the risk created to be limited due to structural features that mitigate the funds' interaction with constituent bonds.[3,4]

In this paper we provide unique evidence on the asset price implications of flows to corporate bond mutual funds and ETFs during a period of turmoil. Although mutual and ETFs are both pooled

[1] The authors cite collateralized mortgage obligations in the 1980s and 1990s, mortgage backed securities during the 2000s, and money market funds in 2008 to motivate the theory that innovations sparked by virtues of diversification, tranching, and insurance offer cash flows believed to be good substitutes for the original. Excessive issuance prior to the revelation of news regarding the vulnerability of the new securities to unattended risk results in market fragility.

[2] "The obvious risk—perhaps better labeled the 'liquidity illusion'—is that all investors cannot fit through a narrow exit at the same time," Bill Gross. See: https://www.wsj.com/articles/goldman-sachs-joins-bond-etf-party-1496925000

[3] ICI 2016 Factbook states "There are many reasons to believe [concerns that outflows to bond funds could pose challenges for fixed-income markets] are overstated." The reasons given are aggregate flows offsetting the risk of individual funds, ETFs growing popularity in the space, derivatives usage to manage flows, and management of a liquidity buffer. http://www.icifactbook.org/deployedfiles/FactBook/Site%20Properties/pdf/2016_factbook.pdf

[4] Bill McNabb, CEO of Vanguard, states "This discovery that most ETF share trading does not lead to any activity in the ETF portfolio means the impact of ETFs — and the possibility of disruption or volatility — on the primary market is limited." See: https://www.ft.com/content/53054716-e6e9-11e6-893c-082c54a7f539

investment vehicles, their distinguishing features make the mechanism through which outflows to the funds would impact the pricing of the underlying distinct. For the more familiar mutual funds, investors can redeem shares for cash at the end of day net asset value (NAV). The consequences of the redeeming investor's outflow are borne by the remaining investors and thus create the potential for strategic complementarities. Goldstein, Jiang, and Ng (2015) find that active corporate bond mutual funds are particularly susceptible to this behavior and subsequent runs due to a concave flow to return relationship rather than the convex relationship found in equity mutual funds (Brown, Harlow, and Starks, 1996; Chevalier and Ellison, 1997; Ippolito, 1992; Lynch and Musto, 2003; Sirri and Tufano, 1998). The authors conclude that evidence of a major effect on market prices and potentially real economic activity is needed for these mutual funds to be a major systemic concern.

ETFs are distinguished from mutual funds by their intraday exchange trading, index focus, and in-kind creation and redemption mechanism that facilitates arbitrage between the ETF shares and the underlying basket. These features mitigate concerns of runs induced by strategic complementarities because the exiting shareholder bears the cost of his own actions. Nevertheless, recent theoretical works suggests that the absence of these externalities does not preclude ETFs, from being a potential source of market fragility. Focusing on ETFs backed by hard to trade underlying, Bhattacharya and O'Hara (2016) claim that following the exponential growth of ETF trading, these new vehicles may no longer "simple appendages" to the market, but rather a preferred vehicle capable of affecting markets. Their model emphasizes inter-market information linkages and predicts that ETFs can exacerbate market instability and herding due to imperfect learning and delayed price synchronization. Pan and Zeng (2017) also model ETFs with a liquidity mismatch to the underlying and predict that the dual role of authorized participants (APs) as corporate bond market makers and arbitrageurs creates conflicting incentives that increase fragility. In a dynamic general equilibrium model, Malamud (2016) shows that the creation and redemption mechanism of ETFs can serve as a shock propagation channel through which temporary shocks impact the prices of the underlying.

We start our empirical analysis by investigating if outflows to corporate bond mutual funds and ETFs in response to a period of turmoil create yield spread pressure. The challenge of addressing this issue is that the majority of asset growth in both investment vehicles has occurred during the post crisis bond bull market, limiting the number of unanticipated exogenous shocks to the funds and their investors. However, in the summer of 2013 the Federal Reserve unexpectedly proposed ending its bond buyback program known as, quantitative easing (QE). The change in expectations about monetary policy led investors to alter their perception of risk. Investors responded to the potential for higher interest rates by withdrawing from bond funds, in an episode commonly referred to as the Taper Tantrum. According to Lipper, the uncertainty in timing and scope of the Fed's QE withdraw led to $8.6 billion in outflows from taxable bond mutual funds and ETFs for the week following the Fed's announcement and $23.7 billion over four weeks, the sharpest four-week exodus since the height of the financial crisis. Studying this event, Feroli, Kashyap, Schoenholtz, and Shin (2014) develop a model in which active managers motivated by relative performance respond to changes in monetary policy in a manner similar to bank runs. Empirically the authors find evidence of aggregate run dynamics.

Using this exogenous shock as a quasi-natural experiment we first examine if outflows to corporate bond mutual funds and ETFs have an impact on the pricing of their underlying. Following the identification strategy of Coval and Stafford (2007), Mitchell, Pulvino, and Stafford (2004), and Lou (2012), we study if outflows to either vehicle during the summer of 2013 create yield pressure that is subsequently reversed. In addition to controlling for observable bond characteristics and liquidity, the inclusion of issuer level fixed effects is key to our identification similar to Manconi, Massa, and Yasuda (2012). Relying on within issuer variation, we effectively compare a bond potentially exposed to fund-induced pressure to an unexposed bond issued by the same firm. We document that outflows from mutual funds have no significant effect on corporate bond yield spreads in the months following the Taper Tantrum. In contrast, we identify significant yield pressure created by ETF outflows. Our findings suggest that a one standard deviation increase in ETF outflows during the summer of 2013 leads to a 12.6 basis point increase in the yield spread of corporate bonds in September 2013. Economically, this implies a 10.7% increase in the yield spread of the average corporate bond in our sample. We document that the effect is temporary, with the significantly higher yield spreads lasting seven months before reverting back to pre-tantrum levels. The transient nature of the yield pressure implies that fund flows cause bonds to momentarily trade at non-fundamental values.

Our analysis continues by attempting to identify which of the distinguishing characteristics of ETFs contribute to the differential impact of their investors' response to the shock on the pricing of underlying bonds. In particular, we examine the index focus of most ETFs, the appeal of intraday trading to short horizon investors, and the portfolio construction and arbitrage implications of the in-kind creation and redemption mechanism. First, an index strategy reduces the flexibility of the manager's response to flows because their objective is to minimize the tracking error rather than to maximize fund returns (Christoffersen, Keim, and Musto, 2008; Elton, Gruber, and Busse, 2004). If the index strategy of ETFs was responsible for the flow-driven price pressure, index mutual funds that follow the same mandate would exert similar pressure on their underlying corporate bonds. Decomposing our mutual fund sample into active and index strategies, we find that Taper Tantrum outflows to neither subset has a significant impact on the yield spread of their holdings in the following months. The insignificance of this characteristic may be attributed to the increased flexibility of the representative sampling technique of most bond index funds or portfolio construction strategies explored below.

Second, intraday trading of ETFs on an exchange may attract a distinct investor base. As described by Chordia (1996), Deli and Varma (2002) and Nanda, Narayanan, and Warther (2000) funds adopt different structures to appeal to the stochastic liquidity needs of investors. Following Poterba and Shoven (2002), we posit that the intraday exchange trading of ETFs is likely to attract short-term traders, who are theorized by Allen, Morris, and Shin (2006), De Long, Shleifer, Summers, and Waldmann (1990a), Froot, Scharfstein, and Stein (1992) and Stein (2005) to focus on the behavior of other investors, rather than on long-term fundamentals. As described by Cella, Ellul, and Giannetti (2013), during normal market conditions the presence of short-horizon investors in ETFs should not affect underlying bonds because other investors readily provide liquidity. However, in periods of turmoil short horizon investors are expected to sell en masse (Bernardo and Welch, 2004; Morris and Shin, 2004). Therefore, if short-horizon investors self-select into ETFs, the underlying bonds held may be exposed to different flow pressures. Using a longer sample period from January 2010 to March 2015, we first document that ETF flows are more volatile, particularly during the Taper Tantrum, than mutual fund flows.[5] Next, we seek to provide further evidence of short term trading in ETFs by examining if feedback trading, i.e investors increasing flows in periods of rising markets (lower interest rates) and decreasing flows in periods of declining markets (higher interest rates), is more prevalent in the behavior of ETF investors than mutual fund investors. Specifically, we regress flows on lagged changes in one- and five-year Treasury rates, an ETF dummy, the interaction between

[5] Alternative measures of investor horizon found in the literature, including fund turnover and churn, are not as applicable to studies of ETF because the fund itself rarely trades in the underlying.

interest rate changes and the ETF dummy, as well as, controls for lagged fund flows, returns, the average rating and duration of fund holdings, fund turnover, and expense ratio. The coefficient on the interaction term is negative and significant, implying that ETF investors are more sensitive to common market shocks and engage in positive feedback trading by withdrawing funds from ETFs when interest rates increase (prices decrease) that is theorized by De Long, Shleifer, Summers, and Waldmann (1990b) to be potentially destabilizing.

Third, while mutual funds deal directly with all investors through fund share and cash transactions, ETFs only interact with APs through the in-kind creation and redemption mechanism, known as the primary ETF market. ETF creation (redemption) occurs when an AP buys the pre-specified basket of the underlying securities (ETF shares) and exchanges them for a block of ETF shares (underlying basket). The reliance of ETFs on this mechanism has important implications for both portfolio construction and arbitrage. First, because ETFs generally do not need to provide cash on demand they may invest more in benchmark securities allowing them to minimize tracking error. In contrast, mutual funds have an incentive maintain a liquidity buffer, which is shown by Chen, Goldstein, and Jiang (2010), Hoseinzade (2015), and Liu and Mello (2011) to mitigate the adverse effect of investor flows for mutual funds and hedge funds during periods of volatility. Comparing the percentage of assets allocated to different investments in the reporting period prior to the Taper Tantrum, we find that the median mutual fund holds 21.72% of its assets in cash and government bonds, compared to just 2.74% for ETFs, a difference that is both statistically and economically significant. The statistically significant difference remains when comparing only index funds to ETFs. Further, for mutual funds and ETFs in the lowest quartile of flows during the Taper Tantrum, the median mutual fund had 19.77% of its assets in liquid holdings compared to just 8.42% for ETFs, although the difference in Treasuries is not statistically significant. The lack of flow-based yield pressure for mutual funds in the Taper Tantrum suggests that fund managers utilized their liquidity buffer to meet redemption requests without selling corporate bonds at potentially distressed prices, similar to the financial crisis results of Hoseinzade (2015). Nevertheless, we do not rule out that the liquidity management techniques of mutual fund managers would be sufficient in a prolonged market shock in this new corporate bond market regimen.

The primary market also enables APs to engage in arbitrage between the ETF market price and NAV. While arbitrage should be instantaneous, when ETFs are backed by hard to trade assets it is not the case (Bhattacharya and O'Hara, 2016). The persistence of any deviation between the two assets is predicted by the limits to arbitrage literature to be the result of noise trader risk (De Long, Shleifer, Summers, and Waldmann, 1990a), synchronization risk (Abreu and Brunnermeier, 2003), liquidation risk (Shleifer and Vishny, 1997), transaction costs (Pontiff, 1996), and short sale constraints (Ofek and Richardson, 2003). Further theories from Greenwood (2005), Hong, Kubik, and Fishman (2012), Hugonnier and Prieto (2015) and Kyle and Xiong (2001) demonstrate how arbitrageurs can propagate shocks.

To test the impact of imperfect arbitrage on constituent bonds, we first document that ETF arbitrage was impaired for certain funds by splitting ETFs into two groups based on the average percentage price to NAV deviation during the turmoil period. We show that those ETFs with the largest Taper Tantrum discounts, which we denote high arbitrage exposure, traded at slight premiums prior to the event before selling pressure pushed the market price significantly below the underlying NAV. Comparing the characteristics of the ETFs prior to the Taper Tantrum shows that the two groups hold bonds with similar credit quality, but the high exposure group has bonds with greater effective duration for which we would expect a larger yield response. ETFs in the high arbitrage opportunity group have similar volatility of flows and institutional ownership, but fewer assets under management, and higher bid ask spreads suggestive of known limits to arbitrage (Gromb and Vayanos, 2010). Interestingly, the difference in the proxy for AP arbitrage activity from Da and Shive (2013) is insignificant prior to the event, but arbitrage for the high discount ETFs is significantly lower during the Taper Tantrum when the arbitrage opportunity is most profitable.

To test the impact of impaired arbitrage on the underlying bonds, we calculate the holdings-weighted exposure of a bond to ETFs with persistent arbitrage exposure during the tantrum. Then we split the bonds in our sample based on their exposure to Taper Tantrum induced arbitrage opportunity. Those bonds with the lowest exposure, i.e. held by ETFs trading at a discount are deemed high ETF arbitrage exposure bonds. We then regress the yield spread for each month of the Taper Tantrum through March 2015 on a high arbitrage exposure dummy and in the multivariate regression, we control for time to maturity, rating, and the Amihud illiquity measure. We find that the yield spreads of the two groups are not significantly different in the Taper Tantrum period, but as the turmoil mitigated and the price of the ETF and its NAV converge the yield spreads of exposed bonds are significantly higher for ten months before reverting. Therefore we conclude that ETF arbitrage serves as a shock propagation mechanism when arbitrage is limited in a period of turmoil.

Our results contribute to the growing research on ETFs, by identifying another possible unintended risk created this popular investment vehicle. The arbitrage response to noise traders is shown by Ben-David, Franzoni, and Moussawi (2014) to increase stock volatility and by Brown, Davies, and Ringgenberg (2016) to lead to predictable returns. Additional studies of equity ETFs find that they increase co-movement Da and Shive (2013), lower the benefit of information acquisition Israeli, Lee, and Sridharan (2016), and decrease liquidity (Hamm, 2014). Further this paper expands the empirical literature on corporate bond ETFs. To date, Dannhauser (2016) documents that ETF constituency lowers bond yields, but has an insignificant or negative impact on the underlying due to the migration of liquidity traders from the underlying market to ETFs.

The paper also adds to a broader literature that studies asset price movements induced by financial institutions and arbitrageurs, by identifying the short-horizon investors and imperfect arbitrage of ETFs as a new source of price pressure in corporate bonds. In the stock market, equity funds are shown to move underlying stock prices in a variety of settings (Ben-Rephael, Kandel, and Wohl, 2011; Coval and Stafford, 2007; Greenwood and Thesmar, 2011; Jotikasthira, Lundblad, and Ramadorai, 2012; Lou, 2012). Brunnermeier and Nagel (2004) and Griffin, Harris, Shu, and Topaloglu (2011) also study a single event to document that traditional arbitrageurs, hedge funds, amplified rather than stabilized the technology bubble of 2000. Cella, Ellul, and Giannetti (2013) focus on the Lehman bankruptcy to show that stocks held by short-horizon investors experience greater price pressure. In the corporate bond market Manconi, Massa, and Yasuda (2012) find that investors holding securitized bonds in the crisis depressed the prices of corporate bonds and Ellul, Jotikasthira, and Lundblad (2011) find evidence of fire sales by regulatory and financially constrained insurance companies. In broader studies Ambrose, Cai, and Helwege (2012) and Hoseinzade (2015) find no evidence of yield pressure in corporate bonds by insurance companies and mutual funds, respectively.

2. Background

This section provides a detailed discussion of the corporate bond market and its participants, both traditional and nontraditional. In particular, we first focus on the evolution of the market and the emergence of mutual fund and ETF investors. Then we detail the Taper Tantrum of the summer of 2013, which we use as an exogenous shock to fund flows.

2.1. The transformation of the corporate bond market

Since the financial crisis, the corporate bond market has undergone a radical change. Foremost, beneath the backdrop of historically low interest rates corporations have increased their debt issuance. According to the Securities Industry and Financial Markets Association (SIFMA), the amount of corporate debt outstanding has increased 150% since 2000. Panel A of Figure 1 presents the growth in corporate bond assets outstanding and the annual issuance.

[Insert Figure 1]

Second, regulatory pressure has altered the dynamics of the historically opaque market. Traditionally, broker-dealers held large inventories in order to facilitate trades with institutional investors, the majority of who were insurance companies and pension funds characterized by Bessembinder, Maxwell, and Venkataraman (2006) as long-horizon investors. Bid-ask quotes and transaction prices were not readily available until the introduction of the Trade Reporting and Compliance Engine (TRACE) in July 2002. Despite the introduction of delayed trade reporting, Bessembinder, Maxwell, and Venkataraman (2006), Edwards, Harris, and Piwowar (2007) and Goldstein, Jiang, and Ng (2015) all document that corporate bonds trade infrequently, particularly relative to equities and other fixed income investments. Pressured by increased capital requirements the broker-dealer inventory has decreased by more than 50% (Dick-Nielsen and Rossi, 2016). The impact of traditional market makers withdrawal on liquidity is uncertain with practitioners claiming that markets are increasingly illiquid and Anderson and Stulz (2017) and Bao, O'Hara, and Zhou (2016) finding evidence of greater illiquidity in periods of stress. Conversely, Bessembinder, Jacobsen, Maxwell, and Venkataraman (2016) find that liquidity is not significantly lower since the crisis, but that the traditional commitment structure is changing.

Third, as the corporate bond market structure has evolved, nontradional investors, mutual funds and ETFs have emerged as increasingly important investors.[6] The accumulation of assets by

[6] Bloomberg documents the change in the post-crisis bond market model as a transition of power from banks to mutual funds, hedge funds, and exchange traded funds. They state that regulations have paved the way for the buy-side "to exert more influence than ever on markets." See: https://www.bloomberg.com/news/features/2016-08-15/the-rise-of-the-buy-side

these funds, whose investment strategy and investor base is significantly different than traditional investors has implications for the underlying market because of the liquidity they provide their investors and thus the liquidity they may demand. Panel B of Figure 1 plots the Federal Reserve Board data on the amount of corporate and foreign bonds held by two groups. The figure shows that the assets held by mutual funds and ETFs are now equal to those of insurance companies. Panels C and D of Figure 1 present details on the growth of mutual funds and ETFs, including the number of funds and assets under management of all long-term taxable bond funds from ICI FactBook, as well as, corporate bond specific assets from the Federal Reserve Board. From these figures it is evident that a large portion of growth in these investment vehicles has occurred since 2009 with the corporate bond assets of mutual funds doubling and ETF corporate bond assets quadrupling.

Given the focus of this paper on mutual funds and ETFs, an extended discussion of their structures is needed. At the most basic level, mutual funds and ETFs are investment vehicles backed by a basket of corporate bonds. Mutual funds are distinguished by their investment mandate as either active mutual funds, who attempt to outperform their benchmark, or passive mutual fund, who attempt to replicate their benchmark. Regardless of the type of mutual fund, investors are provided with daily liquidity. That is an investor can submit a buy or sell order for the mutual fund shares at any point throughout the day and all transactions will occur at the closing NAV.

Corporate bond ETFs, the first of which was introduced in June 2002, are a hybrid between traditional open-end mutual funds and closed end funds (CEFs). The unique features of ETFs allows them to offer lower management fees, greater transparency, and tax efficiencies to attract investors (Poterba and Shoven, 2002). ETFs provide liquidity to investors in two venues, the primary and secondary markets. The primary market is used by ETFs to handle liquidity shocks in the secondary market, to ensure that orders are filled, and to arbitrage excessive market price deviations from NAV. This market is the direct channel linking ETFs to the underlying. It involves large transactions between APs and the fund sponsor through the in-kind creation and redemption process. In contrast, the creation and redemption process of mutual funds occurs between the fund and individual investors as an exchange of cash for individual units of the underlying basket. The secondary market of ETFs, is where buyers and sellers of the ETF transact directly on the equity exchange without any fund involvement. It is possible that investors with access to the corporate bond market can also engage in risky arbitrage between the secondary ETF market and the underlying market.

In Table 1 we present summary statistics for mutual funds in Panel A and ETFs in Panel B. While the holdings of mutual funds and ETFs have similar duration and credit quality, the distribution of fund characteristics validates the common refrain surrounding ETFs relative to mutual funds. For instance, ETFs have expense ratios and turnover that are more than half of the mean level of mutual funds reflecting the relative simplicity of ETF management. In addition, ETFs have a much greater percentage of fund assets invested in corporate securities that mutual funds and lower levels of cash and government bond investments. Interestingly, the mean assets under management of ETFs is lower than mutual funds, while the median is significantly lower, reflecting the concentration of ETF assets in the largest funds.

2.2. The Taper Tantrum as an exogenous shock to fund flows

An empirical challenge of identifying potential vulnerabilities created by this new corporate bond market regimen is the absence of market shocks and resultant fund flows during the unprecedented bond market since the financial crisis. Nevertheless, the Taper Tantrum of the summer of 2013 serves as our exogenous market-wide shock. Prior to this event, bond funds saw disproportionate inflows relative to other asset classes as the Federal Reserve employed unprecedented policy initiatives such as open market purchases of government bonds and mortgage-backed securities, a process commonly referred to as quantitative easing (QE). The QE program in place since November of 2008 was intended to lower long-term interest rates in an effort to bolster housing markets, employment, and real activity. Following positive economic developments, Chairman Ben Bernanke testified on May 22, 2013 that the Federal Reserve would likely begin slowing or tapering the pace of its bond purchases conditional on continued economic stability. On June 19, 2013 the Chairman held a news conference to document the economic justification for the purchase slowdown. Convinced that the end of QE was near, the market responded by selling assets, in an episode commonly compared to a tantrum. Between May 21, 2013 and the beginning of September both the five- and ten-year Treasuries increased over 100 basis points. Beyond the Treasury rate, investors anticipating a sharp reevaluation of risk took advantage of the liquidity provisions of mutual funds and ETF by swiftly withdrawing assets. According to Trim Tabs Investment Research, a record $69 billion was withdrawn from bond mutual fund and ETFs in June 2013, with outflows continuing throughout July and August. The period of uncertainty was resolved on September 18, 2013 when the Fed officially announced it would wait to begin scaling back the QE program.

[Insert Figure 2]

3. Data

Our corporate bond fund data begins in January 2010, in order to study a period in which the assets managed by these two investment vehicles is no longer negligible, and ends in March 2015. We begin by identifying corporate bond funds using the Center for Research in Security Prices (CRSP) Survivor-Bias-Free US Mutual Fund Database. In particular, we denote any mutual fund or ETF that as an average corporate bond weighting of twenty percent or greater as a corporate bond fund. We also collect fund characteristics from the Morningstar Mutual Fund Database, including the number, the concentration, the average duration, and the average credit quality of the bond holdings. Matching on fund cusip, we then use CRSP to obtain fund holdings, monthly returns, monthly fund assets, turnover, expense ratio, and share class data. Furthermore, we use the CRSP database to distinguish ETFs from mutual funds and to distinguish active and index mutual funds. Using this data we follow the literature to compute the flow to each fund, f, in month, t, as

$$Flow_{f,t} = \frac{TNA_{f,t} - TNA_{f,t-1} * \left(1 + R_{f,t}\right)}{TNA_{f,t-1}} \tag{1}$$

For mutual funds with multiple share classes we aggregate data at the portfolio level by summing fund assets, and value weighting other characteristics.

We use the Trade Reporting and Compliance Engine (TRACE) database to obtain bond transaction data. Using the method of Dick-Nielsen (2009), we filter out possibly erroneous trades. We compute the monthly spread of bond i from issuer j in month t, $Spread_{i,j,t}$ as the volume weighted average yield reported for all transactions in a month over the maturity-matched Treasury rate. We also use the TRACE database to compute the our liquidity proxy, $Amihud_{i,j,t}$ developed by Amihud (2002), which measures the price impact of a \$1 million trade. Specifically, for bond i from issuer j in month t the proxy is computed as the median of the daily measure

$$Amihud_{i,d} = \frac{1}{N_d} \sum_{d=1}^{N_d} \frac{|r_d|}{v_d} * 10^6, \tag{2}$$

where N_d is the number of returns on day d, r_j is the return of consecutive transactions, and v_d is the dollar volume of a trade. This measure can be interpreted as the basis points price movement per one million dollars of traded volume. Bond characteristics come from the Merchant Fixed Income Securities Database (FISD) and are merged on eight-digit CUSIP. In addition, for each bond we create an average rating using numerical conversions of Standard & Poor's (S&P) ratings.

Finally, we obtain the daily shares outstanding of ETFs from Bloomberg. We use the shares outstanding to compute the Da and Shive (2013) creation and redemption intensity measure, $CRI_{i,t}$. The measure is calculated using the shares outstanding for the set ETFs k in month t as

$$CRI_{k,t} = \frac{\sigma(shrout)_{k,t}}{\mu(shrout)_{k,t}}. \tag{3}$$

Creation and redemption could drive underlying liquidity because authorized participants need to compile or sell baskets of the underlying security to maintain the ETF. The activity associated with *CRI* reflects the direct involvement of the affiliates of the ETF in a bond.

4. Methodology and results

This section details the methodology and presents the results on the impact of Taper Tantrum flows to mutual funds and ETFs on the yield spreads of associated bonds. We begin by considering the yield spread effects of each investment vehicle and then examine three potential explanations for our main results.

4.1. The yield spread effect of mutual funds and ETFs

Our empirical analysis begins by examining if outflows during the summer of 2013 following the Federal Reserve announcement, have an impact on the pricing of constituent bonds. We follow the methodology of Coval and Stafford (2007) and Mitchell, Pulvino, and Stafford (2004), by running the tests over several months to look at cumulative returns and subsequent reversals to provide evidence of a non-fundamental shock to prices. Specifically, for each investment vehicle in each of the t months following the summer of 2013, we run the regression

$$\left(Spread_t - Spread_{May}\right)_{i,j}$$
$$= \alpha + \lambda_j + \beta_1 Fund\ Outflow_{i,Tantrum} + \beta_2 Fund\ Outflow^2_{i,J,Tantrum} + \beta_3 Log(Size)_{i,May}$$
$$+ \beta_4 Time\ to\ Matrity_{i,May} + \beta_5 Time\ to\ Maturity^2_{i,May} + \beta_6 Amihud_{i,May}$$
$$+ \beta_7 Spread_{i,May} + \beta_8 \left(Time\ to\ Maturity_{May} * Fund\ Outflow_{Tantrum}\right)_i$$
$$+ \beta_9 \left(Amihud_{May} * Fund\ Outflow_{Tantrum}\right)_i + \epsilon_{i,j,t}. \quad (4)$$

The dependent variable, $\left(Spread_t - Spread_{May}\right)_{i,j}$, is the change in the volume-weighted average yield of bond, *i,* from issuer *j* over the maturity-matched Treasury rate. The change is measured relative to the bond's volume-weighted yield in May excluding all transactions post May 21, the day prior to Bernake's testimony.

The covariate of interest is $Fund\ Outflow_{i,Tantrum}$, the weighted-average monthly flow for either all mutual funds or all ETFs that report bond *i* as a holding prior to the onset of the event. We multiply the measure by -1 to help with interpretation of the coefficient of interest, β_1, which measures the impact of Tantrum outflows to either mutual funds or ETFs on a bond's yield spread relative to pre-event levels. To be included in the regression we require the weighted average flow to be negative, i.e. an outflow. The square of $Fund\ Outflow_{i,Tantrum}$, is used to control for any potential nonlinearities in the relationship of interest

As in Manconi et al. (2012), the inclusion of issuer fixed effects, λ_j addresses endogeneity issues associated with changes in the fundamentals of an issuer. The use of issuer fixed effects, controls for any differential changes in firm fundamentals during our turmoil event by allowing us to effectively compare the change in yield spreads of bonds from the same issuer subjected to different levels of fund induced pressures. Therefore, if a firm has only one outstanding issue subjected to outflows, it automatically drops out of the analysis.

We also include a vector of bond specific characteristics set to their pre-event levels to control for differences in issues from the same firm. We control for the log of the issue size in millions of dollars, *Log(Size),* the number of years left to maturity and its square, *Time to Maturity*, and the liquidity level of the issue using the Amihud illiquidity measure, *Amihud*. The yield spread of the bond prior to the event, $Spread_{May}$ is also used to account for differences in bonds from the same issuer that are not captured by our other controls, for instance differences in covenants. Finally, we include interactions to account for the likelihood that investors sell bonds with higher interest rate exposure, $\left(Time\ to\ Maturity_{May} * Fund\ Outflow_{Tantrum}\right)_i$, and greater liquidity, $\left(Amihud_{May} * Fund\ Outflow_{Tantrum}\right)_i$.

Using equation (4), we run the regression for mutual funds and ETFs separately to identify the impact of each investment vehicle on their underlying bonds. Table 2 presents the results for ETFs in Panel A and mutual funds in Panel B. The results show that there is no significant effect or distinguishable pattern for mutual fund outflows. Conversely, ETF outflows drive spreads significantly higher for up to seven months beyond the event. In September 2013, as the Taper Tantrum subsided, bonds with a one percentage increase in exposure to ETF outflows had yield spreads 8.7 basis points higher than a bond from the same issuer. This corresponds to a 12.6 basis point increase in yield spread relative to bonds from the same issuer for a one standard deviation greater exposure to ETF outflows during the summer of 2013. Economically, this implies a 10.7% increase in the yield spread of the average corporate bond in our sample. The statistical significance in the difference diminishes after seven months with yield spreads reverting to their pre-crisis level.

[Insert Table 2]

In Figure 3, we plot the impact of a one standard deviation outflow to ETFs in Panel A and mutual funds on Panel B on the yield spread of bonds in our regression. The figure shows the impact of outflows during the Taper Tantrum period peaking in September for bonds held by ETFs and the effect lasting through March of 2014. According to Coval and Stafford (2007) if these yield changes are due to changes in fundamentals, the yields should remain permanently higher. Together the higher yield spreads and the reversion suggests that ETFs put temporary pressure on bonds, pushing yields beyond their fundamental levels. Therefore the evidence suggests that changes in yield spreads can be attributed to price pressure created by outflows to ETFs. Panel B shows that there is little statistical significance between mutual fund outflows in the Taper Tantrum and the yield spread of their bonds.

[Insert Figure 3]

4.2. Examining the differential effect of mutual funds and ETFs

The main results of this paper are particularly intriguing given the size and youth of the ETF market relative to the larger and more mature mutual fund market. The differential effect identified suggests the distinguishing features of ETFs may be a source of potential fragility for the corporate bond market. In this subsection we focus on three distinctive features of ETFs in an attempt to identify the source of the ETF induced yield pressure. Specifically, we examine if the index based nature of most ETFs, differences in investor bases, or implications of the creation and redemption mechanism can help to explain the differential impact of flows during a period of turmoil on the underlying bonds.

4.2.1. Index based funds

For nearly a decade, investors have poured money into index based vehicles and away from actively managed funds. ETFs have been a key beneficiary of this investment theme, as nearly all ETFs focus on replicating the returns of a pre-specified benchmark rather than outperformance. While an index strategy reduces the work required of a manager, it also constrains her response to flows (Christoffersen, Keim, and Musto, 2008; Elton, Gruber, and Busse, 2004). Unlike active managers who can use discretion in selecting which assets to trade in response to flows, index managers are mandated to buy and sell index bonds in amounts determined by their benchmark weighting. Of greatest relevance to this paper, active managers may response to redemptions by trading bonds in which they will have the lowest price impact.

Most equity index funds utilize a strict indexing strategy because the benchmarks they follow have a limited number of constituents, which trade frequently. In contrast, fixed income index funds generally employ a representative sampling strategy, selecting only a subset of index bonds to best match the characteristics of the index. While representative sampling does increase the manager's ability to selectively respond to flow, it remains possible that the index-based nature of ETFs is responsible for the flow-induced yield pressure. If the passive nature of ETFs contributed to the results documented above, we would expect similar yield pressure from index mutual funds who follow the same mandate. To examine if the ETF yield pressure results can be attributed to their index strategies, we break down the mutual fund universe into active and index funds. We then execute the same regression in Eq. (4) for the two subsets. Table 3 presents the results for outflows to active mutual funds in Panel A and index mutual funds in Panel B.

[Insert Table 3]

The results of Table 3 show that outflows from neither active nor index mutual funds have a significant impact on the yield spread change of their constituent corporate bonds. Therefore, we conclude that the reduced flexibility of index fund management is not responsible for the yield pressure of ETFs. Instead, we continue by investigating other structural and operational features that influence the clientele and construction of these investment vehicles as potential sources of fragility.

4.2.2. The horizon of investors

ETFs are often described as mutual funds that trade intraday on an exchange. This key structural feature has appealed to investors of all types as evidenced by the outsized secondary market volumes of corporate bond ETFs. Chordia (1996), Deli and Varma (2002) and Nanda, Narayanan, and Warther (2000) theorize that different fund structures may be utilized to appeal to the heterogeneous needs of investors. In particular, Nanda, Narayanan, and Warther (2000) show that in equilibrium different fund structures and fees are used by managers exposed to a systematic liquidity shock to attract investors with different liquidity needs. Together with Chordia (1996), they show that different structures are used by mutual funds to screen out high liquidity demand investors, whose frequent trading exposes more stable investors to trade induced externalities. Moreover, Amihud and Mendelson (1986) and Constantinides (1986) predict that short-term investors self-select into more liquid assets. Considering these theories and the predictions of Poterba and Shoven (2002), we hypothesize that ETFs are more likely to attract short-horizon traders.

Short-horizon investors are theorized by Allen, Morris, and Shin (2006), De Long, Shleifer, Summers, and Waldmann (1990a), Dow and Gorton (1994), Froot, Scharfstein, and Stein (1992), Morris and Shin (2004) and Stein (2005) to specialize in investment strategies that focus not on fundamentals, but instead on the expected behavior of other investors. Cespa and Vives (2015) show that in normal market conditions, where liquidity shocks are persistent short-horizon investors will not impact asset prices. However, their presence can be destabilizing if as predicted by Allen, Morris, and Shin (2006), Bernardo and Welch (2004) and Morris and Shin (2004) in periods of turmoil short-horizon investors are expected to trade simultaneously and place a disproportionate weight on a public signal. Bhattacharya and O'Hara (2016) show that ETFs can expose the underlying to rational herding, where speculators herd on the same systematic signal, which may lead to market fragility in hard to trade underlying assets.

To examine if ETFs appeal to a different investor base we first seek to describe the distribution of flows to the different investment vehicles. Table 4 presents the flows to the different fund types and their distribution during both the Taper Tantrum and non-Taper Tantrum periods. The table provides preliminary evidence that ETFs attract a more active investor base with volatility of flows nearly double that of all mutual funds. During the Taper Tantrum event ETFs in the lowest decile of flow experienced outflows nearly four times greater than those in normal market conditions.

[Insert Table 4]

The literature suggests that one way in which short-horizon investment can be a source of fragility is if these investors engage in positive feedback trading, buying when the market is moving higher and selling when the market is moving lower. De Long, Shleifer, Summers, and Waldmann (1990b) present a model of investors who trade on past price trends and show that a result of their presence is price destabilization. To test if these new corporate bond investors follow a positive feedback strategy, we follow Edelen and Warner (2001), Goetzmann and Massa (2003) and Warther (1995) by examining the sensitivity of investors to lagged market returns over the period from January 2010 to March 2015. Since interest rates dictate the price of the underlying corporate bonds, we test if ETFs are more likely to respond using the following specification

$$Flow_{f,t} = \alpha + \delta\left(\Delta I/R_{t-1} * \ ETF_f\right) + \beta_1 \, \Delta I/R_{t-1} + \ \beta_2 ETF_f + \beta_3 X_{f,t} + \epsilon_{f,t}. \tag{5}$$

The dependent variable in the above regression, $Flow_{f,t}$, is the monthly flow to fund f in month t. $\Delta I/R_{t-1}$ is the change in either the one- or five-year treasury rate in the prior month normalized by its standard deviation. We also control for the average effective duration and rating of the fund's holding, as well as, the expense ratio, turnover, and one-, two-, and three-month lagged fund flows. The coefficient of interest, δ, on the interaction $\Delta I/R_{t-1} * ETF_f$, measures the differential behavior of ETF investors. Table 5 shows the results of these tests.

[Insert Table 5]

The coefficient on $\Delta I/R_{t-1}$ shows that after controlling for other factors lagged changes in interest rates are not a determinant of mutual fund flows. Meanwhile, the coefficient on the ETF dummy suggest that this investment vehicle has larger inflows over the 2010 to 2015 period. Interestingly, the coefficient on the interaction is negative and significant for both one- and five-year interest rate changes suggesting that ETF investors are more likely to demand liquidity when interest rates increased in the previous month. In particular, a one-standard deviation in the one-year Treasury rate leads to 0.09% higher outflows for ETFs than for mutual funds. These results show that ETF investors are more likely to trade in response to interest rate changes, suggesting they are more likely to follow potentially destabilizing positive feedback trading strategies.

Overall, this subsection documents that ETF investors have shorter horizons that mutual fund investors. In normal markets, the secondary market feature of ETFs should prevent the introduction of this new investor type from impacting the underlying. Nevertheless, the presence of these traders, combined with the main findings that ETF outflows led to higher yield spreads for exposed bonds suggest that the liquidity illusion of ETFs is a potential source of fragility for the corporate bond market.

4.2.3. The implications of the creation and redemption mechanism

The key operational difference between mutual funds and ETFs is the reliance of the latter on in-kind creation and redemption, which has important implications for portfolio construction and arbitrage that differentiate ETFs and mutual funds. First, despite having an investor base of liquidity demanders ETFs may have a reduced incentive to manage a liquidity buffer since they do not need to produce cash on demand to meet the flows of investors. In contrast, mutual fund managers rely on liquid holdings during volatile times to reduce the externalities associated with the adverse effect of investor flows as documented by Chen, Goldstein, and Jiang (2010) and Liu and Mello (2011). For corporate bond managers, the liquidity buffer consists of cash, cash equivalents, and the more frequently traded government bonds (Goldstein, Jiang, and Ng, 2015). In Table 6, we present the mean and median assets allocated to cash, government bonds, corporate bonds, and securitized bonds. Panel A presents the comparison of mutual funds and ETFs. The evidence suggests that there is a statistically significant difference in the portfolio construction techniques used by the two investment vehicles. The median mutual fund holds 8.38% and 13.34% of its assets in cash and government bonds, respectively, leaving just 45.44% to allocate to corporate bonds. In sharp contrast, the median ETF holds just 2.40% in cash and 0.34% in government bonds, allowing for the funds to invest over 93% of their assets in corporate bonds. In Panel B, we present the portfolio allocations for mutual funds and ETFs in the lowest quartile of tantrum flows, i.e. those with the greatest outflows. For these funds, the lower cash and higher corporate bond levels of ETFs remain statistically significant for both the mean and median funds. However, the difference in government holdings is no longer significant and only economically interesting for the median values. Finally, Panel C compares the holdings of index mutual funds and ETFs. The results of this comparison are similar to those documented above with one key distinction. While, the liquidity buffer of the median index fund comprises 47.83% of assets, it has a greater representation of government securities than in the broader mutual fund population. The presence of the liquidity buffer helps to explain to absence of any flow-induced price pressure in corporate bonds from mutual funds. Managers can utilize their liquidity buffer to meet redemption requests without selling corporate bonds at potentially distressed prices, similar to the financial crisis period results of Hoseinzade (2015). Nevertheless, we do not rule out that the liquidity management techniques of mutual fund managers would be sufficient in a prolonged market shock in this new corporate bond market regimen.

[Insert Table 6]

Another consequence of the creation and redemption mechanism is that APs can engage in arbitrage between the market price of the ETF and the NAV of the underlying. In normal market conditions and for ETFs backed by assets that are not hard to trade, arbitrage occurs nearly instantaneously. However, a difference in the two prices may occur and persist if limits to arbitrage such as of noise trader risk (De Long, Shleifer, Summers, and Waldmann, 1990a), synchronization risk (Abreu and Brunnermeier, 2003), liquidation risk (Shleifer and Vishny, 1997), transaction costs (Pontiff, 1996), and short sale constraints (Ofek and Richardson, 2003) are present. Further, a number of theories suggest that in the presence of these limits arbitrage may actually amplify fundamental shocks (Greenwood and Thesmar, 2011; Hong, Kubik, and Fishman, 2012; Hugonnier and Prieto, 2015; Kyle and Xiong, 2001).

We begin our study of the impact of imperfect arbitrage during a period of turmoil on constituent bonds, by documenting the existence of persistent arbitrage opportunities. First, we split our ETF sample into two groups based on the average monthly percentage price to NAV deviation during the turmoil period computed as

$$Deviation_{f,t} = \frac{P_{ETF,t} - NAV_{Basket,t}}{NAV_{Basket,t}}. \tag{6}$$

We then denote ETFs with the largest average Tantrum period discount, i.e. the ETF price falls below the NAV, as the high arbitrage exposure group. Figure 4 plots the average deviation of these high arbitrage exposure ETFs over time. The Figure shows that these ETFs previously traded above their NAV before the ETF price fell significantly below the NAV during the Taper Tantrum, reflecting the mass exodus experienced in anticipation of unexpectedly higher interest rates. The ETF discount bottoms in August 2013 before converging in March 2014.

[Insert Figure 4]

In Table 7 we compare the difference between observable characteristics for the high arbitrage exposure and the low arbitrage exposure ETFs. The credit quality of ETF holdings, the volatility of fund flows, and institutional ownership are not significantly different for the two groups. However, the average duration of the high arbitrage exposure group is significantly higher, which is not surprising given that ETFs holding these bonds were under pressure in expectation of higher interest rates. Representative of common limits to arbitrage, the high arbitrage exposure group has higher bid-ask spreads, higher turnover, and fewer assets under management. Despite these differences, the creation and redemption intensity measure, which proxies for the amount of arbitrage undertaken by APs is insignificantly different during normal market conditions. However, during the period of turmoil arbitrage in the high exposure group drops while it is nearly unchanged in the low arbitrage exposure group. The difference in arbitrage intensity between the groups during the Taper Tantrum is significant suggesting that the arbitrage mechanism of the high exposure group was impaired during the event.

[Insert Table 7]

The existence of these arbitrage opportunities translates into potential selling pressure for the individual bonds. Therefore, we posit that bonds exposed to ETFs that experience significant selling pressure and for which arbitrage is impaired were subjected to greater selling pressure by arbitrageurs, who are insensitive to the fundamental price of the bond. To test if impaired arbitrage is a potential source of the yield pressure and reversion, we form two portfolios at the end of the tantrum episode based on the exposure of individual bonds to arbitrage. Specifically, for each bond i we compute the ownership-weighted average deviation of the set of K ETFs that hold bond during the Taper Tantrum as,

$$Exposure\ to\ ETF\ Discount_{i,Tantrum} = \frac{\sum_{k=1}^{K} own_{i,k} * Devation_{k,Tantrum}}{\sum_{k=1}^{K} own_{i,k}}. \quad (7)$$

In the measure $own_{i,k}$ is the amount of bond i held by ETF k in the holdings period prior to the onset of the tantrum episode and $Devation_{k,Tantrum}$ is the average deviation of ETF k during the Taper Tantrum months.

Using this measure we divide the entire sample of bonds into high and low discount exposure portfolios. The high discount exposure portfolio includes all bonds with exposure measure of Eq. (7) less than the median value. We then track the yield spread of these two portfolios until the end of our sample in March 2015 in Panel A of Figure 5. As you can see from this Figure, the yield spreads of the two portfolios are close during the period of turmoil, but begin to diverge as the Taper Tantrum concludes and limits to arbitrage dissipate. As arbitrageurs reentered the market by selling the underlying and buying the ETF, the yield spreads of high exposure to ETF discount bonds are pushed above those without similar arbitrage pressure. In Panel B of Figure 5, we present the difference in the yield spreads for the two portfolios and the t-statistics of the difference. The pattern of the differences shows the yield spreads of high exposure bonds increasing significantly before reverting in July 2014, suggesting that arbitrageurs serve as a shock propagation mechanism from the liquid ETF to the underlying bonds. The timeline for the convergence of the two portfolios coincides with the closing of the arbitrage opportunity shown in Figure 4 supporting our hypothesis that the non-fundamental move in prices can be partially attributed to arbitrage.

[Insert Figure 5]

To formally test the impact of impaired ETF arbitrage on constituent corporate bonds, we run both univariate and multivariate regressions. Corresponding to Figure 5, we first run a univariate specification of the yield spread level of bond i in month t on the high exposure dummy, $High\ Exposure\ to\ ETF\ Discount_{i,Tantrum}$. We also run the following multivariate specification to control for bond level characteristics,

$$\begin{aligned} Spread_{i,t} = \alpha + \beta_1 High\ Exposure\ to\ ETF\ Discount_{i,Tantrum} + \beta_2 Time\ to\ Maturity_{i,t} \\ + \beta_3 Amihud\ Illiquidity_{i,t} + \beta_4 Rating_{i,t} + \epsilon_{i,t} \end{aligned} \quad (8)$$

Table 8 presents the results of the univariate test in Panel A and the multivariate test in Panel B. Focusing on the multivariate specification shows that after controlling for observable characteristics of bonds, there is no significant difference between the yield spread levels of bonds with high exposure to ETF arbitrage during the tantrum period. This suggests that as the price of the ETF moved lower, the yield spreads of exposed constituents did not react significantly different to the change in the markets expectations of interest rates. Rather, it was after the turmoil and limits to arbitrage subsided, that those bonds most exposed to arbitrage opportunities created by extreme selling pressure in the ETF move significantly higher. Specifically, the yield spreads of bonds exposed to high arbitrage trading are 14.2 basis points higher in September than those from the low arbitrage exposure group. The difference in yield spreads peaks in December 2013 and completely reverts to an insignificant level by July 2014.

[Insert Table 8]

The results of this subsection show that the unique creation and redemption mechanism of ETFs has significant implications for the asset prices of constituent bonds. First, we document that mutual funds utilize a liquidity buffer to respond to temporary periods of turmoil, such as the Taper Tantrum studied in this paper. For ETFs the in-kind mechanism reduces the funds' reliance on the buffer and allows for greater investment in constituent bonds. However, when arbitrage is limited the liquidity of the ETF relative to the illiquidity of the underlying may create persistent arbitrage opportunities that allow for a market-wide shock to propagate to exposed bonds. In particular, we show that bonds held by ETFs subjected to selling pressure during the Taper Tantrum have significantly higher yield spreads as arbitrageurs reenter the market leading to the convergence of the ETF price and NAV, but pushing the constituent yield spreads beyond fundamental levels before they revert as arbitrage pressure abates.

5. Conclusion

The corporate bond market long dominated by broker-dealers and long-term investors, such as insurance companies, has seen its primary market makers withdraw and new more liquid forms of innovation emerge. This paper uses an unexpected increase in the interest rates and subsequent outflows from ETFs and mutual funds, in an event known as the Taper Tantrum, to cleanly identify the impact of outflows to these investment vehicles on bond yields. Comparing bonds from the same issuer, we find that ETF outflows lead to significantly higher yield spreads in the months following the shock, with the impact lasting seven months. The significance and pattern of the coefficients of our regression indicate that ETFs contribute to flow-induced yield spread pressure in the corporate bond market. There is no significant relationship between Tantrum period outflows to mutual funds and subsequent changes in yield spreads.

We further investigate the differences between ETFs and mutual funds and show that the contrasting findings for can be attributed to the structural and operational features of ETFs. We first rule out that the index-based mandate of ETFs is responsible for the pattern indicative of flow-induced yield pressure by documenting that index mutual funds do not have a similar effect on their constituent bonds. Second, we show that ETFs and mutual funds appeal to a different investor base, with the greater flow volatility of ETFs suggestive of shorter-horizon investors. Further, ETF flows more sensitive to changes in interest rates, implying that these new investors in corporate bond markets may engage in potentially destabilizing positive feedback trading. Third, we consider the portfolio construction and arbitrage implications of the in-kind creation and redemption mechanism used by ETFs. We document that mutual funds have a significant liquidity buffer. The lack of flow-based yield pressure for mutual funds in this turmoil period suggests that fund managers utilized their liquidity buffer to meet redemption requests without selling corporate bonds at potentially distressed prices, similar to the financial crisis results of Hoseinzade (2015). Nevertheless, we do not rule out that the liquidity management techniques of mutual fund managers would be sufficient in a prolonged market shock in this new corporate bond market regimen. For ETFs the in-kind mechanism reduces the funds' reliance on the buffer and allows for greater investment in constituent bonds. However, when arbitrage is limited the liquidity of the ETF relative to the illiquidity of the underlying may create persistent arbitrage opportunities that allow for a market-wide shock to propagate to exposed bonds. In particular, we show that bonds held by ETFs that trade at significant discounts to their NAV due to selling pressure during the Taper Tantrum have significantly higher yield spreads as arbitrageurs reenter the market leading to the convergence of the ETF price and NAV, but pushing the constituent yield spreads beyond fundamental levels before they revert as arbitrage pressure abates.

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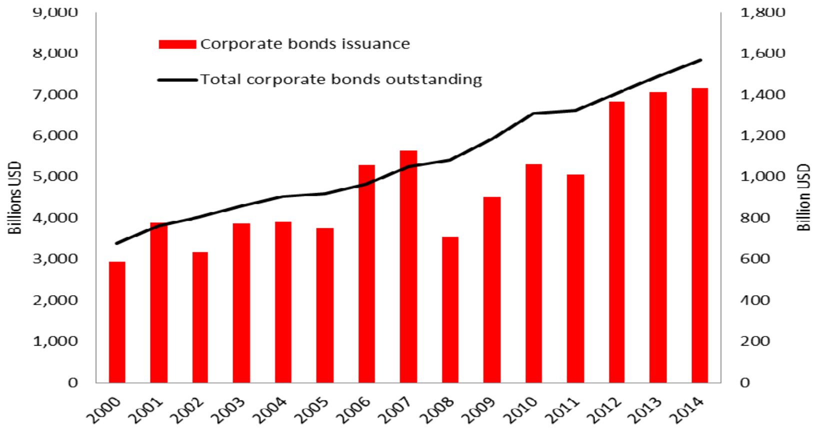
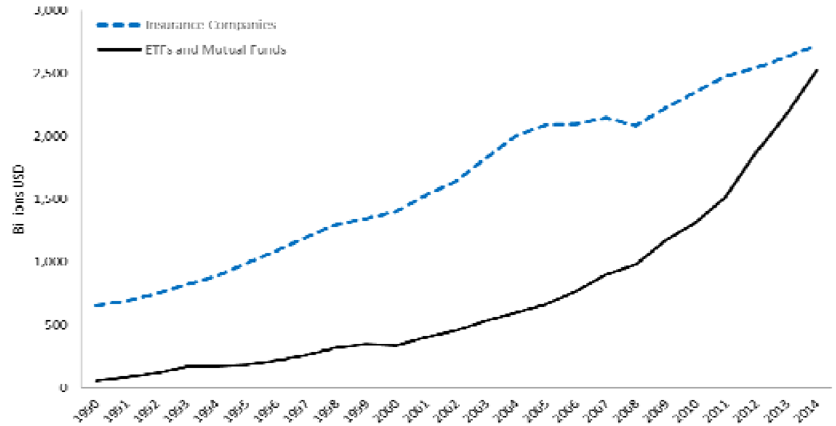
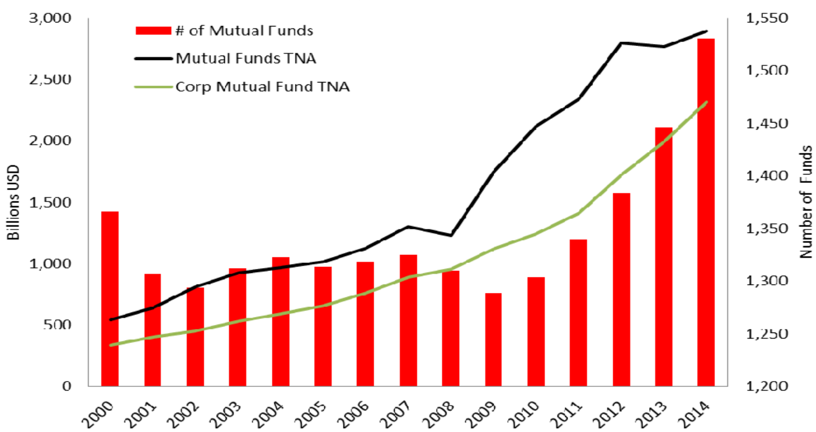


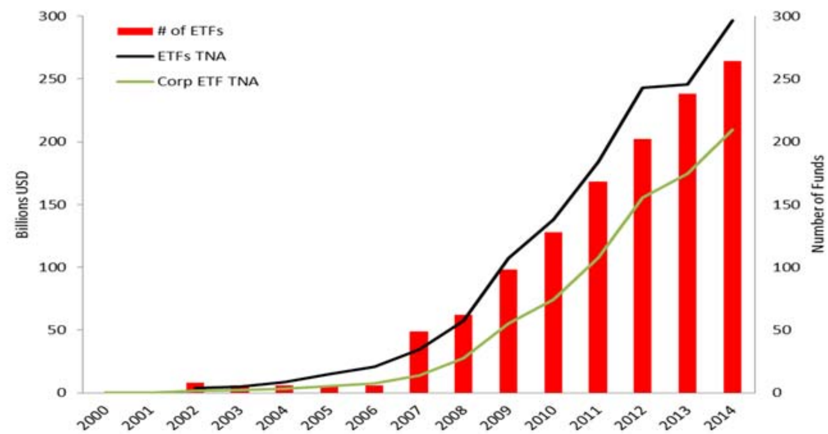
Panel A: The growth of the corporate bond market



Panel B: The holdings of corporate bond market participants



Panel C: The growth of the corporate bond mutual funds



Panel D: The growth of the corporate bond ETFs

Fig. 1: The evolution of the corporate bond market and its participants

Panel A plots the growth of the corporate bond market since 2000. The left hand axis and black line represent the total dollar amount outstanding in corporate bonds. The right hand axis and the red bars document the total amount of new issuance each year. Panel B plots Corporate bond assets held by different market participants since 1990. The data comes from the Federal Reserve Board. Insurance assets are the sum of life and property-casualty insurers. ETFs and mutual funds include all ETFs and open-end mutual funds. Panel C plots the growth in assets under management and the number of corporate bond mutual fund alternatives. The left axis document the total assets under management. The solid line represents all taxable long-term bond fund assets from ICI Factbook, while the dashed line depicts the total corporate bond assets held by long-term open-end mutual funds from the Federal Reserve Board. The right axis and red bars plot the number of long-term taxable bond mutual fund offerings from ICI. Panel D plots the growth of assets and number of ETFs as in Panel C.

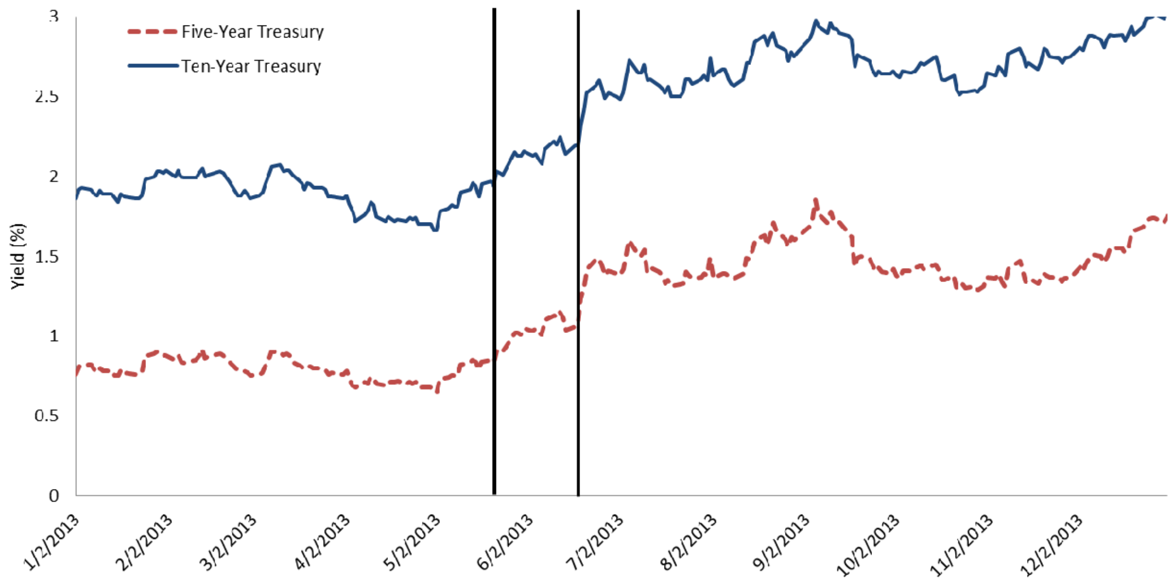
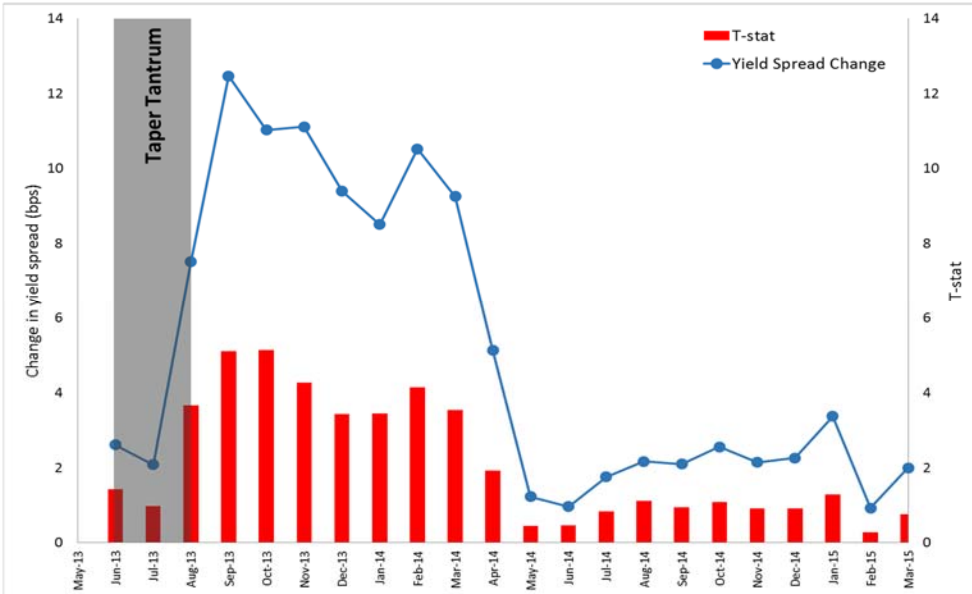
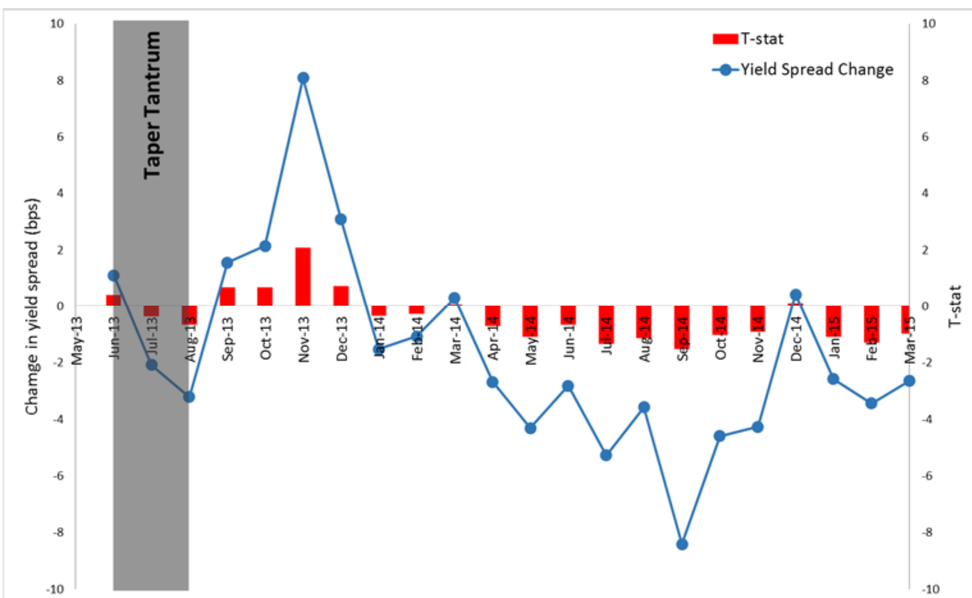


Fig. 2: The yield on government bonds during 2013

This figure presents the daily closing yield on the five- and ten-year Treasury bond during 2013. Important dates related to our period of turmoil, the Taper Tantrum are denoted by the vertical lines. The first line represents the day that the episode began, May 22, 2013, when the Federal Reserve Chairman, Ben Bernake, first mentioned slowing down the bond buyback program, known as Quantitative Easing (QE). The second line demarks, June 19, 2013, the date that Chairman Bernake held a press conference documenting the economic reasoning behind the tapering of the QE program.



Panel A: The change in yield spread of bonds exposed to ETF Taper Tantrum outflows



Panel B: The change in yield spread of bonds exposed to mutual fund Taper Tantrum outflows

Fig. 3: The impact of a one standard deviation change in Taper Tantrum outflows on yield spreads

This figure presents the impact of a one standard deviation increase in turmoil outflows to ETFs in Panel A and mutual funds in Panel B on the cumulative yield spread of constituent bonds exposed to outflows relative to bonds from the same issuer. The line plots the change in the volume-weighted average yield of a bond over the maturity-matched Treasury rate. The change is measured relative to the bond's volume-weighted yield in May excluding all transactions post May 21, the day prior to Bernake's testimony. The bars represent the t-statistics from the regression described in Table 2.

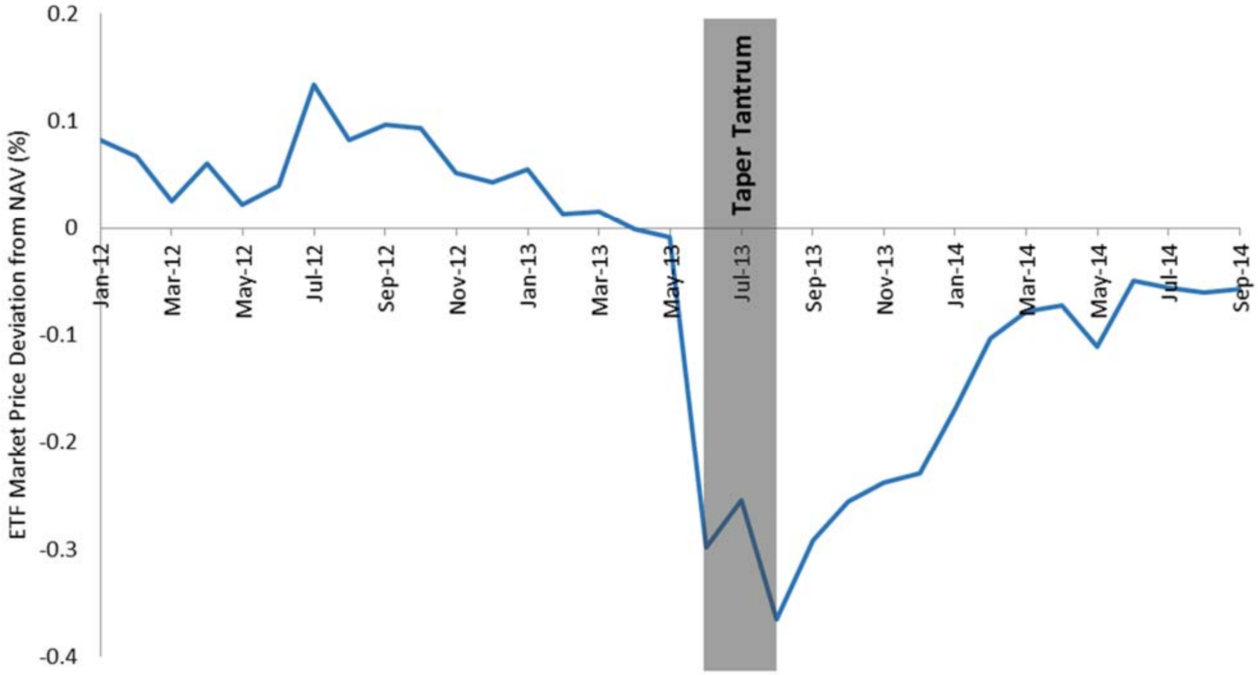
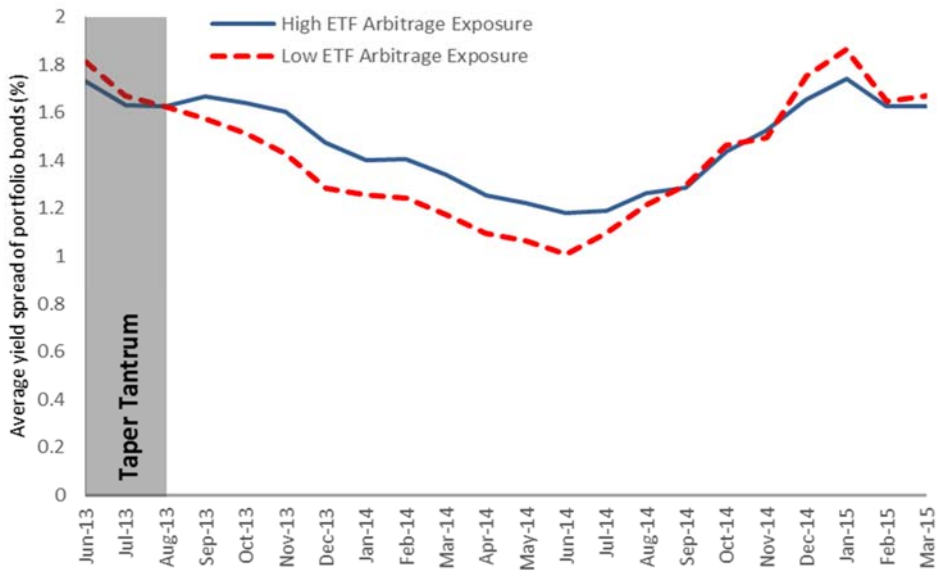
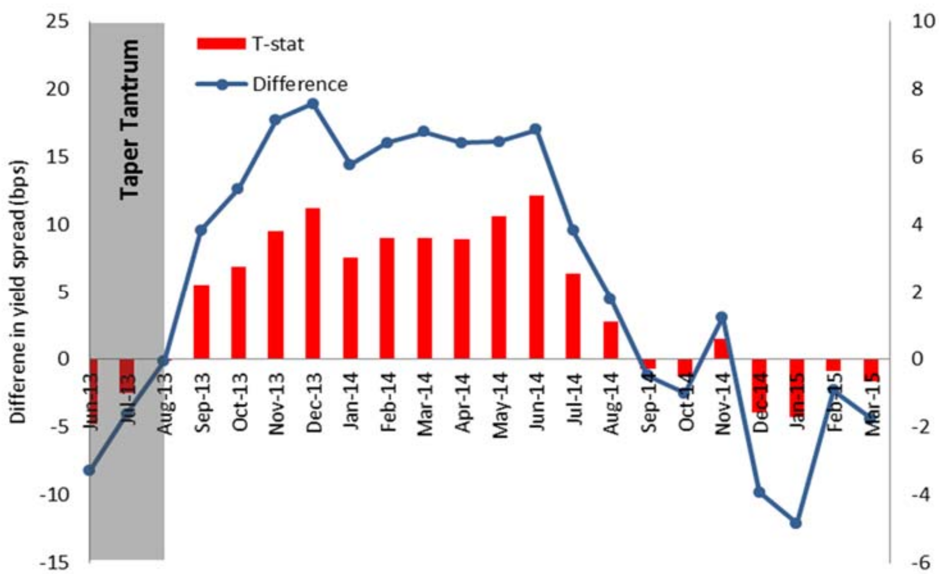


Fig. 4: The arbitrage opportunity of high deviation ETFs during the Taper Tantrum.

This figure plots the time series of average monthly deviation, computed as computed as $(P_{ETF} - NAV)/NAV$, of all ETFs falling in the lower half of the distribution during the Taper Tantrum.



Panel A: The average yield spread of bonds in the high and low ETF exposure portfolios



Panel B: The difference in yield spreads of bonds in the high and low ETF exposure portfolios

Fig. 5: The impact of ETF arbitrage on exposed bonds

This figure presents the impact of high ETF arbitrage exposure on portfolios of bonds. In Panel A we present the average yield spread and Panel B the difference and relevant t-statistics. For each bond i we compute the ownership-weighted average deviation of the set of K ETFs that hold bond during the Taper Tantrum as,

$$Exposure\ to\ ETF\ Discount_{i,Tantrum} = \frac{\sum_{k=1}^{K} own_{i,k} * Devation_{k,Tantrum}}{\sum_{k=1}^{K} own_{i,k}},$$

where $own_{i,k}$ is the amount of bond i held by ETF k in the holdings period prior to the onset of the tantrum episode and $Devation_{k,Tantrum}$ is the average deviation of ETF k during the Taper Tantrum months. Using this measure we divide the entire sample of bonds into high and low discount exposure portfolios. The high discount exposure portfolio includes all bonds with exposure measure less than the median value, i.e. held by ETFs trading at a discount.

Table 1: Summary Statistics

Summary statistics by investment vehicle type for the quarterly holdings data released in March 2013 immediately before the Taper Tantrum are presented below. The data is composed of corporate bond mutual fund and exchange traded funds (ETFs). Panel A presents the distribution of observable summary statistics for corporate bond mutual funds, including both active and index funds. Panel B documents the distribution for ETFs. Total net assets is the dollar value in millions for all share classes of the fund. # of holdings is the number of unique bonds held by the fund. % in top 10 holdings documents the percentage of assets concentrated in the largest holdings of the fund. Turnover is a yearly measure defined by CRSP. Expense ratio is the asset-weighted percent expense ratio of the fund for all share classes of the fund. Average duration and Average credit quality are the value-weighted characteristics of all bonds holdings

Panel A: *Mutual Funds*	Mean	STD	10%	25%	50%	75%	90%
Total net assets ($mln)	1,751.39	5,989.49	25.80	89.80	356.10	1,209.50	3,316.30
# of holdings	430.61	822.88	20.00	85.00	263.00	494.00	918.00
% in top 10 holdings	31.40	50.50	6.45	11.04	18.89	36.48	85.34
Turnover	1.27	1.77	0.21	0.37	0.69	1.39	3.15
Expense ratio (%)	0.85	0.49	0.31	0.56	0.80	1.00	1.33
Average duration	4.05	1.89	1.50	3.08	4.23	5.12	5.89
Average credit quality	2.68	1.25	1.00	2.00	3.00	4.00	4.00
% invested in cash	12.99	14.64	1.85	4.13	8.38	15.98	28.50
% invested government bonds	17.76	18.49	0.00	0.56	13.31	28.39	43.61
% invested corporate bonds	51.52	28.16	19.83	27.60	45.44	77.62	94.77
% invested securitized bonds	14.85	15.91	0.00	0.30	9.67	26.47	38.30
% invested municipal	0.99	2.88	0.00	0.00	0.05	0.86	2.53
Panel B: *ETFs*	Mean	STD	10%	25%	50%	75%	90%
Total net assets ($ mln)	3,719.44	13,947.26	10.50	45.00	212.90	1,101.60	10,074.10
No of holdings	675.43	1,840.71	43.00	104.00	232.00	760.00	1,410.00
% in top 10 holdings	21.00	20.02	4.45	8.60	15.39	24.98	43.56
Turnover	0.50	0.76	0.05	0.10	0.18	0.65	1.30
Expense ratio (%)	0.31	0.22	0.11	0.16	0.24	0.42	0.55
Average duration	4.85	3.24	0.91	2.89	4.74	6.01	7.81
Average credit quality	2.97	1.26	1.00	2.00	3.00	4.00	4.00
% invested in cash	8.90	16.29	0.00	0.60	2.40	7.41	29.88
% invested government bonds	12.12	19.57	0.00	0.00	0.34	19.11	45.25
% invested corporate bonds	74.78	29.30	23.59	50.50	93.27	98.49	99.99
% invested securitized bonds	3.49	9.81	0.00	0.00	0.01	0.45	12.77
% invested municipal	0.61	1.72	0.00	0.00	0.00	0.07	1.76

Table 2: Panel regressions of cumulative bond yield spreads relative to pre-event level on mutual fund and ETF Tantrum outflows

Panel A reports results for mutual funds and Panel B for ETFs of the following monthly panel regressions

$$(Spread_t - Spread_{May})_{i,j} = \alpha + \lambda_j + \beta_1 Fund\ Outflow_{i,Tantrum} + \beta_2 Fund\ Outflow^2_{i,J,Tantrum} + \beta_3 Log(Size)_{i,May} + \beta_4 Time\ to\ Matrity_{i,May} + \beta_5 Time\ to\ Maturity^2_{i,May} + \beta_6 Amihud_{i,May} + \beta_7 Spread_{i,May}$$
$$+\beta_8 (Time\ to\ Maturity_{May} * Fund\ Outflow_{Tantrum})_i + \beta_9 (Amihud_{May} * Fund\ Outflow_{Tantrum})_i + \epsilon_{i,j,t}.$$

The dependent variable, $(Spread_t\text{-}Spread_{May})_{i,j}$, is the change in the volume-weighted average yield of bond of bond *i* from issuer *j* over the maturity-match Treasury rate in month *t*. The change relative to the bond's volume-weighted yield in May excluding all transactions post May 21, 2013, the day prior to Bernake's testimony. The months *t* run from 1M (September 2013) to 16M (December 2014) after the end of the turmoil period in the summer of 2013. λ_j is an issuer fixed effect, whose inclusion allowing us to effectively compare the change in yield spreads of bonds from the same issuer subjected to different levels of fund induced pressures. *Fund Outflow* $_i$ *,Tantrum* is the weighted average monthly flow for all mutual funds or ETFs that reported bond *i* as a holding immediately before the event. Only bonds with negative flow exposure are included. Bond issue level controls included are the log of the issue size in millions of dollars, *Size;* the number of years remaining until maturity, *Time to Maturity; the* median monthly Amihud illiquid proxy, *Amihud;* and the yield spread of the bond prior to the event, *Spread. All* issue level controls are set to their May level. t-stastistcs are clustered at the issuer level and presented below the coefficients. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	Panel A: ETFs						Panel B: Mutual Funds					
	1M	**4M**	**7M**	**10M**	**13M**	**16M**	**1M**	**4M**	**7M**	**10M**	**13M**	**16M**
Fund Outflow	0.087***	0.066***	0.065***	0.007	0.015	0.016	0.015	0.030	0.003	-0.028	-0.084	0.004
	(5.12)	(3.43)	(3.54)	(0.47)	(0.94)	(0.92)	(0.67)	(0.73)	(0.07)	(-0.65)	(-1.52)	(0.12)
Fund Outflows^2	-0.006***	-0.003	-0.003*	0.001	0.001	0.000	-0.002	-0.006	-0.001	0.001	0.005	-0.005
	(-3.30)	(-1.37)	(-1.66)	(0.80)	(0.37)	(0.20)	(-0.63)	(-0.94)	(-0.21)	(0.22)	(0.93)	(-1.37)
Log(Size)	0.004	-0.010	-0.014	0.003	0.016	0.008	0.047	0.016	0.025	-0.043	0.023	-0.018
	(0.28)	(-0.55)	(-0.86)	(0.24)	(1.06)	(0.43)	(1.47)	(0.43)	(0.64)	(-1.39)	(0.49)	(-0.80)
Time to Maturity	0.006	0.013*	0.020***	0.028***	0.034***	0.039***	-0.010**	0.004	0.003	0.013	0.012	0.035***
	(1.58)	(1.69)	(3.88)	(4.67)	(6.94)	(7.16)	(-2.49)	(0.31)	(0.38)	(1.12)	(0.61)	(7.20)
Time to Maturity^2	0.000	-0.000	-0.000	-0.000*	-0.000***	-0.000***	0.000	-0.000	-0.000	-0.000	-0.000	-0.000***
	(0.37)	(-0.48)	(-1.51)	(-1.74)	(-2.72)	(-3.12)	(0.80)	(-0.45)	(-0.38)	(-0.67)	(-0.41)	(-2.93)
Amihud	-0.542	-0.022	-0.863	0.415	0.731	-0.311	-0.712	-1.755	-1.435	-0.783	-0.256	-1.579
	(-0.39)	(-0.02)	(-1.06)	(0.53)	(0.90)	(-0.18)	(-0.24)	(-0.90)	(-0.90)	(-0.43)	(-0.13)	(-1.42)
$Spread_{May}$	-0.181**	-0.250**	-0.296***	-0.391***	-0.409***	-0.430***	0.181***	-0.052	-0.007	-0.148	-0.150	-0.343***
	(-2.55)	(-2.57)	(-3.63)	(-5.49)	(-5.76)	(-4.92)	(6.30)	(-0.42)	(-0.07)	(-0.76)	(-0.49)	(-5.22)
Time to Maturity * Fund Outflow	-0.002***	-0.002***	-0.002***	-0.001	-0.001**	-0.001*	0.001	0.000	0.000	0.001	0.003*	0.001
	(-3.49)	(-3.76)	(-3.31)	(-1.58)	(-2.37)	(-1.67)	(0.55)	(0.13)	(0.30)	(0.95)	(1.89)	(0.42)
Amihud * Fund Outflow	0.360	0.028	0.374	-0.132	-0.239	0.199	-1.499	0.846	0.759	0.394	-0.072	1.041
	(0.59)	(0.05)	(1.00)	(-0.39)	(-0.66)	(0.24)	(-0.68)	(0.68)	(0.72)	(0.41)	(-0.07)	(1.50)
Issuer Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# Obs	2,952	2,889	2,847	2,816	2,752	2,739	3,684	3,553	3,426	3,313	3,198	3,151
R^2	0.647	0.716	0.758	0.852	0.887	0.932	0.686	0.628	0.697	0.773	0.713	0.891

Table 3: Panel regressions of cumulative bond yield spreads relative to pre-event level on active and index mutual fund Tantrum outflows

Panel A reports results for mutual funds and Panel B for ETFs of the following monthly panel regressions

$$(Spread_t - Spread_{May})_{i,j} = \alpha + \lambda_j + \beta_1 Fund\ Outflow_{i,Tantrum} + \beta_2 Fund\ Outflow^2_{i,J,Tantrum} + \beta_3 Log(Size)_{i,May} + \beta_4 Time\ to\ Matrity_{i,May} + \beta_5 Time\ to\ Maturity^2_{i,May} + \beta_6 Amihud_{i,May} + \beta_7 Spread_{i,May}$$
$$+\beta_8 (Time\ to\ Maturity_{May} * Fund\ Outflow_{Tantrum})_i + \beta_9 (Amihud_{May} * Fund\ Outflow_{Tantrum})_i + \epsilon_{i,j,t}.$$

The dependent variable, $(Spread_t\text{-}Spread_{May})_{i,j}$, is the change in the volume-weighted average yield of bond of bond i from issuer j over the maturity-match Treasury rate in month t. The change relative to the bond's volume-weighted yield in May excluding all transactions post May 21, 2013, the day prior to Bernake's testimony. The months t run from 1M (September 2013) to 16M (December 2014) after the end of the turmoil period in the summer of 2013. λ_j is an issuer fixed effect, whose inclusion allowing us to effectively compare the change in yield spreads of bonds from the same issuer subjected to different levels of fund induced pressures. *Fund Outflow* $_i$ *,Tantrum* is the weighted average monthly flow for all active and index mutual funds that reported bond i as a holding immediately before the event. Only bonds with negative flow exposure are included. Bond issue level controls included are the log of the issue size in millions of dollars, *Size;* the number of years remaining until maturity, *Time to Maturity; the* median monthly Amihud illiquid proxy, *Amihud;* and the yield spread of the bond prior to the event, *Spread. All* issue level controls are set to their May level. t-stastistcs are clustered at the issuer level and presented below the coefficients. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	Panel A: Active mutual funds						Panel B: Index mutual Funds					
	1M	**4M**	**7M**	**10M**	**13M**	**16M**	**1M**	**4M**	**7M**	**10M**	**13M**	**16M**
Fund Outflow	0.010	0.007	0.005	-0.035	-0.047	-0.004	0.014	0.038	-0.012	-0.009	-0.050*	-0.026
	(0.80)	(0.36)	(0.22)	(-1.32)	(-1.58)	(-0.16)	(0.54)	(1.36)	(-0.45)	(-0.37)	(-1.81)	(-0.83)
Fund Outflows^2	-0.000	-0.001	-0.000	0.001	0.001	-0.000	-0.005	-0.012	0.002	0.003	0.005	-0.001
	(-0.22)	(-0.67)	(-0.37)	(1.10)	(0.83)	(-0.35)	(-0.73)	(-1.60)	(0.23)	(0.61)	(0.90)	(-0.08)
Log(Size)	0.051	0.023	0.024	-0.014	0.023	-0.009	0.046***	0.011	0.012	0.009	0.017	0.030
	(1.55)	(0.60)	(0.60)	(-0.29)	(0.49)	(-0.35)	(2.88)	(0.52)	(0.72)	(0.67)	(1.06)	(1.51)
Time to Maturity	-0.005	0.005	0.007	0.002	0.016	0.039***	-0.000	0.004	0.010**	0.023***	0.025***	0.034***
	(-1.00)	(0.39)	(0.69)	(0.15)	(0.82)	(5.84)	(-0.01)	(0.66)	(2.12)	(4.78)	(5.99)	(4.50)
Time to Maturity^2	0.000	-0.000	-0.000	0.000	-0.000	-0.000**	0.000	0.000	-0.000	-0.000*	-0.000**	-0.000*
	(0.02)	(-0.50)	(-0.56)	(0.34)	(-0.59)	(-2.06)	(0.20)	(0.01)	(-0.55)	(-1.69)	(-2.47)	(-1.77)
Amihud	-3.015	-3.094	-1.554	-6.309**	-5.758*	-3.368	1.591*	2.062**	1.830**	1.457*	1.388	-0.911
	(-0.97)	(-1.08)	(-0.75)	(-2.49)	(-1.72)	(-1.29)	(1.74)	(2.20)	(2.30)	(1.82)	(1.44)	(-0.43)
$Spread_{May}$	0.178***	-0.040	-0.023	0.051	-0.188	-0.378***	-0.142***	-0.282***	-0.299***	-0.387***	-0.387***	-0.381***
	(5.73)	(-0.33)	(-0.23)	(0.22)	(-0.61)	(-5.06)	(-4.07)	(-2.66)	(-3.56)	(-4.79)	(-5.90)	(-2.92)
Time to Maturity * Fund Outflow	-0.000	0.000	0.000	0.000	0.001*	0.000	0.000	0.001	0.001	0.000	0.002*	0.002
	(-0.14)	(0.25)	(0.20)	(0.61)	(1.68)	(0.24)	(0.44)	(0.61)	(1.09)	(0.38)	(1.91)	(1.30)
Amihud * Fund Outflow	-0.397	1.070	0.740	2.346**	1.833	1.309	-0.694	-1.232**	-1.243**	-0.947*	-0.790	0.578
	(-0.25)	(0.93)	(0.85)	(2.45)	(1.60)	(1.58)	(-1.06)	(-2.09)	(-2.44)	(-1.90)	(-1.37)	(0.46)
Issuer Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# Obs	3708	3579	3456	3349	3212	3158	2092	2033	1997	1992	1944	1945
R^2	0.716	0.641	0.716	0.762	0.749	0.904	0.718	0.702	0.769	0.820	0.827	0.889

Table 4: The distribution of fund flows by fund type

This table shows the stastics for flows to funds of different corporate bond investment vehicles, including exchange traded funds (ETFs), all mutual funds, index mutual funds, and active mutual funds. The full sample period is from January 2010 to March 2015. Also presented are flow characteristics in normal periods, Non-Taper Tantrum, and those during the turmoil event studied in this paper, the Taper Tantrum. Taper Tantrum months are June, July, and August of 2013.

	Mean	Std. Dev	10%	25%	50%	75%	90%
ETFs							
Full Sample	4.76	12.5	-1.97	-0.29	1.21	6.27	16.58
Non-Taper Tantrum	4.82	12.35	-1.67	-0.27	1.29	6.21	16.51
Taper Tantrum	3.92	14.22	-6.1	-1.06	0.02	7.14	17.28
All Mutual Funds							
Full Sample	1.32	7.78	-2.73	-0.97	0.19	1.99	5.86
Non-Taper Tantrum	1.38	7.75	-2.58	-0.91	0.22	2.02	5.86
Taper Tantrum	0.48	8.05	-4.54	-2.05	-0.36	1.48	5.86
Index Mutual Funds							
Full Sample	1.46	8.11	-2.55	-0.67	0.39	2.14	5.87
Non-Taper Tantrum	1.59	8.21	-2.31	-0.57	0.45	2.24	6.15
Taper Tantrum	-0.52	6.02	-4.62	-1.97	-0.48	0.66	2.87
Active Mutual Funds							
Full Sample	1.32	7.76	-2.74	-0.98	0.18	1.99	5.86
Non-Taper Tantrum	1.37	7.74	-2.59	-0.93	0.21	2.01	5.85
Taper Tantrum	0.69	8.53	-4.52	-1.92	-0.22	1.76	6.58

Table 5: The sensitivity of fund flows to changes in interest rates

This table reports the results from the following panel regression using over the entire data sample from January 2010 to March 2015

$$Flow_{f,t} = \alpha + \delta(\Delta I/R_{t-1} * ETF_f) + \beta_1 \Delta I/R_{t-1} + \beta_2 ETF_f + \beta_3 X_{f,t} + \epsilon_{f,t}.$$

$Flow_{f,t}$ is the monthly percentage flow of fund f in month t. $\Delta I/R_{t-1}$ is the lagged change in either the one- or five-year Treasury rate normalized by its standard deviation. ETF_f is a dummy equal to one for ETFs and zero for mutual funds. X_{ft} are fund level covariates including the effective duration and credit rating of the fund's holdings, one-, two-, and three-month lagged flows, the average monthly fund return over the previous three months, as well as, the expense and turnover ratios of the funds. t-stastistcs are clustered by date and presented below the coefficients. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	I/R= One-Year Treasury		I/R= Five-Year Treasury	
$\Delta I/R_{t-1}*ETF_f$	-0.083*	-0.091**	-0.102**	-0.084*
	(-1.76)	(-2.44)	(-2.02)	(-1.82)
$\Delta I/R_{t-1}$	-0.072	-0.049	-0.104	-0.034
	(-0.62)	(-0.38)	(-0.94)	(-0.36)
ETF_f	3.639***	1.091***	3.676***	1.142***
	(7.05)	(5.41)	(7.12)	(5.66)
Effective Duration	-0.420***	-0.208**	-0.420***	-0.208**
	(-3.15)	(-2.38)	(-3.16)	(-2.38)
Average Rating		-0.0283		-0.0306
		(-0.30)		(-0.33)
$Flow_{t-1}$		1.692***		1.691***
		(9.47)		(9.49)
$Flow_{t-2}$		1.275***		1.272***
		(7.82)		(7.82)
$Flow_{t-3}$		0.893***		0.895***
		(7.93)		(7.96)
Fund $Ret_{t,t-3}$		0.604***		0.594***
		(4.90)		(4.81)
Expense Ratio		-0.076		-0.077
		(-1.34)		(-1.36)
Turnover		-0.027		-0.027
		(-0.54)		(-0.54)
No. of Obs.	49095	31343	49095	31343
R^2	0.17	0.18	0.12	0.14

Table 6: Portfolio composition by investment vehicle prior to the onset of the Taper Tantrum

This table presents statistics on the percentage of fund assets held in different investment categories by mutual funds and ETFs for the period immediately before the onset of the period of turmoil. Panel A shows the statistics for all funds in our study, Panel B for only those funds in the lowest quartile of flows during the Taper Tantrum, and Period C for index mutual funds and ETFs only. To test the difference between medians we use nonparametric two-sample test. In each panel the mean and median, as well as the difference between the mutual fund and ETF stastitics are presented. * indicates significance at the 10% level; **, at the 5% level; and ***, at the 1% level.

Panel A: All Funds	Mean				Median			
	Mutual funds	ETFs	Difference	P-Value	Mutual funds	ETFs	Difference	P-Value
Cash	12.99	8.90	4.09**	0.02	8.38	2.40	5.98***	0.00
Government bonds	17.82	12.12	5.70***	0.01	13.34	0.34	13.00***	0.00
Corporate bonds	51.52	74.78	-23.26***	0.00	45.44	93.27	-47.83***	0.00
Securitized bonds	14.81	3.495	11.32***	0.00	9.54	0.01	9.53***	0.00
Panel B: Lowest quartile	Mean				Median			
	Mutual funds	ETFs	Difference	P-Value	Mutual funds	ETFs	Difference	P-Value
Cash	10.52	3.74	6.78*	0.05	5.42	1.33	4.09***	0.002
Government bonds	18.37	18.72	-0.35	0.93	14.35	6.99	7.36	0.47
Corporate bonds	53.58	74.64	-21.06***	0.00	46.4	93.00	-46.60*	0.10
Securitized bonds	14.65	1.82	12.83***	0.00	6.97	0.18	6.79***	0.00
Panel C: Index funds	Mean				Median			
	Index funds	ETFs	Difference	P-Value	Index funds	ETFs	Difference	P-Value
Cash	8.65	8.90	-0.25	0.93	4.51	2.40	2.11*	0.06
Government bonds	34.16	12.12	22.04***	0.00	42.32	0.34	41.98***	0.00
Corporate bonds	41.58	74.48	-32.90***	0.00	25.2	93.27	-68.07***	0.00
Securitized bonds	14.73	3.49	11.24***	0.00	12	0.01	11.99***	0.00

Table 7: ETF summary statistics based on Taper Tantrum arbitrage exposure

This table presents statistics on ETFs based on the average arbitrage opportunity during the months of the Taper Tantrum, June, July, and August of 2013. For all corporate bond ETFs, we compute the monthly deviation as the average daily percentage difference between the ETF market price and its NAV. We then split the ETFs into two groups based on this measure. ETFs with below median deviations trade at signficant discounts during the turmoil episode and are deemed *High Arbitrage Exposure* . ETFs with average Tantrum deviation above the median are called *Low Arbitrage Exposure* . Here we test the significance of the differences in means between the mean credit rating and effective duration of the fund's holdings from the holdings report and the portion of ETF shares outstanding held by insitutional investors, *IO,* prior to the onset of the event. We also compute the volatiltiy of fund flows over the prior twelve months and compare the difference in the average monthly bid-ask spread and Turnover of the ETF betwen January and April 2013. We use the creation and redemption intensity measure of Da and Shive (2014) to create a proxy for the level of arbitrage conducted by Authorized Participants, *CRI* . The proxy is computed as the standard deviation of ETF shares outstanding in a month divided by the average shares of the ETF outstanding that month. Pre-Taper Tantrum *CRI* is computed as the monthly average between January and April and again during the Taper Tantrum.

	Pre-Taper Tantrum							Taper Tantrum
	Credit Quality	Effecive Duration	IO (%)	12 Month Flow Vol	Bid Ask Spread	Log(AUM)	CRI (%)	CRI (%)
High Arbitrage Exposure	2.76	5.52	47.55	7.78	0.004	4.64	3.300	1.7
Low Arbitrage Exposure	2.82	3.58	43.98	8.52	0.001	5.46	4.100	3.9
Difference	-0.06	1.94	3.57	-0.73	0.003	-0.82	-0.800	-2.2
T-stat	-0.19	2.71***	0.58	-0.41	2.80***	-1.73*	-0.74	-2.48**

Table 8: the impact of arbitrage opportunities on bond yield spreads

This table presents the results of our tests for the impact of turmoil induced arbitrage ETF on constituent bonds. For all corporate bond ETFs, the monthly deviation is computed as the average daily percentage difference between the ETF market price and its NAV. For an individual bond we compute its exposure to ETF arbitrage by calculating the ownership-weighted average deviation of the ETFs that hold the bond during the Taper Tantrum. The measure is computed as

$$Exposure\ to\ ETF\ Discount_{i,Tantrum} = \frac{\sum_{k=1}^{K} own_{i,k} * Devation_{k,Tantrum}}{\sum_{k=1}^{K} own_{i,k}}.$$

The sample of bonds is divided into high and low exposure portfolios. Bonds denoted high exposure have an exposure measure below the median, indicative of being held by ETFs trading at a discount. In Panel A, we present the results of the univariate regression

$$Spread_{i,t} = \alpha + \beta_1 High\ Exposure\ to\ ETF\ Discount_{i,Tantrum} + \epsilon_{i,t}$$

where *Spread* $_{i,t}$ is the monthly-volume weighted yield of bond i over the maturity-matched Treasury rate in month t and *High Exposure to ETF Discount* $_{i,t}$ is a dummy set to one if the bond's exposure measure is below the median. In Panel B, we persent the results of the mutlivariate regression that controls for bond characterstics, including the years remaining until maturity, *Time to Maturity*, a proxy for illiquidity, *Amihud Illiquidity*, and a numerical conversion of the credit rating of the bond, *Rating*.

$$Spread_{i,t} = \alpha + \beta_1 High\ Exposure\ to\ ETF\ Discount_{i,Tantrum} + \beta_2 Time\ to\ Maturity_{i,t} + \beta_3 Amihud\ Illiquidity_{i,t} + \beta_4 Rating_{i,t} + \epsilon_{i,t}$$

t-stastistcs with standard errors clustered by issuer are presented next to the coefficient. * indicates significance at the 10% level; **, at the 5% level; and ***, at the 1%

Panel A: Univariate analysis

Month	High Exposure Dummy	t-stat	Constant	t-stat	No. of Obs
Jun-13	-0.0816*	-1.92	1.813***	59.13	4,906
Jul-13	-0.0403	-0.98	1.670***	56.3	4,861
Aug-13	-0.00129	-0.03	1.626***	53.87	4,980
Sep-13	0.0956**	2.2	1.573***	50.35	4,818
Oct-13	0.126***	2.76	1.516***	46.24	4,789
Nov-13	0.177***	3.81	1.425***	42.73	4,691
Dec-13	0.189***	4.47	1.284***	42.3	4,654
Jan-14	0.144***	3.01	1.258***	36.78	4,625
Feb-14	0.160***	3.58	1.245***	38.72	4,526
Mar-14	0.168***	3.61	1.172***	34.79	4,504
Apr-14	0.160***	3.57	1.096***	33.68	4,428
May-14	0.161***	4.25	1.062***	38.39	4,366
Jun-14	0.170***	4.86	1.011***	39.16	4,367
Jul-14	0.0950**	2.55	1.094***	39.64	4,292
Aug-14	0.0448	1.13	1.217***	41.47	4,171
Sep-14	-0.0117	-0.27	1.297***	40.59	4,172
Oct-14	-0.0248	-0.51	1.464***	40.63	4,169
Nov-14	0.031	0.61	1.494***	39.19	4,114
Dec-14	-0.0978	-1.57	1.753***	37.28	4,077
Jan-15	-0.121*	-1.69	1.861***	34.31	4,032
Feb-15	-0.0226	-0.34	1.647***	32.77	3,954
Mar-15	-0.0437	-0.66	1.670***	33.14	3,941

Panel B: Multivariate analysis

Month	High Exposure Dummy	t-stat	Time to Maturity	t-stat	Amihud Illiquidity	t-stat	Rating	t-stat	Constant	t-stat	No. of Obs
Jun-13	0.0472	1.14	0.0105***	4.71	13.44***	10.31	0.210***	55.01	-0.280***	-6.28	4,530
Jul-13	0.0677	1.57	0.00912***	3.88	11.37***	8.64	0.185***	47.87	-0.165***	-3.64	4,440
Aug-13	0.014	0.3	0.0170***	6.53	11.26***	8.76	0.175***	42.8	-0.142***	-2.94	4,453
Sep-13	0.142***	3.01	0.0127***	4.94	13.85***	9.18	0.178***	41.41	-0.209***	-4.18	4,423
Oct-13	0.167***	3.31	0.0150***	5.46	14.81***	7.8	0.189***	39.7	-0.354***	-6.52	4,356
Nov-13	0.237***	4.47	0.0118***	4.12	11.28***	6.63	0.184***	36.71	-0.369***	-6.48	4,175
Dec-13	0.249***	5.24	0.0128***	5.03	10.22***	6.69	0.170***	38.17	-0.401***	-7.92	4,181
Jan-14	0.193***	3.48	0.0157***	5.15	14.43***	7.32	0.175***	33.96	-0.488***	-8.27	4,196
Feb-14	0.182***	3.57	0.0188***	6.84	10.10***	5.99	0.184***	37.94	-0.550***	-10.06	4,044
Mar-14	0.169***	3.1	0.0215***	6.99	10.31***	6.32	0.171***	32.81	-0.531***	-8.99	4,074
Apr-14	0.152***	2.96	0.0175***	6.27	12.29***	6.86	0.163***	32.39	-0.510***	-9.06	4,023
May-14	0.117***	2.74	0.0190***	8.29	10.59***	7.24	0.141***	33.42	-0.342***	-7.25	3,924
Jun-14	0.112***	2.84	0.0191***	9.19	8.459***	6.05	0.136***	33.87	-0.326***	-7.38	3,919
Jul-14	0.00539	0.13	0.0237***	10.27	8.863***	6.06	0.145***	34.07	-0.343***	-7.25	3,812
Aug-14	-0.0389	-0.88	0.0305***	12.1	6.984***	5.06	0.187***	40.56	-0.606***	-12.03	3,604
Sep-14	-0.0464	-0.97	0.0229***	8.96	13.67***	7.77	0.189***	37.56	-0.536***	-9.86	3,695
Oct-14	-0.0354	-0.69	0.0198***	7.09	19.40***	9.82	0.230***	40.54	-0.712***	-11.92	3,734
Nov-14	0.0418	0.74	0.0152***	5.05	12.88***	7.08	0.224***	36.03	-0.585***	-8.97	3,645
Dec-14	-0.155**	-2.33	0.0250***	7.06	20.01***	10.97	0.292***	39.46	-0.998***	-12.73	3,656
Jan-15	-0.103	-1.31	0.0216***	5.05	12.25***	5.43	0.305***	34.9	-0.959***	-10.33	3,632
Feb-15	-0.0525	-0.72	0.0290***	7.17	11.01***	5.6	0.282***	34.41	-0.991***	-11.41	3,523
Mar-15	-0.0435	-0.61	0.0238***	6.36	14.84***	7.01	0.270***	33.88	-0.872***	-10.18	3,568