Short Selling Equity Exchange Traded Funds and its Effect on Stock Market Liquidity

Egle Karmaziene
University of Groningen & SHOF*

Valeri Sokolovski
HEC Montréal†

March 11, 2019

Abstract

We examine short selling of equity exchange traded funds (ETFs) using the September 2008 short-sale ban. Contrasting the previously-documented contractions in other bearish strategies, we demonstrate that during the ban the short sales of the largest and the most liquid ETF, the S&P 500 Spider, significantly increased. We offer evidence that it was driven primarily by short sellers circumnavigating the ban. We also document a concurrent increase in the supply of ETF shares suggesting that they can be created to accommodate short-sales. Additionally, we show that the detrimental effect of regulatory short-sale constraints on stock liquidity was up to 10% less severe for the constituents of the Spider. Our results suggest that short-sales of ETFs are a viable substitute for directional short-sales of individual stocks. They also highlight a novel channel through which ETFs can have a positive effect on the liquidity of its underlying securities.

Keywords: Exchange traded funds, ETFs, financial crisis, liquidity, short selling, short-sale ban, short-sale restrictions, regulation.
JEL Classification: G14, G18, G28.

*University of Groningen, Department of Economics, Econometrics & Finance, Nettelbosje 2, 9242 AE, Groningen, The Netherlands. Email: e.karmaziene@rug.nl.

†HEC Montréal, Finance Department, 3000 Côte-Sainte-Catherine Road, Montréal, H3T 2A7, QC, Canada. Email: valeri.sokolovski@hec.ca.

1 Introduction

Existing empirical literature finds that regulatory short selling constraints are severely detrimental to stock market quality (Boehmer et al. (2013), BJZ hereafter, Beber and Pagano (2013)). One could expect bearish derivative strategies to alleviate some of these constraints (e.g. Figlewski and Webb (1993)). However, empirically, it is not the case as derivative markets seem to fail to replace stock short sales, particularly in times when this replacement is needed most. Analyzing the 2008 U.S. temporary short-sale ban on financial-sector stocks ("the ban" or "short-sale ban" hereafter), prior studies show that short-sale order flow did not migrate from stocks to either options or single-stock futures markets. Instead, they find that those markets experienced a pronounced deterioration in liquidity (Battalio and Schultz (2011), Grundy et al. (2012), GLV hereafter).

We focus on financial instruments that have not been previously examined in this context – the ETFs (portfolios of securities that, similar to stocks, trade continuously on the stock exchange and can be sold short). Over the last decade, the ETF market grew immensely and currently its total size is estimated to be around $5 trillion (EY (2017)). Regulators and practitioners have expressed concern about the potential negative effects of ETFs.[1] The concern is not unfounded, as a growing body of work on this subject shows that ETFs can, for example, increase non-fundamental volatility and return co-movement of the underlying securities (Ben-David et al. (2018), Da and Shive (2018)). The existing evidence of the effect of ETFs on liquidity is, however, less clear.[2] In this paper, we bridge the literature on short-sale constraints and ETFs. Using the setting of the 2008 short-sale ban as a laboratory, we examine short selling of equity ETFs, its ability to alleviate short-sale constraints and its effects on the liquidity of the underlying stocks.

[1] See, for example, "ETF growth is 'in danger of devouring capitalism'", by Robin Wigglesworth, Financial Times, 4 February 2018.

[2] For example, Israeli et al. (2017) and Hamm (2014) find that ETF ownership leads to deterioration of the liquidity of the underlying stocks, while Sağlam et al. (2018) suggest that it improves liquidity.

The September 2008 short-sale ban was a surprise, temporary regulatory intervention by the U.S. Securities and Exchange Commission (SEC) banning short sales of essentially all the listed financial-sector stocks. The ban period lasted 14 trading days and led to a significant decrease in the short sales of the banned stocks (BJZ). It, however, placed no restrictions on the short selling of ETFs. Assuming that the demand for short selling the banned stocks remained relatively unaffected by the ban, we ask whether some of the short-sale order flow migrated to the ETF market. To answer this question, we examine a sample of 198 U.S. equity, long-only, non-synthetic (*vanilla*) ETFs that were traded at the time of the ban. We find no average increase in the aggregate ETF short selling, but we find a strong increase in the short sales of the Standard and Poor's Depository Receipt (SPDR) S&P 500 ETF (ticker symbol SPY), also known as the Spider. Given that the ban only affected financial sector stocks, we would expect to see an increase in short sales of only the ETFs that provided exposure to the financial sector. Our results are in line with this because around 70 stocks in the Spider's portfolio were banned, and the correlation between the daily returns of the Spider and a financial-sector index was over 90% during our sample period.

The short interest of the Spider increased, on average, by 35% during the ban period. We estimate that, at its maximum, close to $5 billion of new short positions were established using this ETF during the ban period. Importantly, we show that this increase was not driven by ordinary arbitrage activity. Moreover, examining the short interest dynamics of the Spider's underlying stocks, we find no evidence of an increase in their short interest. This suggests that the increase in the Spider's short-sales is unlikely to have been the result of an increase in aggregate short selling activity during the ban period. In addition, we offer evidence of a dynamic response of the ETF supply to the short-sale ban. A unique feature of ETFs is that the number of shares they have outstanding can be quickly and easily increased through the ETF's creation mechanism. Hence, ETF shares can potentially be

created for the purpose of lending them to a short seller (a concept referred to as "create-to-lend" in the financial industry (Welter, 2010)). We document that during the ban the number of Spider shares outstanding increased by around 36%. In sum, our results are in stark contrast to the findings of the prior literature showing a contraction in all other bearish trading strategies (e.g. Battalio and Schultz (2011), GLV).

However, if this surge in the short sales of the Spider was driven primarily by traders circumnavigating the ban, an immediate concern remains. Why do we observe an increase in the SPY rather than in seemingly more natural ETF substitutes (i.e. the financial-sector ETFs, the short-sales of which increased only marginally during the ban)? Although the Spider was not a perfect substitute, we argue that once one considers the characteristics of the cross section of available ETFs together with the short-sale ban's institutional details, the SPY emerges as the most appropriate instrument to bypass the ban.

The SPY is the world's oldest, largest and most liquid ETF. In fact, the average market capitalization of the Spider ($75 billion) around the ban period represents 25% of the total market capitalization of all ETFs in our sample. The Spider's market capitalization was 6 times larger than the total market capitalization of all the financial-sector ETFs and around 45 times as large as the market capitalization of an average ETF in our sample. For this reason earlier ETF studies focused almost exclusively on the Spider (e.g. Elton et al. (2002)) Moreover, the Spider's average borrowing fee and bid-ask spread were around three and ten times smaller, respectively, than those of an average ETF during our sample period. Additionally, unlike the financial-sector ETFs, the Spider did not experience a significant deterioration in its liquidity during the ban. Importantly, short selling the Spider as a way of bypassing the ban would have allowed the short sellers to mask the true intent of their trades and minimize the risk of their new short positions being banned. These were the key concerns of short sellers at the time due to regulatory uncertainty (Battalio and Schultz, 2011), "moral suasion" and regulators' "intimidation tactics" (Sirri, 2009). Provided that

some of the increase in Spider short sales was driven by traders circumnavigating the ban, our results are the first clear example of the use of ETFs to substitute for the short selling of individual stocks – a concept for which we only had anecdotal evidence.[3]

Irrespective of the exact motives for the increase in the short sales of the Spider, our results imply that the constituents of the Spider could be sold short indirectly via the Spider despite the ban. Hence, the banned constituents of the Spider were relatively less short-sale constrained than other similar banned stocks. Given that regulatory short-sale constraints worsen liquidity, we ask whether the relaxation of such constraints via ETF short sales can, at least partially, offset their detrimental effect. In particular, we investigate whether the banned constituents of the Spider, i.e. the members of the S&P 500 index, experienced a less severe deterioration in liquidity during the ban than the banned stocks for which the short-sale constraints were strictly binding. To this end, we calculate the standard liquidity measures suggested by Holden and Jacobsen (2014) and use a difference-in-differences-in-differences (triple differences) approach to evaluate whether the average change in the relative liquidity of the banned, S&P 500 member stocks during the ban was significantly different to the non-member banned stocks.[4]

Corroborating the results of the existing studies, we show that the average liquidity of the banned stocks severely deteriorated during the ban. We also find that for the group of the banned constituents of the Spider, this detrimental liquidity effect is at least 9% less severe than for the other stocks. In other words, the banned S&P 500 member stocks experienced a significantly milder liquidity deterioration relative to similar firms during the

[3]See "More Equity Hedge Funds Turn to Shorting ETFs" by Alistair Barr, MarketWatch, 1 June 2007.

[4]We note the difficulty of finding an appropriate comparison group for S&P 500 member stocks which are, on average, relatively large firms. We try to mitigate this concern through careful sample selection and by appropriately controlling for firm size in all of our regressions. For example, in order to reduce the effect of small, illiquid stocks, we only consider stocks whose average size is greater than that of a smallest S&P 500 member firm and that had listed options at the time of the ban. Additionally, our sample selection procedure excludes the largest financial institutions and S&P 500 index members that were also the greatest benefactors of the TARP rescue package (such as Citigroup, JP Morgan and Bank of America). Hence, our results are not driven by the liquidity dynamics of the largest TARP recipients.

ban. We find that this is particularly pronounced for the price impact measure of liquidity, which measures how much a given trade tends to push the price over the next couple of minutes. The effect holds even after accounting for the aggregate liquidity deterioration. Importantly, this result is robust to controlling for firm size and the firm size interactions with the ban indicators, as Brogaard et al. (2017) show that larger firms experienced a relatively milder liquidity deterioration during the short-sale ban. Thus, our findings are in line with the hypothesis that stocks that were less short-sale constrained, due to the ETF short selling channel, experienced a less severe deterioration in their liquidity. However, given the particularity of the S&P 500 firms, we are unable to claim that all of the differential effect stems from the ETF-short-selling channel.[5] Nevertheless, our results highlight an additional dimension of how ETFs can affect the liquidity of its constituents.

We contribute to two strands of literature. First, we directly relate to the literature on short-sale restrictions, in particular the work on the 2008 short-sale ban. Due to its surprise imposition and temporary nature among other factors, this ban remains a useful laboratory for studying the effects of short-sale constraints. The setting has been used to study the effect of short-sale constraints on the equity markets (BJZ), options markets (Battalio and Schultz (2011), GLV), American Depository Receipts (Jain et al. (2013)), and high frequency trading (Brogaard et al. (2017)). To the best of our knowledge, this is the only paper analyzing short selling of ETFs during the short-sale ban and our results indicate that ETFs were the only financial instruments that experienced a meaningful increase in short positions during that period.[6]

Second, we contribute to the growing literature on ETFs, specifically the few studies

[5]The existing literature finds that S&P 500 index addition can have a positive impact on the price of the added firm (Chen et al. (2004)) and its liquidity (Hegde and McDermott (2003)). The focus, however, is on the level effects and the existing studies offer no guidance as to the potential reasons of why the liquidity S&P 500 firms would be affected differently by an imposition of short-sale constraints.

[6]Both Hendershott et al. (2013), who survey the literature, and GLV briefly examine the inverse, rather than vanilla, equity ETFs and report that trading these ETFs was severely disrupted by the ban.

examining ETF short sales. Evans et al. (2018) and Huang et al. (2018) study ETF short sales executed for operational and hedging motives respectively. Our work is closest in spirit to Li and Zhu (2018) who study directional (speculative) ETF short sales and find that high levels of ETF short-sales predict future returns of the underlying. They further argue that ETFs are used to short stocks that are difficult to short directly (they do not, however, consider the effects on market quality). Additionally, by examining the effects of ETF short sales on the liquidity of its underlying securities, we also add to the current debate on the potential side effects of ETFs. Bhattacharya and O'Hara (2017) develop a model showing that ETFs can increase market fragility. Existing empirical studies show that ETF ownership indeed leads to a number of undesirable outcomes, like increasing non-fundamental volatility (Ben-David et al., 2018), return co-movement (Da and Shive (2018)) and commonality in liquidity (Agarwal et al. (2018)). On the other hand, ETFs have also been shown to improve informational efficiency of its underlying stocks (Glosten et al. (2016)) and to have long-term positive valuation impact on corporate bonds (Dannhauser (2017)). The existing literature, however, finds conflicting results regarding the effect of ETFs on the liquidity levels of its underlying assets. Israeli et al. (2017) and Hamm (2014) find that ETF ownership leads to deterioration of the liquidity of the underlying stocks, while Sağlam et al. (2018), using higher frequency data, find that the liquidity actually improves. Our results are most in line with the latter as we find that ETFs alleviate the detrimental effect of short-sale restrictions on the liquidity of its constituents. However, we differ significantly from the existing studies on liquidity in that we do not consider the level effect. Moreover, the channel that we aim to investigate is not driven by ETF ownership per se, but rather by the ETF short selling. Finally, our findings may have implications for policy makers. Regulators wishing to restrict short sales need to pay greater attention to the effects of the proposed regulation on the ETF market.

2 Institutional background

We use the setting of the 2008 temporary short-sale ban on the financial-sector stocks in the U.S. to conduct our study. The setting has been used and explained in detail in a number of previous studies (see for example Battalio and Schultz (2011), BJZ, and GLV). Hence, we provide only a brief description of the ban and focus on the issues that are most relevant to our research question.

September 2008 was a particularly turbulent period for the U.S. financial markets, with a growing political pressure for regulators to intervene. In an attempt to stabilize the markets, the SEC uncharacteristically imposed a number of short selling restrictions. For more than 70 years, regulators had been consistently relaxing short selling constraints, hence any short sales restrictions would have been a surprise to the market (see Sirri (2009) for a discussion).

First, on the evening of Wednesday, September 17, the SEC issued an emergency order banning "naked short selling" of all U.S. stocks, effective from 12:01 a.m. the following day (release no. 34-58572).[7] On Thursday, September 18, after the U.S. market closed, the SEC made a surprise announcement, issuing another emergency order that put a temporary ban on all short sales in 797 financial stocks (release no. 34-58592). A subsequent 134 companies were added to the list and 10 removed during the ban. No ETFs were on the initial list nor were they ever added to the list of banned securities. The ban was effective immediately and was to last 10 business days, terminating at 11:59 p.m. EST on 2 October 2008, with the possibility of an extension to a maximum of 30 calendar days.

On the same day, September 18, the SEC issued an additional order requiring institutional money managers with more than $100 million in assets under management to file a

[7]The SEC defines "naked short selling" as selling short without borrowing the necessary securities to make delivery.

new form, Form SH, on a weekly basis, detailing their short-selling activity in the previous week (release no. 58591).[8] The following day, September 19, the SEC issued a press release announcing an expansion of a "sweeping investigation of market manipulation". The expanded investigation included obtaining statements under oath from hedge fund managers, broker dealers and other market participants.[9] Both of these regulatory actions exemplify the use of moral suasion by the U.S. regulators as an additional tool to discourage short selling during that period (see Sirri (2009) and McCaffrey (2009) for detailed discussions).

On Sunday, September 21, the SEC made a few technical amendments to the initial ban that were effective immediately (release no. 34-58611). The key amendments to the ban were the delegation of the decision making about the ban status of the firms to the exchanges and the clarification of the fact that market makers were exempt from the ban if they were shorting as part of the *bona fide* market making and hedging activities. However, in its release, the SEC also stressed that market makers are strongly discouraged from using their exemption to facilitate customers' short sales if the market maker knows that such a trade would result in "establishing or increasing an economic net short position (i.e., through actual positions, derivatives, or otherwise)" in the shares of a firm covered by the ban. The wording seems designed to discourage the exploitation of potential regulatory loopholes that would allow one to bypass the ban and is, arguably, another example of the SEC's use of moral suasion to discourage short selling.

On Thursday, October 2, at the end of the initial period, the SEC chose to extend the ban to October 17 (its statutory limit) or three business days following the enactment of

[8]The short selling activities to be disclosed included the number and value of securities sold short and the details on the exact timing of trades. The order further required that the form be filed electronically and be publicly available on EDGAR. A later amendment allowed Form SH to be filed on a non-public basis.

[9]Press Release, U.S. Securities and Exchange Commission, "SEC Expands Sweeping Investigation of Market Manipulation" (September 19, 2008), available at http://www.sec.gov/news/press/2008/2008-214.htm.

TARP, whichever came first.[10] On Friday, October 3, President George W. Bush signed the TARP bill and the ban was lifted on 8 October 2008.

3 Data

Our sample period is from 1 August through 31 October 2008 and is selected to ensure homogeneity in the time series and to better relate to the existing studies on the short-sale ban, in particular BJZ, Battalio and Schultz (2011), and Brogaard et al. (2017).

We utilize data from a number of different sources. In the first part of the paper, we focus on U.S. equity ETF short-sales. For this analysis, we use the securities-lending data from the Markit Securities Finance (MSF) and data on prices and basic characteristics from the Center for Research in Security Prices (CRSP).[11] We construct our sample of 198 long only, physical (non-synthetic) U.S. equity ETFs by matching the MSF and CRSP databases and applying a number of filters that identify the relevant ETFs. We provide a detailed description of the ETF sample selection procedure in Appendix A-I.

MSF, formerly known as *Data Explorers*, collect self-reported data from the lending desks of most of the largest participants in the securities-lending industry, including custodians, lenders, borrowers and brokers, thus offering a very wide coverage.[12] The securities-lending data are provided at a daily frequency. The frequency of the data suits our needs because we are interested in the positions that persist overnight and are not related to high-frequency trading or market making. The data comprise security-level information on lending activity. The variables that we employ are the values and quantities of securities

[10]The TARP (formally, H.R. 1424, the Emergency Economic Stabilization Act of 2008) enabled the U.S. federal government to buy up to $700 billion of distressed and difficult-to-value assets.

[11]For the SPY ETF, we source the daily data on its NAV and shares outstanding from the State Street Global Advisors website.

[12]According to MSF, their data cover at least 80 percent of the equity loan transactions in the market. Drechsler and Drechsler (2014) reports that for the period, January 2004 to December 2013, the lending activity covered by the MSF database includes over 95 percent of the US equities in the CRSP database.

on loan and the lending fees. These variables are measured as of the settlement day, which is typically three days after the trade day in our sample. Following Jones et al. (2016), we adjust the variables by three days to eliminate this settlement lag and reflect data in trade time.[13] Although the securities-lending variables are not a direct measure of short-selling activity, they are a good proxy that have been used in the literature (e.g. Jones et al. (2016), Geraci et al. (2018)) and are well-suited for the questions posed in this paper. Hence, we treat the securities-lending variables as short-selling variables in our analysis.

In the second part of the paper, we examine the liquidity of common stocks around the short-sale ban. We source the stock prices, returns and characteristics from CRSP and we use the Monthly TAQ database to calculate liquidity measures. We obtain S&P 500 index constituents from Compustat-Capital IQ database. Additionally, we use the OptionMetrics database to establish whether a stock had traded options during our sample period. In order to identify the stocks that were subject to the short-sale ban, we use the list of 797 stocks provided by the SEC in its original release and the supplementary information, available from the NASDAQ website, on all the subsequent additions to the list of banned stocks and removals from it.[14] We provide a detailed description of the stock sample selection procedure in Section 5.1.1 and Appendix A-II.

4 ETFs and the short-sale ban

4.1 ETF descriptive statistics

In this subsection we provide an overview of our sample of ETFs. Table 1 reports the descriptive statistics for the market capitalizations, the short-sale variables and the bid-ask

[13]Not adjusting for the timing of the settlement date, leaves all our main results practically unchanged.

[14]Information on all the changes to the banned stocks list that were made during the short-sale ban is available at: www.nasdaqtrader.comTrader.aspx?id=trader_sec_shortsale

spreads. We consider primarily the period before the short-sale ban (1 August 20008 to 18 September 2008) for computing the statistics in order to give a clearer picture of the ETF market at the onset of the ban.

Our sample consists of 198 U.S. equity, long-only, non-synthetic ETFs. Their total market capitalization was, on average, $302 billion just before the ban period. There are 12 pure financial-sector ETFs in our sample, but they constitute only around 4 percent of the total ETF market capitalization. The most distinctive feature of the ETF market, however, is the severe skewness of the distribution of ETF sizes. Figure 1 plots the average market capitalization of each of the 198 ETFs in our sample, highlighting the lopsidedness of the distribution. The five largest ETFs capture close to 42 percent of the total market capitalization. Most noteworthy is the Spider, the largest and oldest ETF, which accounts for around 25 percent of the total market capitalization of the U.S. equity ETF market during our sample period. The Spider is four times larger than the second largest ETF in our sample, the Powershares NASDAQ 100 (ticker symbol QQQ). This makes it, just on account of its size, a unique ETF.[15]

Examining the short-sale variables, we again observe the Spider's prominence. The total market value of ETF short positions during our sample period was around $31 billion with short-sales of the Spider accounting for a third of that amount. Focusing on the short interest, which we define as the total number of shares on loan for an ETF on each day over the total number of shares outstanding on 18 September 2008, we see that the average short interest for the full sample and the Spider is 5.61 percent and 13.92 percent respectively. Given the distribution of ETF sizes, the simple average may put too much weight on the smaller ETFs distorting the economic interpretation, hence we also calculate

[15]The uneven distribution is also present among the different sector funds. Most sector funds, such as the financial or technology sectors are dominated by one or two flagship funds that attract the majority of assets under management. For example, the largest financial-sector ETF in our sample represents around 55% of the total market capitalization of the 12 financial-sector ETFs.

the value-weighted (market-capitalization-weighted) average short interest. Regardless of the measure used during our sample period, the Spider appears to have been more actively short sold than the other ETFs.

Lastly, we look at the borrowing fees (a measure of short-sale cost) and the bid-ask spreads.[16] For both measures, we calculate the equal-weighted and value-weighted averages. The results highlight the stark difference between the borrowing fees and the spreads of the SPY and those of the other ETFs. The Spider's average borrowing fee (0.35 percent) and bid-ask spread (0.01 percent) were around three and ten times smaller, respectively, than those of an average ETF during our sample period. Additionally, we report the change in the value-weighted fees and bid-ask spreads between the pre-ban period (1 August to 18 September) and the short-sale ban period (19 September to 8 October). Similar to what was documented for other asset classes, equity ETFs experienced a substantial decrease in liquidity during the ban period (the bid-ask spread rose on average by 0.19 percentage points across all the ETFs). However, the bid-ask spread of the Spider increased only marginally by 0.01 percentage points (the increase is not statistically significant). We also observe a significant increase in the borrowing fees across all the ETFs during the ban period. It is worth noting, however, that the absolute increase in the borrowing fees of the Spider (0.24 percentage points) was around four times smaller than the corresponding increase in the borrowing fees of financial-sector and non-financial ETFs. In sum, the Spider appears to be substantially larger, more liquid and relatively more resilient to aggregate liquidity shocks than all the other ETFs.

[16]The borrowing fees are expressed in percent per annum and represent a rate that a short seller is required to pay to borrow a security. The bid-ask spread is the difference between the end-of-day ask and bid price from CRSP divided by half their sum and expressed as a percentage.

4.2 Short-sales of ETFs

In this section we ask whether there was a significant increase in short selling of ETFs during the short-sale ban. To this end, we estimate the following ordinary least squares (OLS) regression on our panel of ETFs.

$$ShortInterest_{i,t} = \alpha_i + \beta \, \text{Ban}_t + \theta X_{i,t} + \varepsilon_{i,t}, \tag{1}$$

where $ShortInterest_{i,t}$ denotes the number of shares on loan for ETF i on day t that is scaled by the total number of shares outstanding on 18 September 2008.[17] α_i is a time-invariant ETF fixed effect and Ban_t is an indicator variable that takes the value of one on the days of the 2008 short-sale ban and zero on the other days. $X_{i,t}$ is a vector of controls. We present the regression results in Table 2. We conduct statistical inference using the standard errors clustered by individual ETF and time whenever considering a panel of ETFs and Newey and West (1994) standard errors when considering just a single series.

First, we examine the full sample of ETFs in order to establish a benchmark. The estimated coefficient on the short-sale ban indicator is around zero, suggesting that there was no widespread increase in short interest among the equity ETFs (Table 2, Column 1). This finding is reasonable because the 2008 short-sale ban covered only the financial-sector stocks, hence, one would not expect to see an increase in short sales in a broad spectrum of equity ETFs, even in the presence of order flow migration.

Next, we analyze separately the twelve financial-sector ETFs. Our results indicate that there was no significant increase in short selling of financial sector ETFs during the ban period (Table 2, Column 2). These results may seem surprising because, at first

[17] We scale by the shares outstanding on a specific date because ETF shares outstanding fluctuate daily. Hence, scaling by the each day's shares outstanding would introduce additional noise into the analysis of short-sales. We discuss the issues surrounding ETF share creation later in the paper.

glance, financial-sector ETFs appear to be a suitable substitute for the banned financial-sector stocks. However, once we consider their small size, relative illiquidity and regulatory disadvantages it becomes clear that short selling financial-sector ETFs was not a viable alternative to short selling financial-sector stocks during the 2008 ban. We discuss this in detail in the next subsection.

Finally, we separately examine the dynamics of the short interest of the S&P 500 Spider. We proceed by estimating Regression 1 which, in this case, simplifies to a single time-series regression. We observe a quantitatively large and statistically significant increase in the short interest of the SPY during the ban period (Table 2, Column 3). The average level of the short interest increased by 4.83 percentage points during the ban, which represents a 35 percent increase from SPY's average level of short interest in the period before the ban. This is an economically significant increase. Based on the price of the Spider on the 18 September 2008 ($120 per share), this increase in short positions amounted to the creation of around $4 billion worth of new short positions during the ban period.[18]

One potential explanation for this increase in short-sales could be that it was simply the effect of daily arbitrage activity. An ETF may trade at either a premium or a discount relative to its underlying portfolio. In practice, most liquid ETFs trade close to their NAV due to the presence of a simple arbitrage mechanism (see Marshall et al. (2013) for a discussion). For example, when an ETF sells at a premium an arbitrageur can buy the underlying portfolio and short sell the ETF to lock in the spread. The arbitrageur can then deliver it to the ETF market maker (Authorised Participant) in exchange for shares in the ETF, which can be used to cover the short position. Hence, an increase in short sales

[18]This figure can be viewed as a lower bound of the total value of the new short positions during the ban because it represents a net average increase over the 14 trading days of the ban and does not take into account the turnover in short sales. For example, Geczy et al. (2002) report that the median duration of a stock loan is just three trading days i.e. many short positions are opened and closed within a couple of days. Hence, assuming this duration applies to the SPY, the marker value of the total number of new SPY short positions established during the ban could be in the region of $18 billion.

could be driven by NAV-arbitrage. To control for this effect, we include SPY's premium (difference between the price and the NAV of the SPY) as a control. Following Elton et al. (2002), we lag it by one day because price differences from NAV are measured at the end of the trading day and signal an arbitrage opportunity the following day. Our results suggest that the strong increase in Spider short-sales during the ban was not the result of NAV-arbitrage. Although the estimated coefficient on the premium has the expected (positive) sign and is statistically significant, its inclusion does not decrease the coefficient on the *Ban* dummy (Table 2, Column 4).

To sum up, we find that during the ban period there was neither a market-wide increase in ETF short selling, nor a significant increase in short-sales of financial-sector ETFs. In contrast, we show that there was a pronounced increase in the short-sales of the SPY during the ban and our results suggest that it was not driven by ordinary arbitrage activity.

4.3 The drivers of Spider short-sales

In this section we offer a potential explanation for what drove the strong increase in short sales of the SPY during the short-sale ban. Due to concerns related to suitability, scalability, liquidity and secrecy, we argue that the most plausible explanation is that much of the growth was driven by short sellers attempting to bypass the ban by establishing alternative short positions.

Figure 2 shows a time-series of the Spider's short-interest index during our sample period. The regression results of the previous section are supported by visual inspection. It is clear from the figure that short interest of the SPY was significantly elevated during the 14 trading days of the ban period. It reached its sample period maximum during the ban and returned to the pre-ban level after the ban was lifted. Visually, it appears that the ban was the primary cause of the increase. However, the ban coincided with the epicenter

of the financial crisis and it is possible that this growth of SPY's short interest may be a product of an aggregate increase in short selling due to, for example, increased "market pessimism" during that time period. It is worth noting that an optimum portfolio that is short the market is difficult to reconcile with standard financial theory.[19] Nevertheless, it is possible that during the financial crisis there was an increase in aggregate short selling activity, particularly around the ban period.

To check if a broad increase in short selling could be driving the results, we construct value-weighted indexes of short interest of S&P 500 member stocks. This analysis is motivated by the assumption that if the observed increase in short-sales of the Spider is driven by a broad increase in short selling, such an increase would also be reflected in the Spider's underlying stocks. Figure 2 plots separately the time series of the short selling index of the financial sector S&P 500 member stocks and the index of the S&P 500 stocks that excludes the financial-sector (S&P 500 Ex-Financials). We scale each series by their respective values on 1 August 2008 for ease of visual comparison. Although we notice a slight increase in the short interest of both the SPY and its underlying stocks at the time of the Lehman Brothers bankruptcy, we do not observe any pronounced trends prior to the imposition of the ban. Importantly, the short selling in all of the S&P 500 stocks appears to decrease during the ban period in contrast to the short sales of the SPY. We confirm our visual intuition by running Regression 1 on the short interest index of S&P 500 Ex-Financials stocks.[20] The estimated coefficient on the ban indicator is negative, albeit insignificant, indicating that there was no increase in the short interest of the non-financial-sector S&P

[19] In classical general equilibrium models the conditional expected return to the aggregate stock market, for which the S&P 500 is a proxy, is higher than the risk-free rate in equilibrium (see, e.g., Cochrane (2009)). Hence, in such a framework, if an investor short sells the aggregate stock market it implies either that the entire market is temporarily mispriced or that the investor is irrational. Neither of these two extreme cases are typically considered.

[20] In this analysis we examine only on the stocks that were not subject to the short-sale ban, S&P 500 Ex-Financials, because it has already been shown that short selling of the financial-sector stocks decreased significantly during the ban (e.g. BJZ).

500 stocks (Table 2, Column 5).[21] This result suggests that it is unlikely that there was an increase in aggregate short selling activity during the ban period.

As an additional test, we examine another large ETF with similar characteristics to those of the Spider. We consider the Russell 2000 ETF (ticker symbol IWM) which is a portfolio of 2000 small U.S. stocks and it is the fourth largest ETF in our sample (its average market capitalization is around $11 billion). It is a broad market index and, given that small stocks tend to underperform in a recession, it would have been a good target for a short seller wishing to short the entire market. Importantly, similar to the SPY it is actively sold short. Its average short interest during our sample period is around 49 percent, which contrast the other 3 large ETFs (the QQQ, the IWB and the VTI) whose average short interest is negligible (less than 0.6 percent) during our sample period. We plot the short interest of the Russell 2000 ETF in Figure 2. Similarly to the short interest of the S&P 500 constituents, short interest of the Russell 2000 ETF decreases during the ban period further suggesting that there is little evidence to imply that there was an aggregate increase in short selling activity during the ban period.

We cannot rule out completely that some of the new short-sale positions in the SPY were created by those wishing to short the entire market. A more likely explanation, however, is that the surge in short positions of the SPY was driven by short sellers wishing to short financial-sector stocks during the short-sale ban. In order to better illustrate this argument, we consider the problem of a typical short seller of financial-sector stocks at the time of the ban. First, we note, as was discussed in Section 2, that the 2008 short-sale ban was a surprise to all the market participants and it was common knowledge that the ban would be temporary. Second, we assume that if a speculative trader was short

[21] We check that the decrease in the average short selling of the underlying stocks (a decrease in quantity) is not driven by a significant increase in the lending fees (price). In unreported results, we examine the average lending fee of the underlying non-financial sector stocks and contrast it to the lending fee of the Spider during the ban. We do not observe a significant increase in the lending fees of the underlying stocks, which implies that cost-based substitution was not the driver of the increase in Spider short-sales.

selling financial sector stocks at the time of the announcement of the ban, he or she was short a portfolio of financial sector stocks rather than just a single stock. We believe this to be a reasonable assumption because during the 2008 crisis many financial firms were experiencing difficulties and could have been similarly likely short-selling targets. Third, we assume that the traders sought low short selling costs and potential scalability of their positions. Lastly, we assume that, because of the increased regulatory and public scrutiny of short sellers at the time of the ban, secrecy was a vital concern. Usually short sellers balance conflicting incentives for secrecy. On the one hand, a short seller has an incentive to publicize her opinion to hasten the stock price going down, on the other hand a short seller may also want to short in secret to minimize recall risk and, importantly, to avoid being sued or harassed (e.g. Lamont (2012)). However, given the almost universal hostility towards short sellers at the time of the 2008 ban, remaining secret was, arguably, the primary concern.[22] Hence at the onset of the ban, a typical short seller needed to establish a temporary alternative position, at short notice, that would provide short exposure to a portfolio of financial-sector stocks and that would ideally not attract undue regulatory attention to either the short seller or her prime broker. For a number of reasons, the Spider was an ideal instrument for short selling financial-sector stocks during the ban.

Most importanly, short selling the SPY would have provided effective exposure to the financial sector and it was simple to execute. At the time of the ban, around 16 percent of the the Spider's underlying portfolio was comprised of financial sector stocks. In fact, the correlation of daily returns of the Financial Select Sector SPDR ETF (XLF) which seeks to replicate the performance of the financial sector of the S&P 500 Index and the

[22] As we discuss in Section 2, the new obligation for short sellers to disclose all of their positions, the expansion of the SEC's investigation into short selling activity and the discouragement of market makers from facilitating short sales in banned stocks are some of the features of the 2008 short-sale ban that would have made secrecy preferable. Moreover, during that time period, short sellers were often threatened with persecution. For example, the New York State Attorney General Andrew Cuomo announced a "wide ranging" investigation into short selling and said that "I want the short sellers to know... that I am watching" (see McCaffrey (2009) for a discussion).

daily returns of the SPY was around 90 percent during our sample period before the implementation of the ban (1 August 2008 to 18 September 2008).[23] Given that the Spider is a popular and well-understood financial instrument (e.g. Elton et al. (2002)) and the fact that practitioners are known to frequently short sell ETFs, particularly the SPY, for risk management purposes (Gastineau (2010)), it would have been a natural and easy trade to execute, even at short notice. Given that the ban was a surprise and market participants had little time to fully understand the temporary short-sale regulations, a simple trade would have been preferred. Of course, by short selling the Spider the short seller would be effectively short selling all its underlying stocks. However, in order to create an almost perfect short of the financial-sector S&P 500 stocks, the short seller of the SPY would have needed to simply open a few offsetting long positions in the SPY's underlying non-financial-sector stocks. We present some suggestive evidence of this in Appendix A-IV. Moreover, for those short sellers with strict investment mandates limiting their use of derivatives or the lack of established derivative trading technology, the Spider offered an additional advantage of being an equity instrument.

One may wonder whether the financial-sector ETFs would not have been better suited for short selling the financial sector stocks. However, we argue that was not the case during the 2008 short-sale ban because of the Spider's additional advantages. The Spider offered unparalleled scalability and liquidity. As we have discussed in Subsection 4.1 the Spider was around six times larger and ten times more liquid than the financial-sector ETFs available at the time. Additionally, as was shown in Table 1, the Spider was more resilient than any other ETF to the aggregate liquidity shock experienced during the ban period. Moreover, given the regulatory uncertainty at the time and the fact that additional securities were added to the banned list almost every day during the ban, it is not unreasonable to believe that market participants may have been concerned that short selling financial-sector ETFs

[23]The R^2 of the regression of daily returns of the Financial Select Sector SPDR ETF (XLF) on the daily returns of the Spider is 83 percent.

would eventually also be restricted. The Spider's liquidity and its large size made it a superior instrument for short selling not only to other available ETFs, but also to options, the liquidity of which evaporated during the ban period (Battalio and Schultz (2011) and GLV). Finally, short selling financial-sector stocks via the short selling of the Spider would have allowed the short sellers to mask the true intent of their trades and give their brokers "plausible deniability" in facilitating such a trade as it could be argued that it was executed for risk management purposes.[24] Given the concern for secrecy during the short-sale ban, short selling banned stocks via the Spider would have been a better alternative to short selling financial-sector ETFs or to entering a derivative trade (e.g. buying put options) in which one's intentions were obvious to both one's broker and the regulators.

In sum, both our empirical results and the institutional details of the 2008 short-sale ban, are suggestive of the observed increase in the short sales of the Spider being driven by traders wishing to circumvent the ban and to indirectly short sell some of the banned financial-sector stocks.

4.4 Supply of the Spider and the "create-to-lend" mechanism

A distinctive feature of ETFs is that the number of ETF shares can change daily through the creation-redemption mechanism. Typically this mechanism ensures that ETFs trade close to their NAV. However, additional shares of an ETF can be created solely to facilitate short selling. This ability, termed "create-to-lend", is unique to exchange traded funds. Essentially, if a prime broker is faced with a request to borrow ETF shares, which are not readily available, this broker can purchase or borrow the underlying securities and create new ETF shares to subsequently lend to a short seller.[25] There is substantial anecdotal

[24] As we have discussed in Section 2, the SEC explicitly instructed that market makers not facilitate transactions that were attempting to bypass the spirit of the ban.

[25] In the event that the broker purchases the underlying basket of securities in order to create an ETF and lend it to the short seller, the broker may short sell the underlying securities in order to offset its

evidence of this practice (Gastineau (2004, 2010), Welter (2010)), however, to the best of our knowledge, there is no analysis of it in the academic literature.

In this section, we seek to establish empirical evidence for the "create-to-lend" mechanism. In other words, we evaluate whether the supply of ETF shares is pro-actively increased during the surge of ETF short-sale demand. Our approach is as follows. Having established that there was a significant increase in the short-sales of the SPY during the ban, we examine whether it coincided with an increase in SPY ETF shares. Our identification assumption is that the ban was an exogenous shock to the ETF short sales and, subsequently, to the quantity of ETF shares outstanding.

The result can be communicated visually. Figure 3 presents the time series of the total shares outstanding of the Spider as well as its market capitalisation (which is roughly equivalent to its assets under management). We see a dramatic increase in the quantity of SPY shares. Regression analysis confirms the visual intuition (Appendix A-III). Visually examining the market capitalization of the Spider highlights the increase. Despite the general decrease in prices, the total market value of the Spider increased during the ban as the effect of the new share issuance overshadowed the effect of the falling price. Between the start and the end date of the ban around 230 million new SPY shares were created, whose market value is around $30 billion at 18 September 2008 prices. After the ban is lifted we observe a pronounced dip in SPY shares outstanding, but not a complete reversal. As both activities, the creation and destruction of ETF shares, carry a cost, we do not expect many ETF shares to be destroyed after the short positions are covered and the borrowed ETFs are returned. The lenders can simply sell their ETF shares once they receive them back from the short sellers.

Our results support the notion that the short-selling ban led to a additional creation of

exposure. We present a diagrammatic description of this process in the Appendix A-III.

Spider shares. We cannot claim with certainty that these shares were created primarily for the purpose of lending to short sellers. However, in the absence of a reasonable alternative explanation, and given the concurrent increase in short selling as well as the timing of this increase in shares outstanding almost perfectly coinciding with the ban period, our results are suggestive of this motive.

5 Liquidity of the underlying stocks

In this section, we examine the effect of ETF short selling on the liquidity of its underlying stocks. Existing literature finds that short-sale bans have only a negligible effect on prices, but a strongly detrimental effect on liquidity (Beber and Pagano (2013), BLZ). If regulatory short-sale constraints deteriorate the liquidity of stocks, then one could expect the relaxation of such constraints via ETF short sales to, at least partially, counteract the detrimental effect of these constraints. Thus, using the setting of the short-sale ban, we examine the liquidity of stocks and ask whether the adverse effect on liquidity is different for stocks that were sold short indirectly via ETFs.

Given our finding that only the short selling of the Spider increased significantly during the ban, we compare the effect of the ban on the liquidity of the stocks in the Spider's portfolio at the time of the ban with the effect of the ban on the liquidity of the stocks that were not in its portfolio. The Spider is simply a portfolio of S&P 500 stocks, hence our analysis essentially amounts to the comparison of the changes in liquidity around the ban of the banned S&P 500 index member stocks and the banned stocks that were not members of the S&P 500 index. Naturally, the special features of the S&P 500 member stocks present a challenge for disentangling any effects. To alleviate this concern, we first select our sample accordingly and, second, we use a difference-in-differences-in-differences (triple difference) approach in our formal analysis. We present the detailed description of

our approach and the empirical results in the next subsections.

5.1 Stock sample construction, variable defintions and descriptive statistics

5.1.1 Sample construction

We closely follow the existing literature in constructing our sample of stocks. In particular, we restrict our sample to only the common stocks that were listed on the three main U.S. exchanges and we require that, at the start of the ban, the stock price of each firm in our sample was not lower than $5 a share and each firm had traded options on its stocks. After applying these initial filters, we identify the stocks that were subject to the short-sale ban and exclude from the sample all the stocks that were added to the banned list after 23 September 2008 or were removed from the list at any time before the expiration of the ban.[26] We differ from the prior studies in that our research question requires the comparison between firms that were and were not members of the S&P 500 index. This complicates the sample selection process because S&P 500 member firms are typically larger firms. However, size is not the only determinant for a firm's inclusion in the S&P 500 index.[27] The determination of the S&P 500 membership is not purely rule-based, but is decided, with a degree of discretion, by the Standard & Poor's Index Committee based on the criteria such as domicile, liquidity, size of its public float, sector classification and other factors. Thus, there is scope for finding a control group of non-S&P 500 member firms relatively comparable in sizes to those of the index members.

We identify the firms that were S&P 500 members as of the first day of the short-

[26] We provide additional details regarding our sample construction in Appendix A-II.

[27] This is well illustrated by the fact that among the 500 largest common stocks in our initial sample on 18 September 2008 only 358 were members of the S&P 500 index. Additionally, prior to 2013 the S&P 500 index could only include U.S. companies. For example, both Goldman Sachs and Deutsche Bank were on the short-sale ban list and were similar in size (approximately $42 billion) at the onset of the ban, yet only Goldman Sachs was a member of the S&P 500 index.

sale ban. Then, guided by the sample trimming rule proposed by Crump et al. (2009) to alleviate limited overlap in covariate distributions between treatment groups, we restrict our sample to firms whose average market capitalization in July 2008 was in the range delimited by the minimum ($0.7 billion) and the 90th percentile ($46 billion) of the market capitalization of the banned S&P 500 stocks.[28] Our final sample consists of 1,397 stocks, 66 of which are banned S&P 500 index members and 110 of which are also banned, but are not members of the S&P 500 index (nonmembers).[29] The other 1121 stocks are the stocks that were not subject to the short-sale ban (nonbanned stocks) and 344 of those were members of the S&P 500 index. We include in our sample the stocks that were never subject to the short-sale ban as they are necessary for controlling for broad market effects. However, the identification of the differential effect of interest is driven exclusively by the banned stocks in our sample, hence we focus the discussion on their properties.

Panel A of Table 3 presents the descriptive statistics of the firm sizes for the four different groups of stocks in our sample − the banned S&P 500 members, the nonbanned S&P 500 members, the banned nonmembers of the S&P 500 and the nonbanned nonmembers of the S&P 500. Among the group of S&P 500 member stocks and the group of nonmember stocks, the average size of the banned and nonbanned firms is very similar. However, as expected, an average S&P 500 member firm is significantly larger than an average nonmember firm. The average (median) size of a banned S&P 500 member firm and a banned nonmember firm is $13.79 billion ($10.27 billion) and $3.3 billion ($1.86 billion) respectively. Notwithstanding, the two groups are not incomparable. It's worth noting that in BJZ's analysis of sub-samples of the banned stocks of different sizes, most, if not all, of the banned stocks in our sample would have been assigned to their "largest-quartile" group of

[28] Our main results remain quantitatively similar if we instead consider the 1st, 5th or 10th percentile of the market capitalization of the banned S&P 500 stocks as the lower cut-off for sample selection.

[29] Among the members of the S&P 500 index that were on the short-sale ban list, our trimming procedure only eliminates the six largest firms such as General Electric (market capitalization around $280 billion) and JP Morgan (market capitalization around $130 billion) for which no reasonable comparable firms exist.

stocks.[30] Figure 4 separately displays the average sizes of each firm of the banned S&P 500 members and the banned nonmembers. Visual inspection of Figure 4 suggests that there are a number of commonalities between the two groups. For example, the minimum and maximum sizes of the different types of firms in our sample are, by construction, essentially identical. Moreover, for any firm of a given size in the group of banned S&P 500 member stocks it is possible to find at least one firm of a comparable size in the group of banned, nonmember stocks. In fact, a few firms in the group of banned nonmembers were subsequently included in the S&P 500 index. For example, NASDAQ (ticker symbol NDAQ) and BlackRock (ticker symbol BLK) were added to the S&P 500 index on 22 October 2008 and 1 April 2011 respectively. Nevertheless, it is evident that there is a higher prevalence of larger firms in the group of banned S&P 500 member stocks. Unfortunately, the limitation of analyzing members of the S&P 500 index lies in the inability to find a perfect control group. As we discuss in the next sections, we ameliorate this concern by using an identification strategy that does not rely on the treatment and control groups having the same *ex ante* characteristics and we control for firm size in all our formal empirical tests.

5.1.2 Liquidity measures

Similar to BJZ, for each stock in our sample and for each day, we calculate four standard measures of liquidity − the quoted spread, effective spread, realized spread and price impact. When calculating these measures we follow the procedure of Holden and Jacobsen (2014) that has been shown to deliver more precise estimates of liquidity by appropriately accounting for withdrawn quotes and economically irrational states during computation.

[30]BJZ report that they have 182 stocks in their largest-quartile of stocks, while our sample contains 176 large stocks stocks (we have dropped 6 of the largest stocks). The reported median sizes of their third quartile (second-largest quartile) of stocks is only \$0.481 billion, while the smallest banned firm in our sample size is \$0.7 billion, which makes it unlikely that many, if any, of the firms in our sample would be assigned to their third quartile. Although we do not know the exact firms in their sample, given these statistics and the fact that we follow a very similar sample construction procedure, it is reasonable to assume that most of the banned stocks in our sample would be in their largest-quartile sub-sample.

The four liquidity measures are defined as follows:

$$Quoted\ Spread_s = (Ask_s - Bid_s)/\,\text{Mid}_s \tag{2}$$

$$Effective\ Spread_k = 2 * D_k * (P_k - Mid_k)/Mid_k \tag{3}$$

$$Realized\ Spread_k = 2 * D_k * (P_k - Mid_{k+5})/Mid_k \tag{4}$$

$$Price\ Impact_k = D_t * (Mid_{k+5} - Mid_k)/Mid_k, \tag{5}$$

where Ask_s and Bid_s are the National Best Ask and Best Bid assigned to interval s and Mid_s is the midpoint, which is the average between Ask_s and Bid_s. Mid_{k+5} is a midpoint price 5 minutes after trade k. P_k denotes the stock price at trade k. D_k takes a value of 1 if trade k is categorized as buyer-initiated and the value of -1 if it is categorized as being seller-initiated. We categorize trades using the Lee and Ready (1991) algorithm. We aggregate each measure to the daily level. For each stock on each day the quoted spreads and effective spreads are the time-weighted and dollar-volume-weighted averages of $Quoted\ Spread_s$ and $Effective\ Spread_k$ respectively. For the other two liquidity measures, the daily aggregates for each stock are equal-weighted averages across all the trades on each day. After calculating the measures, we winsorize each one at the 1^{st} and the 99^{th} percentile to limit the effect of outliers. For ease of exposition we express the liquidity measures in basis points. It is worth noting that each of our liquidity measures is actually a measure of illiquidity, hence an increase signifies a deterioration of liquidity.

In Panel B of Table 3, we present the averages of the four liquidity measures for the period before the imposition of the ban (1 August 2008 to 18 September 2008) and the ban period. For each group of stocks, we calculate a time series average over the stated period and then calculate a cross-sectional average. These statistics show that there was a universal deterioration of stock market liquidity during the ban, which makes sense given the market dislocation around that time. Additionally, in line with the results of the

existing studies, we clearly see that the liquidity of the banned stocks deteriorate most severely. For example, the average quoted spread of a banned S&P 500 stock increased by 8.27 basis points during the ban from its pre-ban average level of 7.08 basis points. While the average change in the quoted spread during the same period for a stock of an S&P 500 firm of a similar size and with similar pre-ban liquidity was only 2.39 basis points.

Importantly, we observe another dimension of the effect that has not been discussed in the existing literature. Irrespective of the liquidity measure we consider, it appears that the liquidity of the banned stocks that were not members of the S&P 500 index deteriorated more than the liquidity of the banned S&P 500 member stocks. For example, the average quoted spread of the banned nonmember firm increased by 15.12 basis points during the ban from its average level of 13.77 basis points in the period before the ban. Of course, nonmember firms are, on average, smaller and the liquidity of their stocks is, on average, slightly lower. Hence, it is possible that this differential effect could be driven by the greater exposure to the aggregate liquidity shocks. Indeed, we observe a relatively stronger deterioration in liquidity of the nonbanned nonmember stocks compared to the liquidity of the nonbanned S&P 500 member stocks (for example, during the ban, the average quoted spread of the nonbanned nonmember stocks increased by 5.22 basis points, compared to the 2.39 basis points increase for the nonbanned member stocks). However, adjusting for the broad market effects by subtracting the average change during the ban in the liquidity of the nonbanned stocks from the average change in liquidity of the banned stocks, appears to preserve the pronounced difference in the liquidity deterioration between the banned S&P 500 member and the banned nonmember stocks (Table 3, Column 2Δ). These statistics suggest that the banned S&P 500 member stocks, i.e. the stocks that were in the Spider's portfolio, experienced a less severe deterioration in liquidity during the ban than the banned stocks that were not in the Spider's portfolio. We examine this formally in the next subsection.

5.2 Identification strategy and empirical methodology

Motivated by the analysis of the previous section, we employ the triple difference methodology to formally evaluate the average effect of a SPY membership on banned stock's liquidity during the short-sale ban. In particular, we estimate the following panel regression:

$$y_{i,t} = \beta_1 Ban + \beta_2 Ban \times Banned + \beta_3 Ban \times Banned \times SP + \beta_4 Ban \times SP + CX_{i,t} + c_i + c_t + \varepsilon_{i,t}, \quad (6)$$

where the dependent variable, $y_{i,t}$, is one of the four liquidity measures defined in the previous section (the five-minute price impact, quoted spreads, effective spreads, or five-minute realized spreads) for each stock i on each day t. *Ban* is an indicator variable that takes the value one on the days of the 2008 short-sale ban and zero on all the other days. *Banned* and *SP* are indicator variables that take the value one for the banned stocks and S&P 500 index members (as of 18 September 2008) respectively, and zero otherwise.[31] $X_{i,t}$ is a vector of controls that includes daily turnover and market capitalization. Given that liquidity levels differ among stocks, Regression 6 includes the time-invariant stock fixed effect, c_i, which absorbs the time-invariant differences in liquidity among stocks.[32] Lastly, we include stock-invariant time fixed effect, c_t, which absorbs market-wide liquidity shocks. We conduct all our statistical inference using the standard errors clustered by individual stock and time.

Regression 6 can be interpreted from the difference-in-differences perspective. The first difference compares the average liquidity between the short-sale ban period and the other periods. The coefficient β_1 captures that effect. The second difference compares average change in liquidity of the banned stocks to the average change in liquidity of the nonbanned

[31] The *Banned* indicator does not differentiate between stocks that were on the initial list and the stocks that were banned on Monday, 23 September 2008. Restricting our analysis to only the stocks on the initial ban list, does not significantly alter the empirical results.

[32] Due to the inclusion of firm fixed effects, we are unable to identify the coefficients on *Banned* and *SP* indicators, thus we omitted them from Regression 6.

stocks during the ban period. This differential effect of the short-sale ban on the banned stocks is the focus of the BJZ study and is captured by the coefficient β_2. Estimated on a sample containing both the banned and nonbanned stocks β_1 captures the effect of market-wide liquidity shocks during the ban on stock liquidity, while β_2 estimates the effect of the short-sale constraints. Our specification adds an additional layer − the difference between S&P 500 member and nonmember stocks. We focus on the effect of the ban on the change in liquidity of the banned S&P 500 member stocks, which is captured by the coefficient β_3.

In order to be able to estimate β_3 consistently the parallel trends assumption needs to hold. In particular, we require that any trends in the liquidity measures for the banned S&P 500 members and the banned nonmembers to be the same before the imposition of the ban. Figure 5 plots the time series of the daily averages of four liquidity measures for the banned S&P member and nonmember stocks. Visually, the evolution of the liquidity of the two groups of stocks appears to be very similar before the imposition of the ban. Hence, the parallel trends assumptions seems reasonable in this case.

However, in our case, this may not be sufficient to identify the S&P 500 member effect. As we have discussed in the previous subsection, the effect of firm's size is an important concern as S&P 500 member stocks tend to be larger stocks. Brogaard et al. (2017) show that larger stocks experienced a relatively less severe deterioration in liquidity during the ban. Thus, following Brogaard et al. (2017), we include as controls the interaction of the natural logarithm of each firm's average size, measured just before the start of our sample period in July 2008, with the *Ban* and *Banned* indicators. We also include the logarithmic of each stock's daily market capitalization and daily turnover (the ratio of daily trading volume to its shares outstanding) as additional controls. In sum, given that the parallel trends assumption appears to hold and we include multiple controls for firm characteristics, we interpret the β_3 as the effect of the S&P 500 membership.

5.3 Liquidity regression results

In this section we discuss the results of regression 6 and we focus our discussion on the price impact measure of illiquidity. Table 4 reports the results. We begin with a benchmark difference-in-difference specification, estimated on the sub-sample of banned stocks, that includes only the stock fixed effects and the $Ban{\times}Banned$ and $Ban{\times}Banned{\times}SP$ indicators. In line with the finding of the existing literature, the results show that the ban led to a strong deterioration in liquidity of the affected stocks. Importantly, we observe that that deterioration in liquidity was significantly less for the S&P 500 index stocks i.e. the coefficient β_3 is negative and significant (Column 1).

However, the benchmark specification does not account for the effect of firm size on liquidity changes. We, thus, also include the interaction of the natural logarithm of each firm's average size in July 2008 with the $Ban \times Banned$ indicator and reestimate the regression. The inclusion of the size controls, preserves both the sign and the statistical significance of the β_2 and β_3 coefficients. It also leads to a substantial increase in the point estimate of the β_2 coefficient resulting in more intuitive estimates. The results indicate that the ban led, on average, to a 16.5 basis points deterioration in the price impact among the banned stocks, with the banned S&P 500 stocks experiencing a liquidity deterioration that was around 2.2 basis points less (Column 2). Although it may appear like a small difference, this amounts to a 13% less severe liquidity deterioration, which is economically meaningful.

Next, we estimate regression 6 on the full sample that includes both the banned and not banned stocks. The triple difference specification helps account for the effect of the aggregate deterioration in liquidity during the ban. The absolute value of the point estimate of the β_3 coefficient decreases slightly, but it remains negative and statistically significant (Column 3). Finally, including additional controls (daily turnover and market capitalization) and time fixed effects, has little impact on the results. The full specification shows

that, on average, the liquidity deterioration of the S&P 500 banned firms during the ban was around 9% relatively less severe (Column 4). However, the results of the regressions using the other three liquidity measures, although in line with the results using price impact, are noticeably weaker. The β_3 coefficient is negative, but it is only statistically significant in the full specification in the case of quoted spreads (Columns 5 – 10).

Nevertheless, given that we find that the Spider was heavily short sold during the ban period and that the constituents of the Spider experienced a less severe liquidity deterioration during the ban, it is suggestive that at least some of the liquidity improvement could have been driven by the ETF short sales.

5.4 Do ETF short sales improve liquidity of its underlying stocks?

In the previous subsection we show that the constituents of the Spider experienced a relatively less severe deterioration in their liquidity during the ban. We posit that at least some of this effect was driven by the short sales of the Spider, however, we are unable to empirically show this link. In this subsection, we take a step further in connecting the short sales of the Spider during the ban with the liquidity of its underlying stocks. We estimate the following regression.

$$\begin{aligned} y_{i,t} = {} & \beta_1 SI_t + \beta_2 SI_t \times Banned + \beta_3 SI_t \times Banned \times SP + \beta_4 SI_t \times SP \\ & + CX_{i,t} + c_i + c_t + \varepsilon_{i,t}, \end{aligned} \tag{7}$$

where the dependent variable, $y_{i,t}$, is one of the four liquidity measures for each stock i on each day t. SI_t denotes the number of shares on loan for ETF i on day t that is scaled by the total number of shares outstanding on 18 September 2008 (similar to $ShortInterest_{i,t}$ in regression 1). *Banned* and *SP* are indicator variables that take the value one for the banned stocks and S&P 500 index members, respectively. $X_{i,t}$ is a vector of controls as in

regression 6. c_i and c_t are the stock and time fixed effects, respectively.

The sole difference between regression 7 and regression 6 is that the *Ban* indicator is replaced by SI_t. We observe in Figure 2 that the short sales of the Spider were relatively stable before the ban and increased rapidly during the ban, however the increase was not uniform during the ban period. Regression 7 exploits the timing of the increase in Spider short sale during the ban to identify the link between Spider short sales during the ban and the liquidity of its constituents. As before, β_3 is the coefficient of interest as it capturers the differential effect of the increase in Spider short sales on its constituents.

We report the regression results in Table 5. The results show that during our sample period an increase in Spider's short interest is correlated with a deterioration of liquidity of the Banned stocks (the coefficient β_2 is positive and significant). This is, however, simply an artefact of the relatively high correlation between Spider's short interest and the Ban indicator during our sample period (correlation coefficient =0.57), hence we interpret it as such. Our focus is on the coefficient β_3, which is negative and statistically significant for the price impact and quoted spreads measures of liquidity. This finding corroborate the results of the previous subsection and indicates that higher levels of short sales of the Spider are associated with improved relative liquidity for the S&P 500 firms during our sample period. Moreover, the magnitude of the effect is similar to that obtained from regression 6 (the detrimental effect of the ban on liquidity is around 9% less severe for the constituents of the Spider).

We stress that our analysis cannot establish a causal link between the short sales of the Spider and differential change in the liquidity of its constituents. Nevertheless, the robustness of our results to this alternative specification further supports this explanation.

6 Concluding remarks

ETFs have proven to be one of the most successful financial innovations of recent history. Since the introduction of the first ETF (the Spider) in 1993, the ETF market has grown to the formidable size of around $5 trillion. Moreover, ETF trading currently accounts for over 30% of the dollar volume on U.S. exchanges.[33] The increasing importance of ETFs has sparked the growth of research on the subject, however some gaps in our understanding remain. In particular, there are only a few studies examining ETF short sales, which is surprising given the prevalence of ETF short sales in practice. We contribute to filling this gap in the literature. Using the setting of the 2008 short-sale ban, we examine short selling of vanilla equity ETFs and find a strong increase in ETF short sale during the ban. Although we are unable pinpoint what proportion of these short sales were directional short sales targeting the banned stocks, we argue that a large part of them were speculative short sales aimed at bypassing the ban. We also find a concurrent increase in the supply of ETFs that would have allowed for an even greater short-sale order flow migration. Moreover, we present evidence suggesting that the ability to short sell stocks via ETFs decreases the negative effect of short sales constraints on their liquidity.

Our findings have several implications. We highlight the ability of ETFs to facilitate directional short sales, particularly for securities that are short-sale constrained. This relaxation of short-sale constraints via ETF short sales could have multiple effects on the underlying stocks. We find a positive effect on stock liquidity, which is in line with the previous results that find that short-sale constraints are detrimental to market quality.

However, our study has a few limitations. First, we focus on a period that is characterized by very high volatility. Second, we are unable to identify what proportion of

[33] See "ETFs are eating the US stock market" by Robin Wigglesworth, Financial Times, 24 January 2017.

the ETF short-sales that we observe were executed to bypass the ban. In order to do so, one would require trader-level portfolio data, to which only the financial intermediaries are likely to have access. Moreover, given the sensitive nature of such data, particularly for the ban period, the data are unlikely to be readily disclosed. Future work could examine ETF short selling in different settings to better understand its impact on market quality, and researchers with access to granular positions data could aid in better understanding the incentives for speculative ETF short sales.

Despite the limitations, our results have implications for policy makers wishing to regulate speculative short selling. Given the global proliferation of ETFs and their ability to be used for speculative short sales, any future regulation would require a more elaborate design than in the past to be able to both restrict short selling of the underlying and not disrupt the workings of the ETF market.

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Table 1: ETF descriptive statistics

Panel A of this table presents the descriptive statistics of the market capitalization, short-sale measures and the bid-ask spread for the long only, physical (non-synthetic) U.S. equity ETFs in our sample. Statistics are presented separately for the full sample of ETFs (All), the purely financial-sector ETFs, the non-financial-sector ETFs (non-financial) and the SPDR S&P 500 ETF (SPY). The sub-sample of non-financial-sector ETFs excludes the SPY. The statistics for the market capitalization (*Size*) include the total, mean, median, 10^{th} percentile and 90^{th} percentile, and are expressed in $ billion. Also reported is the share, in percent, of the total market capitalization represented by the largest (*top 1 share*) and the five largest ETFs in each sub-sample (*top 5 share*) respectively. The short sales statistics include the average total market value of short positions (in $ billion), the average equal-weighted and value-weighted (*v.w.*) short interest (defined as the total number of shares on loan for an ETF on each day over the total number of shares outstanding on 18 September 2008 and expressed in percent), and the average equal-weighted (*fee*) and value-weighted (*v.w. fee*) lending fee (both fee statistics are in percent). The average equal-weighted and value-weighted bid-ask spreads (both in percent) are calculated using the end-of-day bid and ask prices. All the statistics are based on the time series averages of daily cross-sectional averages (for value-weighted statistics, the variable of interest at the ETF level is scaled by its share of the total ETF market capitalization before averaging). The sample period for the summary statistics is from 1 August 2008 to 18 September 2008 (Pre-ban period). Panel B presents the average difference between the Pre-ban period and the Ban period (19 September 2008 to 8 October 2008) for the value-weighted borrowing fees and the the value-weighted bid-ask spreads. *** indicates significance at 1 percent, ** - at 5 percent, * - at 10 percent.

	All ETFs	Financial-sector ETFs	Non-Financial ETFs	SPY
Panel A: Summary Statistics				
N	198	12	185	1
Size ($ bil)				
total	302.12	12.07	214.35	75.70
mean	1.66	1.05	1.26	
median	0.37	0.40	0.36	
10^{th} percentile	0.06	0.07	0.06	
90^{th} percentile	3.55	2.00	3.34	
top 1 share (%)	25.06	54.79	8.42	
top 5 share (%)	42.02	88.88	28.14	
Short sales				
total value ($ bil)	31.14	1.14	19.33	10.67
short interest (%)	5.61	10.85	5.17	13.92
v.w short interest (%)	10.18	9.3	8.91	13.92
fee (%)	2.27	2.21	2.29	0.35
v.w. fee (%)	1.04	1.04	1.28	0.35
bid-ask spread (%)	0.21	0.19	0.21	0.01
v.w. bid-ask spread (%)	0.07	0.13	0.09	0.01
Panel B: Ban − Pre-ban				
Δ v.w. fee (%)	0.75**	0.95***	0.98**	0.24***
Δ v.w. bid-ask spread	0.19***	0.23***	0.25***	0.01

Table 2: The impact of the short-sale ban on the short interest of ETFs

This table reports the regression results of daily short interest on the short-sale ban indicator. Short interest is defined as the total number of shares on loan for an ETF on each day divided by the total number of shares outstanding on 18 September 2008 and it is expressed in percent. Ban is an indicator variable that takes the value one on the days of the 2008 short-sale ban and zero on all the other days. Columns (1) and (2) display the results for the full sample of ETFs and the sub-sample of financial-sector ETFs respectively. The specification includes ETF fixed effects. In columns (1) and (2) the reported standard errors are clustered by ETF and day. Columns (3) and (4) display the results for the SPDR S&P 500 (SPY) ETF. Premium is the daily difference between the price and the NAV of the SPY (it is lagged by one day). Column (5) displays the results for the short interest index of the common stocks, excluding financial sector stocks, in the S&P 500 index. The short-sale index for the S&P 500 stocks is the value-weighted sum of the daily short-interest of the individual S&P 500 member stocks. In columns (3), (4) and (5 t-statistics based on the Newey and West (1994) standard errors are reported. The data are daily and the sample period is from 1 August 2008 to 31 October 2008. *** indicates significance at 1 percent, ** - at 5 percent, * - at 10 percent.

	(1)	(2)	(3)	(4)	(5)
	All	Financial ETFs	SPY	SPY	S&P 500 Ex-Financials
Ban	−0.03	2.06	4.83***	4.84***	−0.10
	(0.25)	(1.63)	(0.70)	(0.70)	(0.07)
Premium_{t-1}				0.21***	−0.03***
				(0.05)	(0.01)
Constant			14.48***	14.43***	1.66***
			(0.37)	(0.36)	(0.06)
Observations	10,506	717	65	65	65
Adj R^2	0.92	0.73	0.63	0.64	0.04
ETF FE	Yes	Yes	No	No	No

Table 3: Descriptive statistics of market capitalization and liquidity for the sample of stocks

This table reports descriptive statistics of the market capitalization and four liquidity measures for the sample of common stocks listed in the U.S. The sample is split into stocks that are members of the S&P 500 index and the stocks that are not. It is further split into stocks that were subject to the 2008 short-sale ban (*Banned*) and those that were not (*Nonbanned*). Each firm's market capitalization is its average market capitalization in July 2008. The statistics for the market capitalization (*Size*) include the mean, median, minimum and maximum and are expressed in $ billion. The four liquidity measures are the quoted spreads, effective spreads, five-minute price impact, and five-minute realized spreads (see Section 5.1.2 for the definitions). For each stock, the four liquidity measures are computed using intraday trade and quote data, and aggregated to the daily level (quoted spreads are time-weighted, effective spreads are trade-weighted, and price impact and realized spreads are equal-weighted). Each measure is proportional to the prevailing quote midpoint and is expressed in basis points. Δ denotes differences (either between periods or between sub-samples of stocks) and 2Δ denotes the difference in difference. The data are daily and two sample periods for the liquidity statistics are the *Pre-ban* period which is the period before the imposition of the short-sale ban (1 August 2008 to 18 September 2008) and the *Ban* period (19 September 2008 to 8 October 2008).

		S&P 500			Non S&P 500			
	Period	Banned	Nonbanned	Δ	Banned	Nonbanned	Δ	2Δ
Panel A								
N		66	344		110	877		
Size ($ bil)								
mean	July 08	13.79	13.12	0.67	3.30	3.00	0.30	
min	July 08	0.72	0.71		0.74	0.70		
median	July 08	10.27	9.09		1.86	1.70		
max	July 08	45.04	45.38		43.99	44.98		
Panel B								
Quoted spreads	Pre-ban	7.08	6.00		13.77	12.29		
	Ban	15.35	8.39		28.89	17.51		
	Δ	8.27	2.39	5.88	15.12	5.22	9.90	4.02
Effective spreads	Pre-ban	8.48	6.76		12.22	11.48		
	Ban	20.83	10.49		30.62	17.71		
	Δ	12.35	3.73	8.62	18.40	6.23	12.17	3.55
Price impact	Pre-ban	4.30	3.66		7.05	6.65		
	Ban	9.04	4.55		15.82	9.32		
	Δ	4.74	0.89	3.85	8.77	2.67	6.20	2.35
Realized spreads	Pre-ban	1.52	1.07		2.22	2.07		
	Ban	3.90	2.07		5.30	3.06		
	Δ	2.38	1.00	1.38	3.08	0.99	2.09	0.71

Table 4: The effect of S&P 500 index membership on stock liquidity around the short-sale ban

This table reports the estimates of the difference-in-differences-in-differences OLS regressions of the form:

$$y_{i,t} = \beta_1 Ban + \beta_2 Ban \times Banned + \beta_3 Ban \times Banned \times SP + \beta_4 Ban \times SP + CX_{i,t} + c_i + c_t + \varepsilon_{i,t}.$$

The dependent variables are four liquidity measures: the five-minute price impact, quoted spreads, effective spreads, and five-minute realized spreads (see Section 5.1.2 for the definitions). For each stock, the four liquidity measures are computed using intraday trade and quote data, and aggregated to the daily level (quoted spreads are time-weighted, effective spreads are trade-weighted, and price impact and realized spreads are equal-weighted). Each measure is proportional to the prevailing quote midpoint and is expressed in basis points. *Ban* is an indicator variable that takes the value one on the days of the 2008 short-sale ban. *Banned* and *SP* are indicator variables that take the value one for the banned stocks and S&P 500 index member (as of 18 September 2008) stocks respectively. All the specifications include time-invariant stock fixed effects, c_i. The specifications in columns 4, 6, 8 and 10 include time fixed effects, c_t. The regressions are estimated first on a sub-sample of banned stocks and then on a full sample that includes banned and nonbanned stocks. The vector of controls, $X_{i,t}$, includes an interaction of the natural logarithm of each firm's average size in July 2008 with the *Ban* and *Banned* indicators ($\overline{Size} \times Ban$ and $\overline{Size} \times Ban \times Banned$), the logarithmic of a stock's daily market capitalization (*Size*) and the ratio of each stock's daily trading volume to its shares outstanding (*Turnover*, in percent). The S&P 500 Effect is coefficient β_3 divided by coefficient β_2. The standard errors are clustered at day and firm level. The data are daily and the sample period is from 1 August 2008 to 31 October 2008. *** indicates significance at 1 percent, ** - at 5 percent, * - at 10 percent.

	Price impact				Quoted spreads		Effective spreads		Realized spreads	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ban×Banned	6.31***	16.46**	15.27**	17.56**	36.21***	32.84***	52.86***	46.09***	13.58**	11.35**
	(1.05)	(6.81)	(6.35)	(6.84)	(13.78)	(12.42)	(17.38)	(15.43)	(6.16)	(5.78)
Ban×Banned×SP	-2.91***	-2.18***	-1.68***	-1.59**	-2.43**	-2.24*	-2.32*	-1.77	-0.03	-0.17
	(0.76)	(0.75)	(0.58)	(0.67)	(1.21)	(1.27)	(1.25)	(1.25)	(0.68)	(0.64)
Ban			1.19							
			(3.25)							
Ban×SP			-0.50	-0.34		-0.12		0.02		0.18
			(0.34)	(0.28)		(0.32)		(0.54)		(0.17)
$\overline{\text{Size}}$×Ban×Banned		-0.47	-0.44	-0.52*	-1.21**	-1.10*	-1.80**	-1.57**	-0.52*	-0.45*
		(0.29)	(0.29)	(0.31)	(0.61)	(0.59)	(0.73)	(0.71)	(0.28)	(0.27)
$\overline{\text{Size}}$×Ban			-0.04	-0.14		-0.28		-0.63		-0.11
			(0.12)	(0.14)		(0.29)		(0.68)		(0.10)
Size				-6.34***		-8.21***		-10.73***		-1.11***
				(0.41)		(0.59)		(0.83)		(0.28)
Turnover				-0.05		-0.50***		0.24***		-0.03
				(0.04)		(0.06)		(0.09)		(0.02)
Observations	11,245	11,245	89,959	89,959	11,245	89,959	11,245	89,959	11,245	89,959
Adj R^2	0.37	0.37	0.37	0.56	0.56	0.84	0.36	0.59	0.10	0.17
Stock FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	No	Yes	No	Yes	No	Yes	No	Yes
Sample	Banned	Banned	All	All	Banned	All	Banned	All	Banned	All
S&P 500 Effect	-46.08%	-13.22%	-10.99%	-9.07%	-6.7%	-6.81%	-4.4%	-3.83%	-.21%	-1.52%

Table 5: Stock liquidity and SPY ETF short-sales

This table reports the estimates of the OLS regressions of the form:

$$y_{i,t} = \beta_1 SI_t + \beta_2 SI_t \times Banned + \beta_3 SI_t \times Banned \times SP + \beta_4 SI_t \times SP + CX_{i,t} + c_i + c_t + \varepsilon_{i,t}.$$

The dependent variables are four liquidity measures: the five-minute price impact, quoted spreads, effective spreads, and five-minute realized spreads (see Section 5.1.2 for the definitions). For each stock, the four liquidity measures are computed using intraday trade and quote data, and aggregated to the daily level (quoted spreads are time-weighted, effective spreads are trade-weighted, and price impact and realized spreads are equal-weighted). Each measure is proportional to the prevailing quote midpoint and is expressed in basis points. SI_t is the daily short interest of the SPDR S&P 500 (SPY) ETF defined as its total number of shares on loan on each day divided by its total number of shares outstanding on 18 September 2008 and it is expressed in percent. *Banned* and *SP* are indicator variables that take the value one for the banned stocks and S&P 500 index member (as of 18 September 2008) stocks respectively. All the specifications include time-invariant stock fixed effects, c_i. The specifications 2, 4, 6 and 8 include time fixed effects, c_t. The regressions are estimated first on a sub-sample of banned stocks and then on a full sample that includes banned and nonbanned stocks. The vector of controls, $X_{i,t}$, includes an interaction of the natural logarithm of each firm's average size in July 2008 with *SI* and the *Banned* indicator ($\overline{Size} \times SI$ and $\overline{Size} \times SI \times Banned$), the logarithm of a stock's daily market capitalization (*Size*) and the ratio of each stock's daily trading volume to its shares outstanding (*Turnover*, in percent). The standard errors are clustered at day and firm level. The data are daily and the sample period is from 1 August 2008 to 31 October 2008. *** indicates significance at 1 percent, ** - at 5 percent, * - at 10 percent.

	Price impact		Quoted spreads		Effective spreads		Realized spreads	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SI×Banned	4.72***	2.49**	10.23***	5.02**	10.86***	7.85***	2.37**	2.19**
	(1.17)	(1.16)	(2.45)	(2.17)	(2.86)	(2.50)	(0.99)	(0.89)
SI×Banned×SP	-0.39***	-0.26**	-0.62***	-0.46**	-0.34*	-0.19	0.03	-0.00
	(0.12)	(0.12)	(0.21)	(0.22)	(0.19)	(0.21)	(0.10)	(0.10)
SI		14.52***		31.94***		13.56***		1.65***
		(0.85)		(1.68)		(1.90)		(0.51)
SI×SP		-0.13***		-0.18***		-0.10		0.04
		(0.05)		(0.07)		(0.07)		(0.02)
$\overline{\text{Size}}$×SI×Banned	-0.15***	-0.07	-0.36***	-0.16	-0.38***	-0.27**	-0.09**	-0.09**
	(0.05)	(0.05)	(0.11)	(0.10)	(0.12)	(0.11)	(0.04)	(0.04)
$\overline{\text{Size}}$×SI		-0.13***		-0.24***		-0.20***		-0.01
		(0.03)		(0.06)		(0.08)		(0.02)
Size		-6.61***		-8.71***		-11.31***		-1.23***
		(0.39)		(0.53)		(0.80)		(0.28)
Turnover		-0.04		-0.47***		0.26***		-0.03
		(0.04)		(0.06)		(0.09)		(0.02)
Observations	11,245	89,959	11,245	89,959	11,245	89,959	11,245	89,959
Adj R^2	0.45	0.57	0.68	0.85	0.42	0.59	0.12	0.17
Stock FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	Yes	No	Yes	No	Yes	No	Yes
Sample	Banned	All	Banned	All	Banned	All	Banned	All

Figure 1: Market capitalization of U.S. equity ETFs around the 2008 short-sale ban

The figure displays the average market capitalization of all the long only, physical (non-synthetic) U.S. equity ETFs in our sample. The box reports the average market capitalizations (in $ billion) of the five largest ETFs during our sample period. Our sample contains 198 ETFs and the sample period is from 1 August 2008 to 31 October 2008.

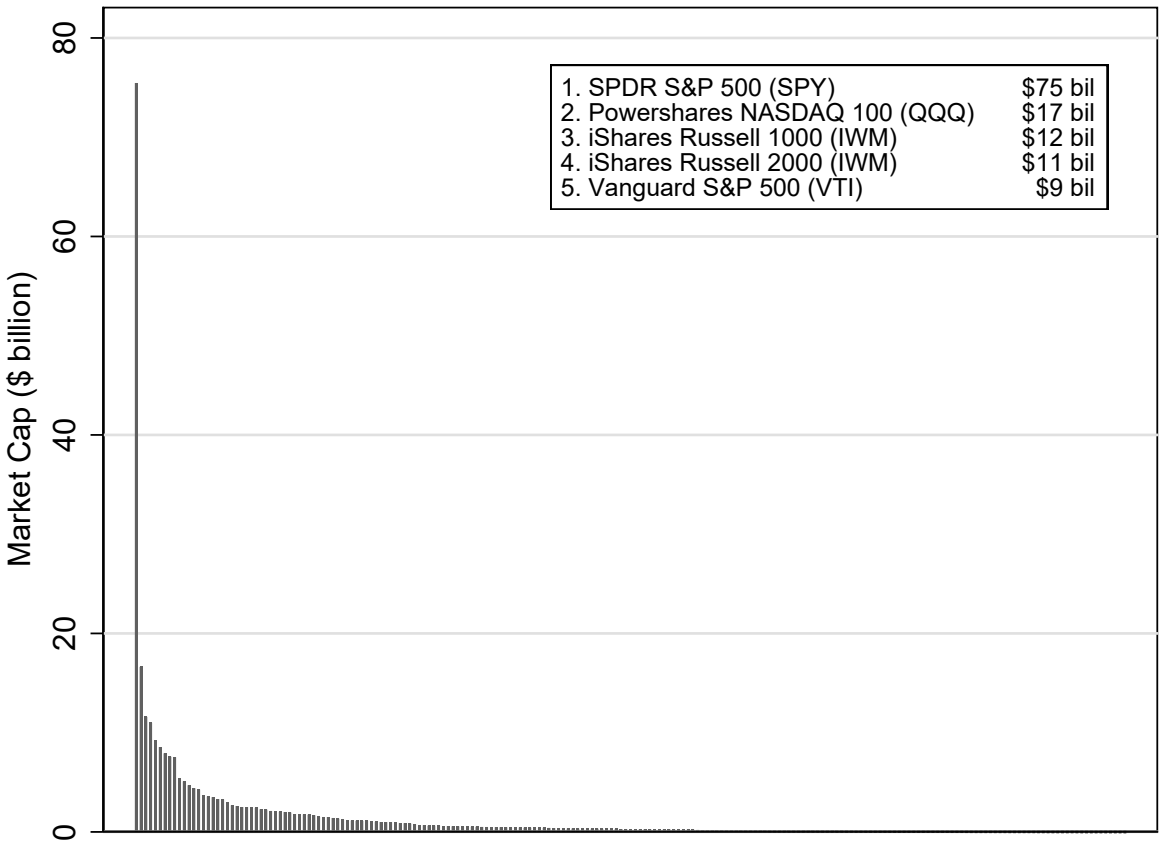


Figure 2: Short selling of the SPY and its underlying around the 2008 short-sale ban

The figure displays the time series of daily short interest of the SPDR S&P 500 ETF (SPY), the short interest indexes of the common stocks in the S&P 500 index and the Russell 2000 ETF. The short-sale indexes for the underlying stocks are constructed as the value-weighted sums of the daily short-interest of the individual S&P 500 member stocks. Each series is scaled by their respective values on 1 August 2008. The two vertical dotted lines indicate the short-sale ban period. The data are daily and the sample period is from 1 August 2008 to 31 October 2008.

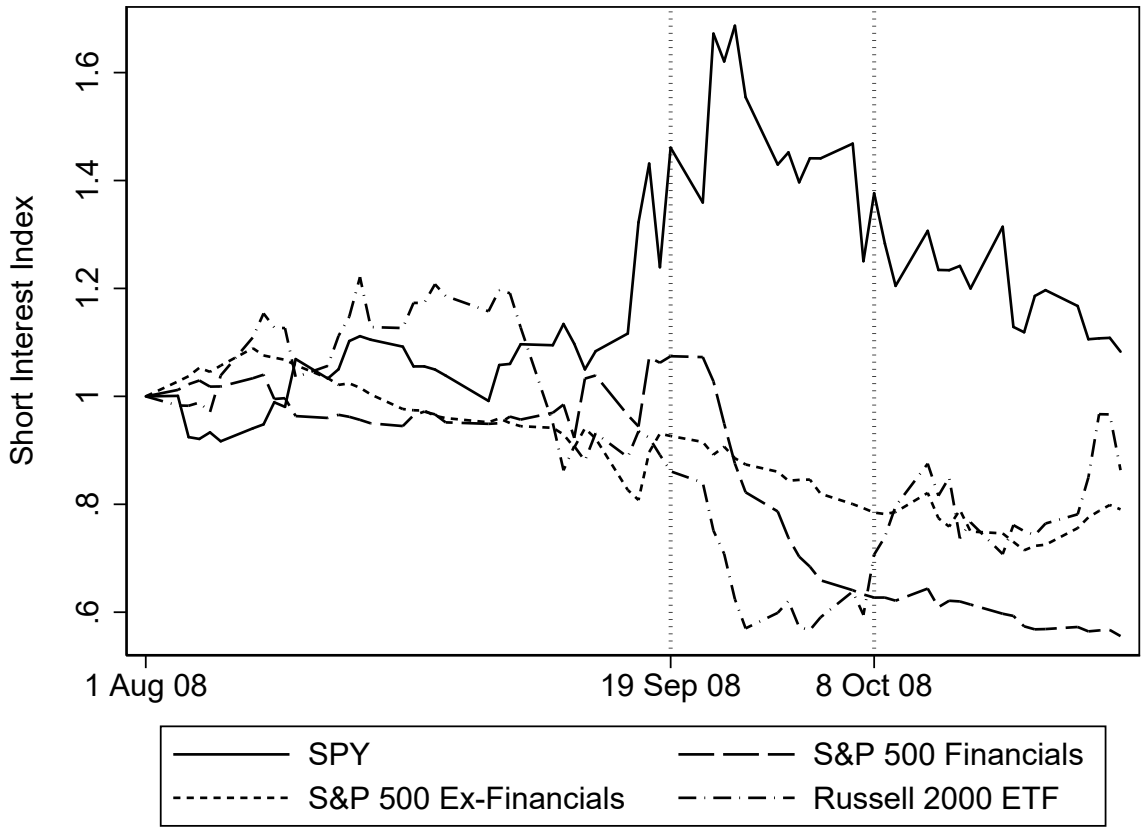


Figure 3: Creation SPY ETF shares around the 2008 short-sale ban

The two panels of this figure plot the daily time series of the number of SPDR S&P 500 ETF (SPY) shares outstanding (in million) and its market capitalization (in $ billion). The two vertical dotted lines mark the beginning and the end of the 2008 short-sale ban on financial-sector stocks. The data are daily and the sample period is from 1 August 2008 to 31 October 2008.

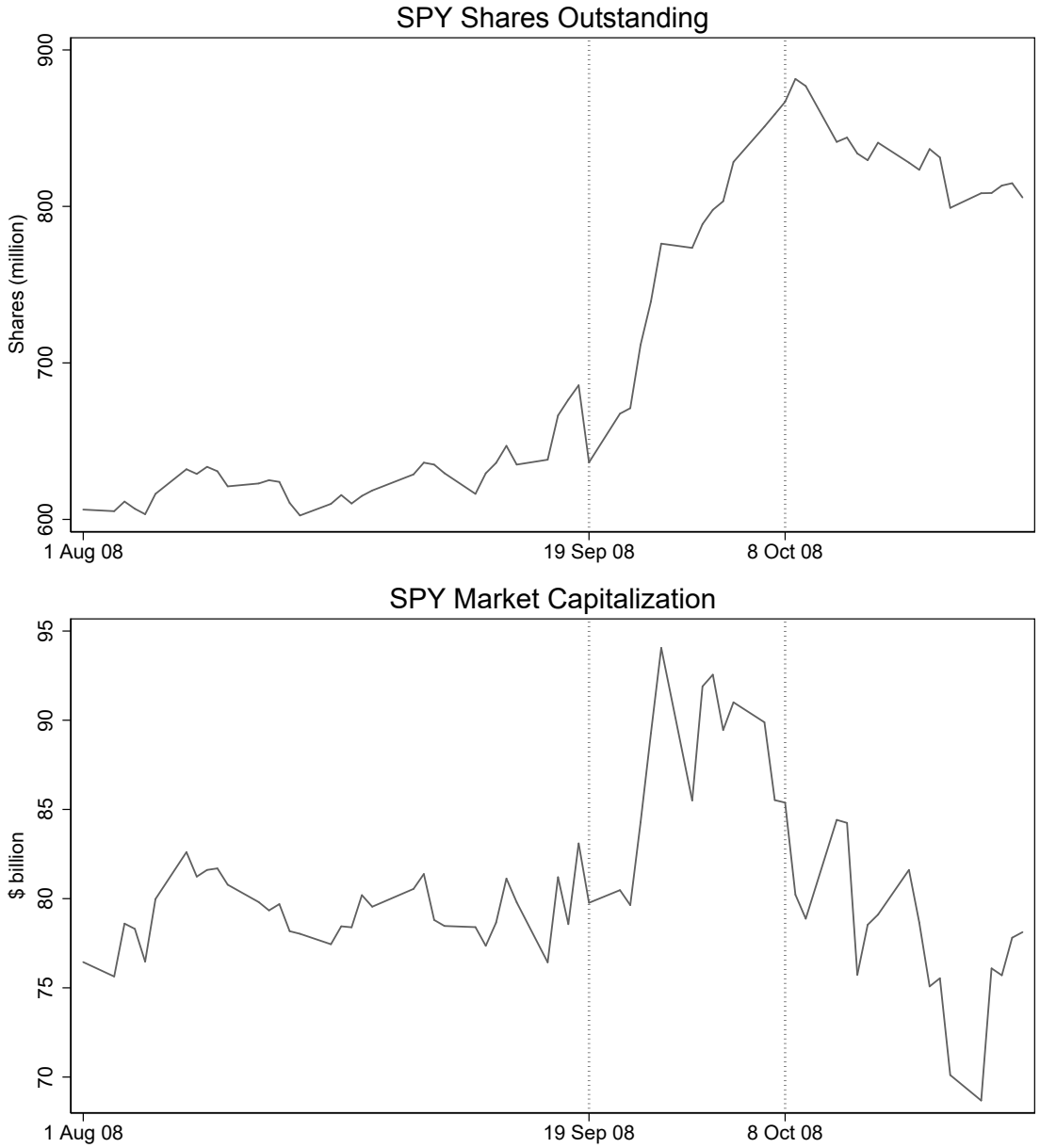


Figure 4: Market capitalization of stocks banned from short selling

This figure displays market capitalization of our sample of firms for stocks banned from short selling during the 2008 short-sale ban. The sample is split into stocks that are members of the S&P 500 index and the stocks that are not. Each stock's ticker symbol is shown on the horizontal axis. Market capitalization is an average market capitalization over July 2008 expressed in $ billion. The horizontal dotted line in each figure indicates the cross-sectional average of each sub-sample.

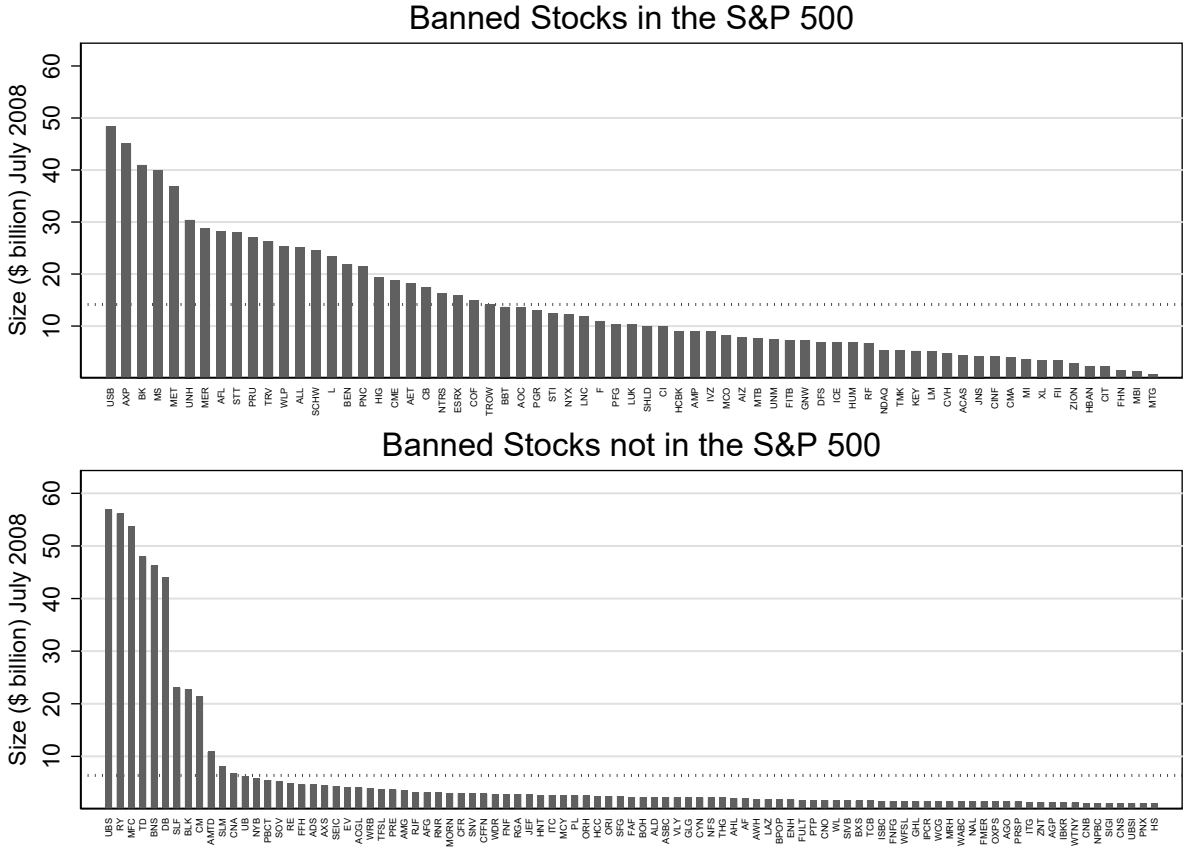
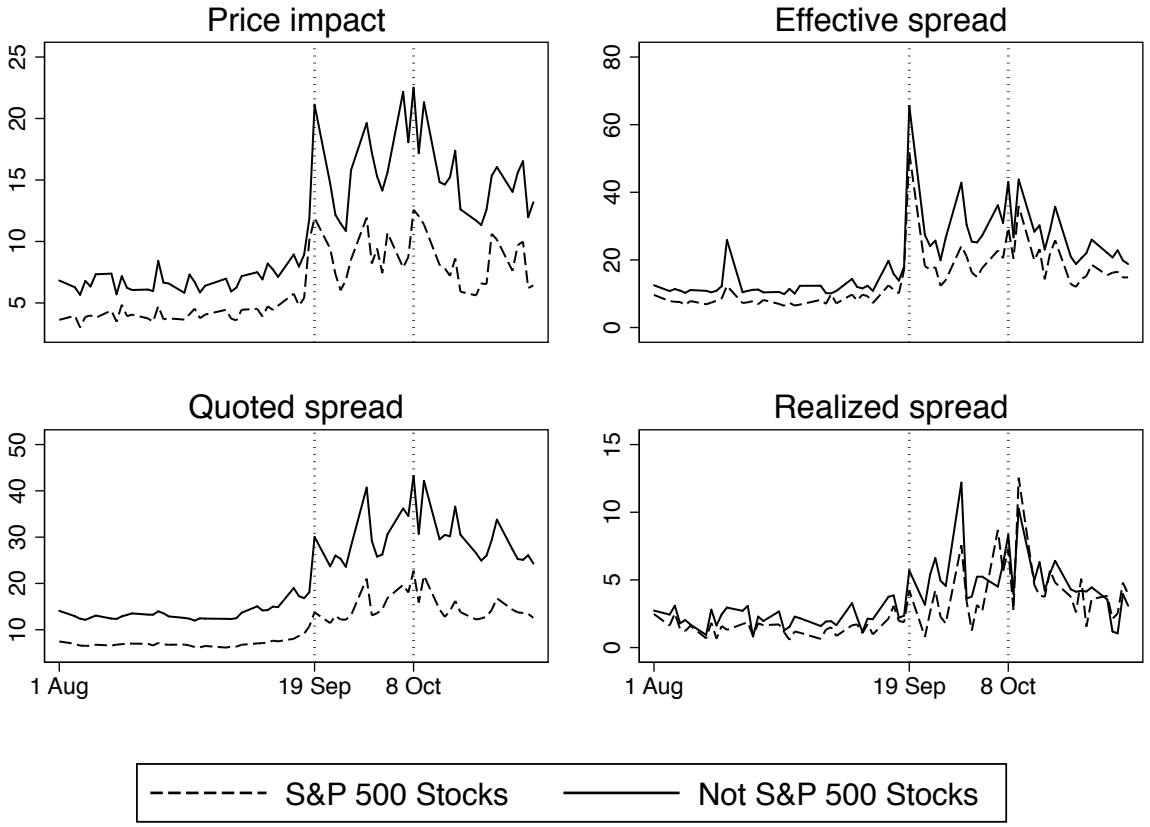


Figure 5: Parallel trends in the liquidity measures

The figure displays the time series of the daily averages of four liquidity measures for the banned stocks. The four liquidity measures are price impact, quoted spread, effective spread, and realized spread. All the measures are expressed in basis points. The sample is split into stocks that are members of the S&P 500 index and the stocks that are not, then the equal-weighted average daily liquidity is calculated for each group of stocks. The two vertical lines indicate the short-sale ban period. The data are daily and the sample period is from 1 August 2008 to 31 October 2008.



Appendix

A-I ETFs sample construction

To construct our sample of ETFs we start with all the ETFs in the MSF database that (i) are categorized as "US ETF", (ii) have non-missing CUSIP identifiers (iii) have non-missing fund names and (iv) are available during our sample period (1 August 2008 to 31 October 2008). We drop ETFs from our sample with names containing any terms that refer to:

- an asset class other than equity (e.g. "bond", "currency", "commodity", "treasuries", "municipal", "T-Bill").
- non-U.S. investments (e.g. "global", "Emerging markets", "Japan", "Pacific").
- government assets (e.g. "Mississipi", "Oklhm").
- short or inverse investments (e.g. "Bear", "Inverse", "Short", "Ultrashort").
- mutual funds (e.g. "Mf", "MF").
- closed end funds.

We manually examine the sample to ensure that the samples contains no non-equity, non-U.S. or inverse ETFs. Next, we keep only the ETFs that have at least two short sales data points during the ban and non-ban period over our sample. Using the CUSIP identifiers, we merge with the CRSP database and then remove small funds with market capitalization on 18 September 2008 lower than $20 million. After applying these filters, we are left with an unbalanced panel of 198 ETFs.[1]

A-II Stocks sample construction

To be included in the sample stocks must meet all of the following criteria:

[1] Our sample contains 12 purely financial ETFs (ETFs with terms like "bank", "insurance", "finance" or "broker-dealer" in their names).

- Following BJZ we require stocks to have a share code of 10, 11 or 12 in the CRSP database. This requirement excludes closed-end funds, ETFs, REITs, warrants, preferred shares and American depositary receipts.
- We keep only the stocks that were traded on the three main stock exchanges - NYSE, NYSE MKT (AMEX in 2008) and NASDAQ.
- To clearly evaluate the effect of short sales restrictions we exclude stocks that were included in the list of the banned stocks between September 23 and the end of the short sales ban or chose to exit the initial list.
- Similar to GLV we exclude securities that had missing information or no options traded in September, 2008 in OptionMetrics database. As most of the S&P 500 index stocks had options traded, we want to match them with similar non-S&P 500 stocks.
- We exclude Wachovia from our sample. The timing of firm's difficulties - a large $8.9billion loss in the second quarter of 2008, a change in its CEO, a "silent run" on it and its acquisition by Wells Fargo - matches the period of our interest.
- Following GLV we exclude stocks with price lower than $5 at the start of the ban because of their potentially lower liquidity.

A-III Additional analysis of "create-to-lend" mechanism

Here, we examine the dynamics of SPY shares using regression analysis. We run the following time series regression:

$$\text{Supply}_t = d_0 + d_1\,\text{Ban}_t + d_2\,\text{LagPremium}_t + \epsilon_{i,t}, \tag{A-2}$$

where they $Supply_t$ is the dependent variable for SPY on day t defined as: i) $MktVal$ - daily value of SPY stocks outstanding in $ billion; ii) $Shares$ - daily number of SPY stocks outstanding in million; iii) $chShares$ - daily change in $Shares$. Ban_t is an indicator variable that takes on value of one for days during the ban period, i.e. from September 19 to October 8. We control for supply inspired by deviations from net asset values by adding $LagPremium_t$ - the difference between the Spider price and the value of its underlying stocks at the end of a trading day, lagged by one period.

The regression results indicate that there was a significant increase of $8.31 billion in the market capitalization of the Spider on average during the ban period (Table A.1, column 1). This growth in market value was predominately driven by the increase in shares outstanding. Our visual inspection on Figure 3 suggests a large increase in the number of shares outstanding during the ban period. The more formal evaluation of the effects reveals that the number of shares outstanding was on average by 77 million higher during the period of short sales than before or after it (A.1, column 2). As the series of the shares outstanding measure is not stationary, we continue the examination by using the dependent variable - an average daily change in number of shares outstanding. The positive and significant estimate on that *Ban* (A.1, column 3) suggests that during the ban period authorized participants were creating on average 13 million ETF units every day.

A-IV Offsetting positions

A trader takes a negative position in 500 individual stocks when she short sells an S&P 500 ETF. To offset an unintentional short position, she has to long stocks, which she unintentionally short sold. We investigate whether during the short-sale ban buying SPY underlying non-financial-sector stocks increased. Such position would be in line with traders 1) selling short the SPY in order to bypass the ban; 2) establishing long positions in order to offset their negative exposure.

To evaluate whether traders were cancelling unintentional short positions during the ban, we examine daily stock turnover, which we treat as a proxy for buying activity, among the non-banned sample stocks.[2] If the traders were establishing sizeable offsetting long positions during the ban, we would observe relatively higher buying activity (turnover) in the SPY's underlying non-financial-sector stocks relative to other non-financial-sector stocks. Hence, using a sample of 344 non-financial-sector stocks in the S&P 500 index and 867 non-financial-sector stocks that are not in the index, we test if during the short-sales ban the trading intensified in S&P 500 stocks by more than in the other stocks. In particular, we estimate the following OLS regression:

$$\text{Turnover}_{i,t} = c_i + e_1 \,\text{Ban}_t + e_2 \,\text{SP}_i + e_3 \,\text{Ban x SP}_{i,t} + \theta X_{i,t} + \epsilon_{i,t}, \tag{A-3}$$

[2] Alternatively, a trader could have created offsetting positions using ETFs. However, as was discussed earlier, due to the large differences in ETF sizes it is difficult to identify ETFs that could have reasonably absorbed the order flow that would have been necessary to offset the short positions created in the SPY.

where $Turnover_{i,t}$ is a proportion of stocks traded on day t, Ban_t is an indicator variable that takes the value of one on the days of the 2008 short-sale ban and zero on the other days, SP_i specifies if a stock i is a member of S&P 500 index; Ban x $SP_{i,t}$ is the interaction between the two variables. c_i is a time-invariant stock fixed effect. Following Lo and Wang (2000) we control for stock characteristics that can affect the trading turnover. $X_{i,t}$ controls for:

- systematic risk – the slope coefficient from the time-series regression of stock i's daily return on the daily value-weighted market return over January-July, 2008.
- residual risk – standard deviation of the residuals of the above time-series regression.
- size – a natural logarithm of stock i's market capitalization on day t.
- price – a natural logarithm of stock i's price on day t.
- yield – weekly dividend yield of stock i.
- autocovariance – first-order autocovariance of returns over January-July, 2008 (a measure of effective trading costs).

We find that the coefficient on Ban x SP is positive and significant (Table A.2, Column 1). The turnover in S&P 500 index stocks increased by 0.11 percentage point during the ban. This finding suggests that during the ban turnover was significantly higher for stocks that could have been used to offset the short position in the SPY (not banned S&P 500 index stocks) than for other stocks (not banned non-S&P 500 index stocks). The finding is in line with the notion that short sellers of the SPY took offsetting positions in S&P 500 index stocks. Alternative regression specifications support the robustness of our results. Controlling for other determinants of turnover, the coefficient on Ban x SP remains essentially unchanged (Table A.2, Column 2). Additionally, including the stock fixed effects actually increases the coefficient of interest (Table A.2, Column 3).

Table A.1: Short sale ban and the supply of SPY ETF

This table presents estimates of an OLS regression, correcting standard errors for 3 Newey-West (1987) lags and reporting them in parentheses below the coefficient estimates. $MktVal$ is a daily market value of SPY ETF in $ billions. *Shares* and Δ*Shares* measure the quantity and the change of Spider shares outstanding and created over one day in million. *Ban* is a dummy variable that takes a value of one for dates between September 19, 2008 and October 8, 2008. *Premium* is lagged ETF premium over the value of underlying shares. The sample covers the period from August 1, 2008 until October 31, 2008. *** indicates significance at 1 percent, ** - at 5 percent, * - at 10 percent.

	(1) MktVal	(2) Shares	(3) Δ Shares
Ban	8.31***	76.86**	12.48*
	(1.73)	(33.72)	(6.61)
Premium_{t-1}		16.95***	-0.45
		(4.77)	(0.51)
Constant	78.71***	689.30***	0.54
	(0.54)	(22.97)	(1.55)
Observations	66	66	66

Table A.2: The impact of the short-sale ban on stock turnover

The table presents the estimates of an OLS regression for the sample of stocks that were not subject to the short-sale ban. The dependent variable, *Turnover*, i defined as a fraction of stocks traded over the trading day and is expressed in percent. *Ban* indicates the ban period between September 19 and October 8. Variable *Banned* takes a value of one if a stock is a member of S&P 500 index. *Ban* x *SP* is the interaction between the two variables. Following Lo and Wang (2000) we control for: systematic risk (*SystR*), residual risk (*ResidR*), weekly dividend yield (*DivY*), first-order autocovariance of returns to measure effective trading costs (*Autoc*), natural logarithms of stock price (*LogPrice*) and market capitalization (*LogMktCap*). The regression includes stock fixed effects in Column 3. Standard errors are clustered at stock and time level. The sample covers the period from August 1, 2008 until October 31, 2008. *** indicates significance at 1 percent, ** - at 5 percent, * - at 10 percent.

	(1) Turnover	(2) Turnover	(3) Turnover
Ban x SP	0.11**	0.10**	0.15**
	(0.05)	(0.05)	(0.07)
Ban	0.21	0.25*	-0.09
	(0.14)	(0.15)	(0.19)
SP	0.01	0.48***	
	(0.07)	(0.08)	
SystR		0.71***	
		(0.08)	
ResidR		61.53***	
		(5.11)	
DivY		1.06***	-0.56***
		(0.08)	(0.19)
Autoc		0.16	
		(0.22)	
LogPrice		0.36***	-0.72
		(0.06)	(0.66)
LogMktCap		-0.10***	-1.43**
		(0.04)	(0.59)
Constant	1.57***	-0.59	
	(0.07)	(0.56)	
Observations	56,917	56,917	56,917
R-squared	0.01	0.26	0.65
Stock FE	No	No	Yes

Figure A.1: Diagrammatic representation of "create-to-lend" process

This figure presents a diagrammatic representation of the "create-to-lend mechanism. In a standard short sale transaction a short seller approaches a prime broker in order to borrow a security for shorting. The prime broker sources this security from a lender such as a large institutional investor in exchange for collateral and a fee, which is then passed onto the short seller. If the security demanded by the short seller is an ETF, the mechanics of the transaction could be the same, with the exception that if the actual ETF is hard to borrow (for example due to low institutional ownership) the prime broker can purchase the underlying securities in the market, pass them onto the ETF provider who, in turn, issues the prime broker with new ETF shares that can be given to the short seller. Subsequently, the broker can hedge its exposure to the underlying portfolio by either short selling the shares or by entering into a derivative contract.