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ABSTRACT

Over two decades, ETFs have become one of the most popular investment vehicle among retail and professional investors due to their low transaction costs and high liquidity, taking market share from traditional investment vehicles such as mutual funds and index futures. Research has shown that in addition to the benefits of enhanced price discovery, ETFs add noise to the market: prices of underlying securities have higher volatility, greater price reversals, and higher correlation with the index. Arbitrage activity is a necessary component in minimizing the price discrepancy between ETFs and the underlying securities. During turbulent market episodes, however, arbitrage is limited and ETF prices diverge from those of the underlying securities.

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1 Introduction

Since the mid-1990s, exchange traded funds (ETFs) have become a popular investment vehicle due to their low transaction costs and intraday liquidity. ETFs issue securities that are traded on the major stock exchanges, and, for the most part, these instruments aim to replicate the performance of an index. ETFs have shown spectacular growth. By mid-2016, they represented about 10% of the market capitalization of securities traded on US stock exchanges.[1]

This article synthesizes the academic literature on ETFs. First, we provide a brief overview of the mechanics of ETFs. Second, we analyze the research that explores the popularity of passive asset management in general and ETFs in particular. Third, we survey the literature discussing the effects of ETFs on the quality of financial markets.

In the first part of this article, we describe how ETFs work and what distinguishes them from other pooled investment vehicles. ETFs either hold a basket of securities passively (physical replication) or enter into derivative contracts delivering the performance of an index (synthetic replication). They issue securities (mostly shares) that are claims on the underlying pool of securities. ETF shares are traded on stock exchanges, and investors can take either long or short positions. Two mechanisms keep ETF prices in line with those of the basket that they aim to track: primary and secondary market arbitrage. The first mechanism involves the creation and redemption of ETF shares by authorized participants (APs), which are the official market makers for a given ETF. When ETF prices and the prices of the underlying securities diverge, APs typically buy the less expensive asset (ETF shares or a basket of the underlying securities) and exchange it for the more expensive asset, leading to the creation or redemption of ETF shares. The second type of trade, consisting of long and short positions in the secondary market, retains some uncertainty with respect to the horizon over which price convergence will occur; thus, it is an arbitrage only in a loose sense.

The second part of this article describes the rise of passive investment and the role of ETFs in the passive asset management space. Passive asset management has expanded in recent decades,

[1] Exchange traded pooled investment vehicles are collectively designated as exchange traded products (ETPs). These include ETFs; exchange traded notes (ETNs), which are senior debt notes and do not invest in a portfolio of securities or a portfolio of derivatives on those securities; and exchange traded commodities (ETCs), which provide investors exposure to individual commodities or baskets and can be structured as funds or notes. In this survey, we restrict our attention to ETFs, which have been the main focus of the literature, given that they hold 95% of the assets in the sector in the United States.

raising questions about what is driving this phenomenon and its implications for financial markets. While some researchers view this trend as evidence that financial markets are becoming more efficient, others warn that passive investments may have adverse effects on price efficiency. Several studies document that ETFs capture market share that was previously taken by traditional passive investment vehicles like index mutual funds, closed-end funds, and index futures.

The third part of the article focuses on how ETFs affect information efficiency in financial markets. A distinct feature of ETFs is that they require active arbitrage activity so that ETF prices indeed track the prices of the underlying index. Some researchers have raised the concern that this mechanical basket arbitrage trading can serve as a channel for the propagation of liquidity shocks across markets and deteriorate the quality of prices. This concern is especially acute given that ETFs are traded by high-turnover investors, who potentially impound liquidity shocks into prices at higher frequencies. The empirical evidence shows a causal relation between ETF ownership and return volatility, justifying these concerns. Similarly, ETF ownership appears to induce excessive correlation of the securities in their baskets. Finally, recent episodes of extreme market turbulence (e.g., the Flash Crash on May 6, 2010, and the events of August 24, 2015) have revealed that the liquidity provision in ETFs can display sudden dry-ups.

Overall, ETFs have transformed the asset management world by introducing low-cost investment vehicles that are traded continuously. The academic literature acknowledges this financial innovation but also points to some potential weaknesses that appear to be sufficiently important to draw regulatory scrutiny.

2 The Mechanics of ETFs

ETFs are investment companies that issue securities that trade continuously on public exchanges. While most ETFs are legally structured as open-ended investment companies, some are classified as unit investment trusts (such as the SPY, the ETF on the S&P 500 sponsored by State Street).[2] Most ETFs aim to track an index and thus hold a replicating basket of securities or enter into derivative contracts that deliver the performance of the index. Unlike mutual funds,

[2] Unit Investment Trusts may not engage in security lending of their portfolio securities, which is one the main differences with other ETFs organized as open-end investment companies.

which only allow investors to acquire or redeem shares at the end of the trading day, investors can trade ETF shares continuously throughout the trading day.

ETFs combine features of both open- and closed-end funds. Like open-end mutual funds, ETFs allow the creation and redemption of shares in the fund. Like closed-end funds, the shares of ETFs are traded on exchanges. However, the open-ended property allows a much more effective arbitrage in ETFs than in closed-end funds, which explains the significantly smaller deviations of ETF prices from the Net Asset Value (NAV) than occurs with closed-end funds.

We can identify two major types of ETFs depending on how replication is achieved: physical ETFs (which, in turn, can adopt full replication or representative sampling) and synthetic ETFs. Physical ETFs attempt to closely follow the return of their benchmark index by holding all or a representative sample of the index stocks in their portfolios, with weights to closely mimic those in the index. In contrast, synthetic ETFs track an index by entering into derivative contracts, such as total return swaps on the benchmark index. The creation of ETF shares occur most often in kind for physical ETFs and in cash for synthetic ETFs. The synthetic ETFs are more popular in Europe than in the United States.

The two types of ETFs are subject to different sources of counterparty risk. The physical ETFs engage in security lending (see, e.g., Blocher and Whaley, 2016), which exposes the fund to the risk of default of the security borrower. Instead, the synthetic ETFs are exposed to the risk of default of the counterparty in the derivative contract. Of course, collateral is envisaged in both types of agreements, which contains the amount of counterparty risk.

The popularity of ETFs has skyrocketed in recent years. ETF daily trading volume exceeded 36% of overall stock market trading volume in the first half of 2016, despite the fact that ETFs' capitalization is about 10% of the market (see Figures 1 and 2). ETFs are also popular instruments for shorting purposes (hedging or directional bearish bets), with about 20% of the overall short interest on US exchanges being in ETF shares (see Figure 3).

The market price of ETF shares often diverts from the net asset value (NAV) of the underlying basket due to asynchronous trading of the ETF and the underlying assets. This fact may generate an opportunity for arbitrage between the ETF shares and the underlying basket of securities depending on whether the discrepancy exceeds the transaction costs. Two types of market participants are poised to benefit from such differences in prices: Authorized Participants (APs) and secondary market arbitrageurs.

APs are a small group of institutions that are allowed to trade with the ETF sponsor directly in the primary market. These transactions typically take place in kind. The APs help to eliminate price discrepancies by purchasing the cheaper asset on the market and selling the more expensive one. When the ETF price is lower than the NAV, the APs purchase ETF shares and redeem them for the underlying securities. When the ETF units are priced above the NAV, the APs purchase the underlying securities and exchange them for newly issued ETF shares. Finally, the APs turn back to the market and sell either the underlying securities that they received or the newly issued ETF notes. These trades apply downward pressure on the prices of the expensive asset and upward pressure on the lower price, so that price discrepancy is kept under narrow bounds.[3] Arbitrageurs can monitor the ETF price as well as the intraday indicative net asset value (IIV or INAV) of the ETF basket during the day on most financial platforms. ETF INAVs are computed using the intraday dollar values of the ETF creation baskets and are published every 15 seconds for underlying baskets that trade continuously in US markets.

The primary market transactions to create or redeem ETF shares occur in large blocks called creation units. While more than 70% of the ETFs traded in the United States have creation units of blocks of 50,000 ETF shares, a few ETFs have larger creation units, equivalent to more than 100,000 shares. The AP generally pays all of the trading costs associated with the operation along with an additional creation/redemption fee paid to the ETF sponsor. This fee averages $1,047 per creation unit, with a median fee of $500 per creation unit. According to Antoniewicz and Heinrichs (2014), there are, on average, 34 APs per ETF. Some AP firms—about five APs on average per ETF—also function as ETF market markers by providing continuous quotes and liquidity for the ETF's shares in the secondary market. In the process of creating and redeeming ETF shares with domestic underlying securities, APs are generally not required to post collateral upfront, unless they fail to clear these transactions within a T+3 settlement date.[4] In some cases, certain APs have three additional days to settle trades (a total of T+6) if their failure to deliver is

[3] Broman (2016) estimates the distribution of the extent of the discrepancy between ETF prices and the NAV values based on the ETF mid-points quotes at the end of the day over the 2006–2012 period. He documents that the standard deviation of the discrepancy is about 0.10% for large ETFs and 0.15% for small ETFs.
[4] Creation and redemption orders are processed by the National Securities Clearing Corporation (NSCC).

the result of bona fide market making. Further details about the mechanics and operation of ETFs are provided in Antoniewicz and Heinrichs (2014); Hill, Nadig, Hougan, and Fuhr (2015); and Hill (2016).

The second mechanism through which ETF and NAV prices are arbitraged is the trading activity of market participants. Specifically, secondary market arbitrageurs are traders who take a position (long or short) in the ETF and an opposite position in the main components of the index, hoping that the discrepancy in prices will eventually disappear. This, of course, is not pure textbook arbitrage since it entails the risk of widening price discrepancy between the ETF and the underlying securities and the horizon over which convergence will occur is uncertain. In today's markets, such trading activity is often performed by hedge funds through automatic algorithmic trading or by some of the same firms that make the markets for ETFs.

3 The Rise of Passive Investing

The asset management industry can be broadly classified as engaging in either active or passive investing. Active investors engage in stock-picking securities and market-timing in order to beat a benchmark or to generate absolute return. In contrast, passive investors construct a portfolio that aims to replicate the performance of an index, such as the S&P 500. While the performance of active investors is typically measured as absolute returns or index-adjusted returns ("alpha"), the performance of passive investors is measured by their ability to minimize the tracking error with respect to the index. ETFs are passive investment vehicles in nature; they own a basket of securities that mimics an index. A recent innovation in the ETF space, active ETFs try to beat their benchmark much like active mutual funds. To date, however, they represent only 1.8% of the AUM in the US Equity ETF market (see Table 1).

ETFs began widely trading in the mid-1990s (the first ETF in the US market was the SPY, which began trading in 1993), and their popularity has expanded rapidly ever since. Table 1 presents time-series statistics about US and foreign stock ownership by active mutual funds, passive mutual funds, and ETFs, in addition to the ownership by fixed-income funds. In mid-2016, ETFs owned about $1.35 trillion of the US stock market, compared with the approximately $6.8 trillion owned by mutual funds. The table shows that all types of funds increase their assets under management over time. However, the growth rate is dramatically different across fund types. From

1999 to 2016, US equity index mutual funds grew from \$0.3 trillion to \$1.8 trillion and actively managed US equity mutual funds grew from \$2.6 trillion to \$5.0 trillion. In contrast, ETFs grew from \$0.03 trillion to \$1.3 trillion. Trends are similar for foreign equity funds and fixed income funds.

3.1 Migration from Active to Passive Investment

In recent decades, index investing has become popular among both individual investors and institutions. This change has prompted researchers to attempt to explain trends in the asset management space and explore their implications on market quality (French 2008, Stambaugh 2014).

One motivation behind the creation of index funds is to provide investors with a cost-efficient way to have exposure to certain common risk factors (Cong and Xu 2016). Stambaugh (2014) analyzes an equilibrium model in which active and passive management co-exist. Active management benefits from exploiting the noise in prices that retail traders create. In equilibrium, the remainder of capital is invested in passive funds, and thus the increase in passive investment indicates that arbitrage opportunities disappear and therefore serve as indicator that the market is becoming more efficient. Not all researchers share the view that the rise of passive asset management is an indication of improved market efficiency. Wurgler (2011) warns against the adverse effects of rising indexation. He argues that indexing can create distortion in securities' valuations, such as inclusion and deletion effects (e.g., see Shleifer 1986, Wugler and Zhuravskaya 2002, Kaul, Mehrotra, and Morck 2002, Greenwood 2005), comovement of the stock with the index (e.g., see Greenwood and Sosner 2007, Basak and Pavlova 2013, 2016, Da and Shive 2016), and higher sensitivity to crashes (because many market participants change their index exposure based on past performance). Baltussen, Da, and van Bekkum (2016) find supporting evidence for the idea that indexation affects the general properties of markets. They report that serial correlation of stock markets around the world became negative as the degree of indexing increased (futures, ETFs, and index mutual funds).

A parallel trend in the marketplace over the last few decades is an increase in concentration in the asset management space. A likely explanation is the economies of scale that passive investment managers enjoy, which makes consolidation attractive. This trend is discussed in Ben-

David, Franzoni, Moussawi, and Sedunov (2015). The researchers find that the top ten investment managers owned about 5% of the US stock market in 1980, and that this share increased to over 23% at the end of 2014. The authors hypothesize that concentration increases the volatility of the underlying securities due to shocks at the investment firm level. For example, an investment firm may affect prices through its correlated trading activity for non-fundamental reasons, such as a change in firm-wide investment policies, the departure of an executive that leads to outflows, or a computer glitch. The authors find that the ownership share of the largest investors is associated with higher volatility in the underlying stocks. To establish causality, the authors show that higher institutional ownership due to geographic proximity results in higher volatility, and that mergers of large institutional investors lead to higher volatility in the underlying stocks.

The rise in passive investment also has implications for corporate policies as the nature and composition of institutional investors change. Bradley and Litan (2011a, 2011b) argue that ETFs are poor at corporate governance, and consequently private firms are reluctant to list on stock exchanges because passive investors, and primarily ETFs, slow down price discovery and eventually jam value signals to managers. Empirical studies have generally found results contradicting this claim. Boone and White (2015) use the change in the ownership of institutional investors following index reconstitution to test the information production of firms. When a stock moves from being at the bottom of the Russell 1000 index to the top of the Russell 2000 index, there is a sharp increase in institutional ownership, primarily among passive indexers. They find that as ownership by index funds increases, firms become more transparent in their reporting. Appel, Gormley, and Keim (2016) use a similar natural experiment to measure the effects of ownership by passive investors on corporate governance. They show that passive investors lead to a host of improvements in corporate governance, such as the removal of poison pills, restrictions on shareholders’ ability to call special meetings, fewer dual-class share structures, and more independent directors.

3.2 Can ETFs Coexist with Traditional Investment Vehicles?

Empirical studies find that ETFs gained market share at the expense of traditional indexing products. Agapova (2011) studies mutual funds and ETFs in the period of 2000–2004 and finds evidence for both substitution and clientele effects. She documents a negative correlation between the aggregate flows to mutual funds and to ETFs. Furthermore, institutions tend to invest in ETFs while retail investors tend to invest in mutual funds. Barnhart and Rosenstein (2010) present evidence that as ETFs gained market share in the US market, the discounts of closed-end funds widened and their trading volume declined. Market participants argue that ETFs are aggressively competing with futures to win big investors with many ETFs having lower fees than the futures roll costs.[5]

Several researchers argue that ETFs and mutual funds have distinct features and therefore appeal to different audiences. Guedj and Huang (2009) propose a model that explores whether ETFs and open-end mutual funds can coexist in equilibrium. In their model, ETFs are more efficient indexers but are exposed to liquidity shocks due to continuous trading. In contrast, mutual funds are immune to liquidity shocks of their investors. In equilibrium, ETFs offer a cheaper investment option for investors who are willing to bear the liquidity shock risk, and mutual funds provide an implicit insurance against such shocks. Madhavan, Marchioni, Li, and Du (2014) argue that ETFs are a superior investment alternative for fully funded investors, compared to index futures, because ETFs provide low transaction costs and avoid the mispricing that often occurs around the futures rolling dates.

Sponsors of ETFs also compete with traditional asset managers for fees. In addition to the management fees that are charged to the ETF fund, sponsors of ETFs benefit from fees generated from lending the securities owned by the fund. Blocher and Whaley (2016) report that lending fees are as important as management fees and that stock ETFs tilt their portfolios toward stocks with higher lending fees. This practice raises the concern that ETFs are exposed to collateral risk, whereby borrowers of shares fail to deliver promised shares at the same time that the ETF is required to redeem its own shares (Mackintosh and Lin 2011). Evans, Moussawi, Pagano, and Sedunov (2016) indeed find evidence that recent increases in ETF settlement failures arising from operational shorting by ETF-authorized participants may be related to a buildup in counterparty risk. Hurlin, Iseli, Pérignon, and Yeung (2014) investigate this claim among European ETFs during six months in 2012. They find no evidence of this buildup in risk during the studied period. It is

[5] Joe Rennison, "Low-cost ETF challengers eat into derivatives market," *Financial Times*, September 11, 2016. Rochelle Toplensky, "Investors replace futures with ETFs," *Financial Times*, March 23, 2016.

important to note, however, that the universe that they test is limited in time and scope; thus, their results do not preclude the possibility of collateral risk in other situations, such as market stress.

The substitution of traditional investment vehicles with ETFs has additional implications for investors. Bhattacharya, Loos, Meyer, Hackethal, and Kaesler (2016) report that retail traders who invest in ETFs perform worse than retail traders who stick with traditional funds. They argue that the ease of ETF trading leads retail investors to attempt to time the market. Since retail investors are bad traders in general (Barber and Odean 2000, Frazzini and Lamont 2008), this behavior results in poor performance. In the same vein, Goetzmann and Massa (2003) find that index mutual fund investors appear to chase returns: flows are stronger following positive past returns; these flows do not have predictive power about future returns. Clifford, Fulkerson, and Jordan (2014) conduct a similar analysis using more recent ETF data and find essentially similar patterns.

4 Do ETFs Impact Asset Prices? Theory and Empirical Evidence

The unique features of ETFs, such as continuous trading and low fees, make them attractive to investors for the purposes of hedging and short-term directional trading. Together, these factors could potentially improve price discovery and provide greater liquidity for the underlying securities. The empirical research finds mixed evidence for these effects, as discussed below.

The additional layer of liquidity that ETFs provide could also serve as a double-edged sword. Specifically, ETFs attract investors with a short-term horizon. These investors may trade due to motives unrelated to the value of the underlying securities, e.g., for liquidity reasons, and therefore may introduce noise to the price of the ETF. Since arbitrageurs continuously attempt to eliminate price discrepancies between the ETF and the underlying securities, investors' demand shocks may be transmitted from the ETF to the underlying securities through the arbitrage mechanism. Researchers have found evidence that ETFs affect the underlying securities, such as through higher non-fundamental volatility and a stronger correlation with the index.

Finally, we discuss two limited cases in which researchers can gain insight into the effects of ETFs on financial markets. First, some studies document that the frequent rebalancing of leveraged ETFs can have a significant impact on the prices of the underlying securities. Second, studies show that the arbitrage mechanism that links the prices of ETFs and the prices of the underlying securities breaks down during market turmoil.

4.1 Price Discovery and Liquidity

Investors often use ETFs as a low-cost platform for directional bets on the index. As such, it is possible that ETF prices reflect news before it is incorporated into the prices of the underlying securities. Relatedly, ETFs add a level of liquidity to the underlying securities through the arbitrage mechanism. By trading the ETF, investors impound index-related information into the price of the ETF. In turn, APs and arbitrageurs ensure that the prices of the underlying securities do not diverge from those of the ETF. The result is that this trading activity helps transmit the systematic information from the ETF to the underlying securities and provides liquidity to the underlying securities. Thus, ETFs could potentially improve price discovery at the index level and enhance liquidity at the level of the underlying securities.

Madhavan (2016) and Madhavan and Sobczyk (2016) advance the view that ETFs enhance the functioning of financial markets. Both studies argue that because ETFs provide a cost-effective tool for investors who wish to take directional bets on the index, they will reflect the new information before the underlying securities. According to both studies, as long as arbitrage is frictionless, ETFs do not propagate shocks into securities, but rather expedite price discovery. In other words, the price discovery at the ETF level leads the price discovery at the underlying securities level.

Several studies confirm that ETFs enhance price discovery. Richie, Daigler, and Gleason (2008) compare the comovement of S&P 500 futures, the main ETF on this index (the Standard and Poor's Depository Receipt, SPDR, ticker: SPY), and the underlying portfolio and conclude that there is little deviation of prices between the futures contract and ETFs, while there are larger deviations from the underlying portfolio. Glosten, Nallareddy, and Zou (2016) find that stocks incorporate information more quickly once they are in ETF portfolios. They argue that some of the increased comovement that was documented by other researchers can be explained by better incorporation of systematic information into stock prices. This evidence is consistent with Da and Shive (2016) study that documents an increased comovement in returns in the stocks that are part of an index. When investors trade on news related to the index, they trade the ETF more actively.

The mechanical basket trading of the underlying securities tied to the ETF through arbitrage exhibits in higher return comovement and causes basket stocks to lose part of their idiosyncratic volatility. Therefore, individual stock response is expected to be less sensitive and less timely to idiosyncratic earnings news. We expect such lagged response to idiosyncratic shocks to exacerbate certain anomalies. Additionally, when investors trade on news related to the index, they trade the ETF more actively and these news will be impounded more quickly into the underlying securities. This is also confirmed by Wermers and Xue (2015) who document enhanced price discovery at the ETF level. Their goal is to separate informed trading from noise trading in ETFs. Their identification assumption is that informed investors trade the ETF. Therefore, on days when ETFs lead the underlying securities portfolio, informed trading dominates. In contrast, on days when ETFs lag the index, the ETF is primarily traded by noise traders. Using this identification strategy, they find that price movements driven by informed traders dominate and are permanent. Price movements driven by noise traders often reverse. Also, Marshall, Nguyen, and Visaltanachoti (2012) find that ETFs move ahead of the underlying portfolio, especially when the liquidity of the underlying securities is low.

Not all researchers agree that ETFs improve the informational efficiency of the securities in their baskets. Israeli, Lee, and Sridharan (2015) show that stocks that are owned by ETFs have higher trading costs; have higher comovement with the index; exhibit lower informational efficiency, measured as lower future earnings response coefficients; and receive less analyst coverage. Bradley and Litan (2011a, 2011b) argue that private firms are reluctant to list on stock exchanges because passive investors, primarily ETFs, slow down price discovery. Da, Engelberg, and Gao (2015) present evidence showing that retail investor sentiment is correlated with ETF volatility. They find that household sentiment, measured by the volume of search engine queries, predicts the price volatility of the largest ETFs. Broman (2016) documents that the degree and direction of mispricing between ETFs and their underlying securities comove across ETFs. He concludes that this phenomenon indicates that ETFs attract short-horizon noise traders with correlated demand across investment styles.

Empirical studies find that ETFs have multiple effects in opposite directions on the liquidity of the underlying securities. In one direction, as argued above, ownership by ETFs can increase liquidity in the underlying securities. This happens due to the arbitrage trades that take place between the ETF and the underlying securities. Marshall, Nguyen, and Visaltanachoti (2015) document patterns that illustrate the activity of arbitrageurs. They find that the liquidity of ETFs is correlated with the liquidity of the underlying stocks. The more liquid the underlying stocks are, the greater ability of arbitrageurs to engage in arbitrage trades, making the ETF liquid as well. Agarwal, Hanouna, Moussawi, and Stahel (2016) document that the liquidity of ETFs comoves with the liquidity of the assets in the ETF baskets. The authors show that higher ETF ownership is associated with higher comovement of liquidity among large and small stocks alike, and they document that such liquidity commonality has increased in recent years and that it is greater during crisis versus non-crisis periods. In the mutual funds market, Schultz and Shive (2016) show that ownership by mutual funds increases the liquidity of the underlying bonds due to flows to and from the mutual funds, which induce trading.

In an opposite direction, ETFs can decrease the liquidity of the underlying securities. Specifically, because ETFs provide an inexpensive way to trade, they can crowd out traders from the underlying assets and detract liquidity. Petajisto (2016) reports a significant deviation of ETF prices from those of the underlying assets, especially for illiquid assets. Piccotti (2014) documents that in some ETFs, the deviation from the value of the underlying assets is permanent, and he argues that market segmentation may explain this regularity. Investors may be willing to pay a premium for access to assets with greater liquidity. Dannhauser (2016) finds that the introduction of corporate bond ETFs leads to a decrease in the liquidity of the underlying bonds, suggesting a crowding out effect. Pan and Zeng (2016) propose a complementary effect: since APs have a dual role in financial markets—APs and market makers—they may occasionally consume more liquidity than they provide. This may happen when there is selling pressure by investors during times of market stress. APs may not be willing to engage in arbitrage when the underlying securities are illiquid. The authors present evidence that APs' trading volume declines when market volatility (captured by the VIX) is high, suggesting that APs operate like arbitrageurs who have limited capital, and thus withdraw from the market when volatility is high (Nagel 2012).

4.2 Propagation of Demand Shocks to Underlying Securities

The additional layer of liquidity that ETFs provide may have undesired effects at the level of the underlying securities. Several studies present evidence consistent with the idea that ETFs inject non-fundamental volatility at the level of the underlying securities. Prior empirical research in other asset classes presents a mixed picture about whether trading activity in derivatives or mutual funds affects the prices of the underlying securities. Coval and Stafford (2007), for instance, find that mutual funds that experience strong outflows engage in fire sales, which have a significant and long-lasting price impact on the underlying securities. In the futures market, MacKinlay and Ramaswamy (1988) report that the volatility of index futures is higher than that of the index itself, and that the idiosyncratic component of futures' returns tends to be autocorrelated, suggesting that it is driven by temporary mispricing. In contrast, Bessembinder and Seguin (1992) find that only the unexpected trading activity of stock futures is correlated with stock volatility. They conclude that these patterns are consistent with the idea that futures trading enhances the liquidity of the underlying securities without adding noise.

The mechanism through which ETFs may transmit noise into the underlying securities is explored in several studies. Malamud (2015) develops a model for ETFs in which APs create and redeem ETF shares. He shows that the creation/redemption mechanism propagates temporary liquidity shocks into the underlying securities. The model also shows that as the liquidity of the underlying securities increases, the degree of shock propagation increases. Ben-David, Franzoni, and Moussawi (2013) investigate a similar mechanism (presented in Figure 4). A demand shock can move the ETF price from the fundamental value (Figures 4a and 4b). If there is limited liquidity in the underlying securities' market, the underlying securities' prices are temporarily pushed away from the fundamental value (Figure 4c). In the long run, liquidity flows back into the market, and both the ETF price and the underlying securities' prices revert back to their fundamental value (Figure 4d). The repeated arrival of demand shocks in the ETF market, through a mechanism like the one just described, can create a link between ETF ownership of stocks and return volatility.

A key component in the proposed mechanism for noise transmission is the existence of demand shocks at the ETF level. In recent years, ETFs have seen high share turnover (see Figure 2) and are traded by traders with short horizons (Ben-David, Franzoni, and Moussawi 2013). Many of these investors tend to make directional bets and hold the securities for a short period of time.

As such, they may use ETFs as low-cost investment conduits for these bets. Stratmann and Welborn (2012) find confirmatory results for this conjecture. They document that investors use ETFs as a way to take short-term directional bets on the market. Previous literature on short-term investors shows the adverse effects of investors with a short horizon. Stein (1987) argues that the entry of short-term speculators lowers the informational efficiency of prices, deterring long-term investors from participating in the market. Cella, Ellul, and Giannetti (2013) find that the presence of short-horizon institutional investors during market turmoil exacerbates price drops, because these investors exit the market. This evidence is consistent with Ben-David, Franzoni, and Moussawi (2013), who show that hedge funds, which on average have higher turnover than other investors, exited the stock market during the financial crash of 2008-2009.

Some studies have tested whether ETF ownership leads to higher volatility. Krause, Ehsani, and Lien (2014) find that stocks owned by ETFs have higher volatility and higher volume. Their setting, however, lacks a strategy to identify exogenous variation in ETF ownership. Thus, the higher volatility may be a result of a selection process in which ETFs end up hold more liquid, and therefore more volatile stocks. To overcome the endogeneity issue and identify an exogenous shift in ETF ownership, Ben-David, Franzoni, and Moussawi (2013) use the Russell 1000/2000 reconstitution as an experiment in which switching stocks experience a sharp change in ETF ownership. The Russell 1000 and Russell 2000 indices are based on stock market capitalization: the Russell 1000 includes the largest 1,000 traded stocks in the United States, and the Russell 2000 tracks the performance of the next 2,000 smaller stocks. Once a year, Russell reconstitutes the indices, and some stocks switch membership according to a mechanical rule. Some stocks in the Russell 2000 that have experienced an increase in their market capitalization switch to the Russell 1000, and those whose market capitalization has decreased switch from the Russell 1000 to the Russell 2000. The researchers use an identification strategy based on the idea that ETF ownership is higher for the top stocks in the Russell 2000 than for the bottom stocks at the Russell 1000, despite the fact that members in the latter groups have larger market capitalization than those in the former group. Using this identification strategy, Ben-David, Franzoni, and Moussawi (2013) conclude that stock volatility increases substantially following this exogenous increase in ETF ownership. Furthermore, the authors show that ETF flows correlate with price movements in the same direction as the flows. This price movement partially reverts over the next few days, consistent with the initial shock being liquidity motivated. These findings suggest that the increased volatility is non-fundamental. Similarly, Staer (2014) finds that ETF flows are contemporaneous with index returns, and that these price effects partly revert after a few days. These patterns are consistent with ETF flows putting temporary price pressure on the underlying stocks. Baltussen, Da, and van Bekkum (2016) find that the serial correlation of stock markets became more negative following indexation. They interpret this result as evidence that index products impound non-fundamental shocks (which then revert) into the underlying security prices.

It is important to note that the (mixed) evidence about improved price discovery in the presence of ETFs and the evidence for greater inefficiencies are not necessarily contradictory or mutually exclusive. It is possible that prices more quickly reflect certain pieces of information, and, at the same time, also more impacted by liquidity shocks. Bhattacharya and O'Hara (2016) propose a model in which ETFs hold assets that are less liquid than the ETF itself. Therefore, some of the price discovery happens at the ETF level. Market makers try to extract relevant information from the ETF about the underlying securities. However, market makers extract a noisy signal, which causes them to propagate noise when they trade the underlying securities.

Another approach to testing for market inefficiency relates to the correlation of securities with the index, once owned by ETFs. The conjecture is that ETF prices are set by investor demand for the index, as opposed to the demand for the individual securities. The result of such demand is that ETF prices primarily will reflect systematic shocks. Because arbitrageurs and APs ensure that prices of the underlying securities are aligned with those of the ETF, the underlying securities will display a greater comovement with the index. Basak and Pavlova (2013, 2016) propose a similar mechanism in the context of institutional investment. Because these investors measure their performance relative to an index, they overweight assets that are included in the index, leading to an increase in asset prices, price volatility, and correlation with other indices.

Empirical studies have found evidence supporting this mechanism. Da and Shive (2016) show that stocks that are part of an index tend to comove with the index and thus lose their idiosyncratic volatility. The effect is stronger for illiquid stocks and at times of market turbulence. To overcome the endogeneity in ETF ownership, they use the inception and closure of ETF funds as an instrument for ETF ownership. Sullivan and Xiong (2012) and Israeli, Lee, and Sridharan (2015) find similar evidence in an empirical setting in which ETF ownership is endogenous.

Chinco and Fos (2016) develop a model in which many ETFs need to rebalance their portfolios. They show that small changes in stock prices can trigger large rebalancing cascades, which affect the prices of all the securities within the same ETF. They conclude that there is a feedback effect in which the rebalancing activity exacerbates the original price shock that prompted the rebalancing.

The mixed evidence on the impact of ETFs on price efficiency possibly reflects the various identification strategies that these studies adopt. To date, the main challenge for researchers has been finding exogenous variation in ETF ownership of the underlying securities. The obvious concern is that ETFs end up owning index stocks, whose prices are more informationally efficient to begin with. Hence, the challenge for future research is to identify sources of truly exogenous variation in ETF ownership.

4.3 Leveraged ETFs

Leveraged ETFs have attracted substantial attention from academics, regulators, and market commentators because these ETFs need to actively rebalance their portfolios on an ongoing and predictable basis, towards the end of the trading day. Leveraged ETFs strive to achieve returns that are a multiple of the underlying index (e.g., x2, x3), or the inverse return on the index (often called bear ETFs), as in a short strategy. To achieve their desired return patterns, these funds rely on leverage or derivatives and need to rebalance their portfolios following price moves of the underlying index. The concern expressed by several parties is that these rebalancing actions have a significant impact on the market. For example, leveraged ETFs were blamed in the 1% run-up in the last 18 minutes of trade of the S&P 500 on October 10, 2011, despite the absence of any news.[6] According to Cheng and Madhavan (2009), the dynamics of leveraged ETFs support the claim of increased volatility toward the end of the day. They also argue that short-term speculators are attracted to these products because they allow traders to make short-term highly-leveraged bets. Jiang and Yan (2016) explore the nature of flows to regular and leveraged ETFs and show

[6] Andrew Ross Sorkin, "Volatility, Thy Name is E.T.F.", DealBook, *New York Times*, October 1, 2011.

that regular ETF flows can be characterized as momentum traders, while leveraged ETF flows are contrarians.

Several studies have attempted to test the claim that leveraged ETFs create a price impact when rebalancing their portfolios. Bai, Bond, and Hatch (2016) focus on the real estate sector and find that rebalancing by leveraged ETFs increases the volatility of the underlying stocks and contributes to price momentum. Tuzun (2014) call leveraged ETF "the new portfolio insurers" because their rebalancing reinforces the original price movement, and thus increases market volatility. His estimation shows that leveraged ETFs contributed significantly to market volatility during the financial crisis of 2008–2009. Shum, Hejazi, Haryanto, and Rodier (2016) present evidence that stock-level end-of-day volatilities are higher following the rebalancing of leveraged ETFs. In contrast, Ivanov and Lenkey (2016) argue that claims about the impact of leveraged ETFs are exaggerated. They show that flows into ETFs counterbalance the hedging demand of ETFs, mitigating their effects on the underlying securities. Despite this compelling argument, the effects documented by Bai, Bond, and Hatch (2016) and Shum, Hejazi, Haryanto, and Rodier (2016) use net rebalancing, i.e., after flows in the opposite direction are taken into account.

ETFs that track volatility indices have properties similar to leveraged ETFs. Volatility indices do not reflect the returns of a constant basket of traded assets, but rather are calculated based on prices of derivatives with weights that change daily, according to the expiration date of the derivatives (e.g., the VIX in the United States). Thus, the ETFs that track the index need to rebalance their portfolios daily in order to match the returns of the index. This setting is ideal to test whether rebalancing affects the prices of the underlying derivatives. Dong (2016) reports that the introduction of VIX ETFs, which hold VIX futures, created strong predicted demand due to rebalancing on the VIX futures and caused a predictable price impact.

4.4 ETFs during Episodes of Market Turmoil

ETFs received much attention during several episodes when markets tumbled and ETF prices appeared to deviate from the prices of the portfolios of the underlying securities. These incidents prompted regulators to be concerned about the possibility that ETFs serve as a transmission conduit for liquidity shocks (Office of Financial Research 2013). In particular, the concern is that during market turbulence, market makers and arbitrageurs cease intermediation activity because they do not have reliable pricing information. As a result, their absence can lead to illiquidity in the underlying securities, amplification of the shock, and transmission to other assets.

During several episodes in recent years, ETFs have displayed a high level of illiquidity during times of market turbulence, which has led regulators and academics to investigate whether ETFs exacerbate liquidity shocks.

Perhaps the most well-known example of a market breakdown in recent years was the Flash Crash of May 6, 2010. On that day, the market was volatile because news about the Greek debt crisis was anticipated. The breakdown in market activity started with an unusual trading volume in the S&P 500 e-mini future contracts, which spread to the equity market and caused the S&P 500 to decline by about 9% within 20 minutes. Hundreds of stocks experienced sharp declines in prices. Borkovec, Domowitz, Serbin, and Yegerman (2010) report that the liquidity of ETFs declined dramatically during the crash: spreads widened significantly, and the limit order book dried up. They interpret this finding as evidence that market participants exited the market once signs of extreme volatility and illiquidity appeared. As a result of the exodus of liquidity providers, price discovery no longer took place at ETFs and there was a disconnect between the returns of ETFs and the returns of the underlying securities. Madhavan (2012) reviews the academic literature discussing the causes of the Flash Crash and agrees that liquidity providers exited the market. He argues that the departure of ETF prices from those of the underlying securities was rooted in the fragmentation of markets. Madhavan claims that stocks are more sensitive to liquidity shocks when markets are fragmented, and finds supporting evidence that these stocks experienced a loss of liquidity during the Flash Crash event and that ETFs linked to these stocks experienced the heaviest volume of canceled orders and price deviations.

Peterffy (2010), who owns and heads one of the largest stock broker houses in the United States, testified that due to bad news from Europe, institutions sold ETF shares. Arbitrageurs bought ETF shares and sold short the underlying stocks. Because of sparse liquidity in some exchanges, some of the arbitrage programs diagnosed unreliable price data and withdrew from the market, leading to a positive feedback loop. As a result, the dry-up of arbitrage capital caused the mispricing between ETFs and the underlying stocks to widen. This mechanism is similar to what is described in the model by Cespa and Foucault (2014). In their theory, market participants rely on information contained in the prices of one asset to price another, e.g., ETFs and the index constituents. However, when one asset becomes temporarily less liquid and its price becomes noisier, market participants are more cautious trading the second asset, leading to lower liquidity. Thus, liquidity shocks travel across assets because they are informationally connected. Also the model of Pan and Zeng (2016) can explain the behavior of arbitrageurs. At times of market stress, when the securities underlying the ETF are illiquid, APs may abstain from engaging in arbitrage activity. It is important to note that prior literature has documented that arbitrageurs exit the market at times of market stress, potentially exacerbating market turbulence (e.g., Aragon and Strahan 2012, Ben-David, Franzoni, and Moussawi 2012).

Following the Flash Crash, several regulators and market commentators voiced concerns about ETFs. Ramaswamy (2011) generalizes the findings from events of market turbulence and argues that ETFs pose a risk to the financial system because their structure lacks transparency and invites market participants to replicate their portfolio using derivatives. He says that past experience shows that assets with a long chain of intermediaries may cause or exacerbate financial shocks due to risk exposure along the chain of financial intermediaries.

Following the Flash Crash of 2010, the SEC adopted rules to halt trading in individual securities, including ETFs, that exhibit extreme volatility swings. However, on August 24, 2015, extreme price movements triggered trading halts of five minutes or longer for more than 300 ETFs.[7] Following steep declines in the futures market prior to the stock market opening, there was a big run on ETF prices immediately after 9:30 am, which caused several ETFs to trade at sharp discounts relative to their NAV. ETF market makers and APs arguably withdrew from the market after a trading pause in the futures market, which they used to hedge their exposure in volatile trading sessions.[8] On August 24, 42% of the overall volume in US equity markets was contributed to ETF trading, despite a big fraction of the trading halts being attributed of US-listed ETFs. The

[7] Eleven ETFs were halted 10 times or more. Corrie Driebusch, Saumya Vaishampayan, and Leslie Josephs, 2015, Wild Trading Exposed Flaws in ETFs, September 13, 2015, *Wall Street Journal*, http://www.wsj.com/articles/wild-trading-exposed-flaws-in-etfs-1442174925.

[8] Chris Dieterich, 2015, The Great ETF Debacle Explained, September 5 2015, *Barron's*, http://www.barrons.com/articles/the-great-etf-debacle-explained-1441434195.

shock that hit ETF prices was eventually transmitted to several large underlying stocks for no fundamental reason.[9,10] Agarwal, Hanouna, Moussawi, and Stahel (2016) use the August 24 event to test whether ETFs pose a liquidity risk in times of market stress. They find improvements in underlying stock liquidity during the period when trading in the ETFs with wild price swings was halted that day. Their results suggest that ETFs create an additional layer of commonality in the liquidity of underlying securities that comes into play in times of market stress.

June 20, 2013 is another instance when the prices of ETFs plummeted, arguably due to the lack of countering arbitrage forces. On this day, the prices of stocks in many emerging markets declined sharply. The ETFs that track the indices of these emerging markets and that are traded in the United States experienced sharp price declines as well. However, because the foreign markets were closed during the operating hours of the US markets, arbitrageurs appear to have abstained from the market, letting ETF prices collapse under the selling pressure of US investors.[11] Following these events and other concerns voiced in the media, the CEO of iShares, the largest manager of ETFs, released an open letter to investors in June 2013,[12] reassuring them that APs are committed to serving investors by ensuring that ETF prices track the price of the underlying securities.

5 Conclusion and Directions for Future Research

ETFs are perhaps the financial innovation that has had the greatest impact on financial markets in the first decades of the 21st century. These investment vehicles offer a combination of the features that have not been available to investors before: low cost transactions, intraday liquidity, and passive index tracking. The rise of ETFs is part of a wider process that has taken place in the asset management industry over the last three decades: passive management has expanded, while at the same time the asset management landscape has become more concentrated.

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[9] Division of Trading and Markets at the SEC, Research Note on Equity Market Volatility on August 24 2015, December 2015, https://www.sec.gov/marketstructure/research/equity_market_volatility.pdf

[10] For example, DVY's decline of 35% caused significant price pressure on large underlying basket stocks, such as GE, which dropped by as much as 21% before reverting back to prior values after the DVY's price stabilized during the day.

[11] Christopher Condon and Michelle Kaske, ETF Tracking Errors in Rout Shows Access Comes With Risks, Bloomberg June 23, 2013.

[12] Mark Wiedman, "Open Letter to Our Investors," iShares, 29 June 2013.

While some of the implications of these trends have been studied (e.g., Ben-David, Franzoni, Moussawi, and Sedunov 2015), some important research questions remain open. In particular, do the low-transaction costs of ETFs encourage the formation of a class of short-term speculators that did not exist before? Do these traders have a significant impact on the quality of prices?

The literature presents mixed evidence about the effects of ETFs on the informational efficiency of the underlying securities. On the one hand, researchers have found that ETF allow information to be more efficiently impounded into security prices. On the other hand, mounting evidence indicates that securities prices have become noisier since the introduction of ETFs. It is possible that both phenomena are taking place in parallel: security prices impound information more efficiently once they are included in ETFs' baskets and, at the same time, become more volatile due to non-fundamental reasons. Missing to date is a welfare analysis exploring the net effect of ETFs on market participants. Do ETFs increase informational efficiency overall? Are there corners of the financial markets where the informational gains are particularly large, and others where they are negative?

The ability of ETF prices to truly reflect the value of the underlying securities depends on the presence of agents who facilitate arbitrage: high-frequency arbitrageurs and APs. The concerns raised by academics and regulators about the risks that these classes of investors may create during events of market turbulence deserve additional investigation. In particular, there is a concern that ETFs provide a false sense of liquidity, where they are liquid at normal trading environment. However, at turbulent times, liquidity dries up since APs and arbitrageurs stay out of the market. The effect could be exacerbate if the presence of ETFs crowds out liquidity from the underlying assets (e.g., corporate bonds, as in Dannhauser 2016). We consider financial economists to have the responsibility for providing analyses that warns against market breakdowns, which could negatively impact the real economy and be potentially harmful for society at large.

Understanding the effects of ETFs on liquidity and efficiency as well as their mechanism is important not only from an academic standpoint, but also from a regulatory perspective. Since the financial crisis of 2008, and due to a few later episodes when the ETF arbitrage mechanism has broken down, both investors and policymakers have raised concerns about the fragility of the

ETF market.[13,14,15] Our hope is that the academic research about ETFs is useful in quantifying the systemic risks that these investment vehicles pose and that it can potentially help addressing them.

[13] See Robin Wigglesworth, Nicole Bullock and Joe Rennison, "SEC gears up for major review of exchange traded funds," *Financial Times*, October 20, 2016.
[14] See Joe Rennison and Thomas Hale, "Explosive growth of bond ETFs stirs fears of impending crisis," *Financial Times*, October 19, 2016.
[15] The head of the SEC, Mary Jo White, recently hinted at a large scale review of the ETF landscape by the U.S. financial market regulator (https://www.sec.gov/news/speech/white-speech-keynote-address-ici-052016.html).

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Figure 1. Time Series of the Total Market Capitalization and the Assets Under Management of ETFs

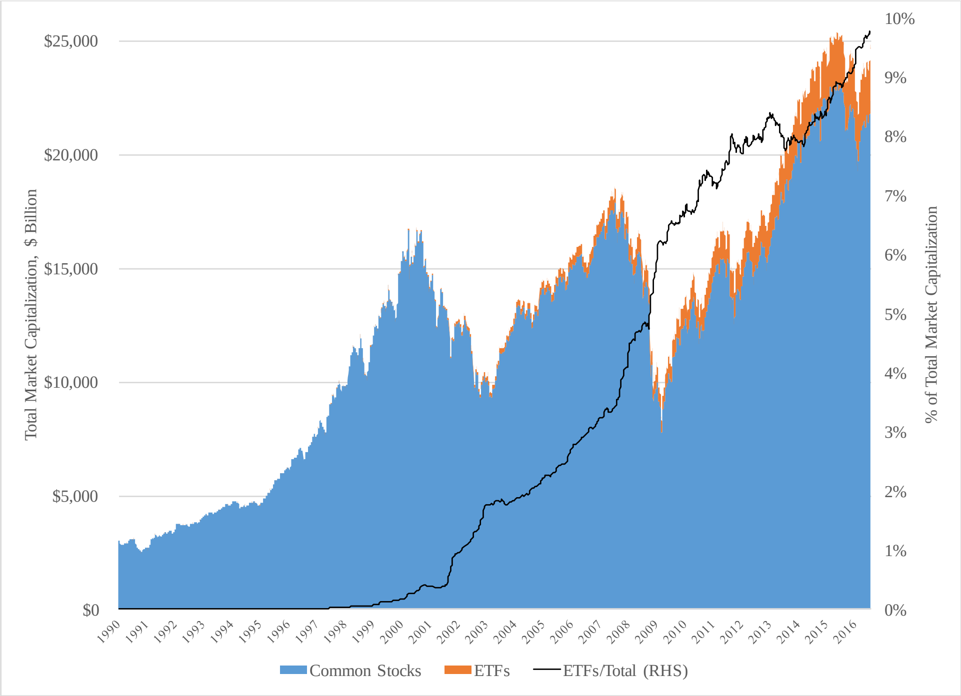

Figure 2. Time Series of Daily Trading Volume

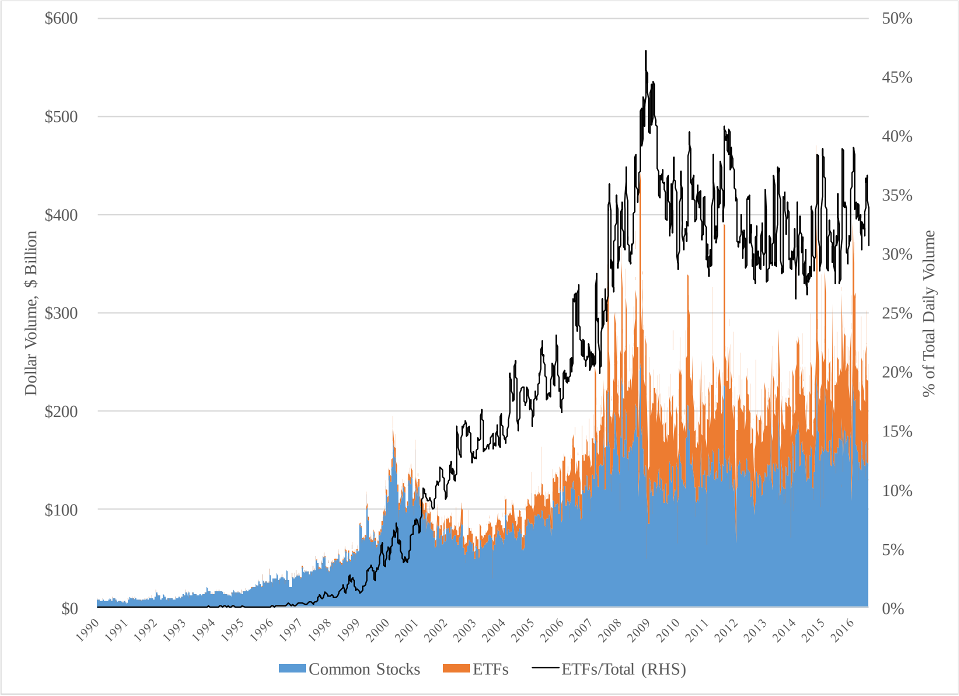

Figure 3. Time Series of Short Interest

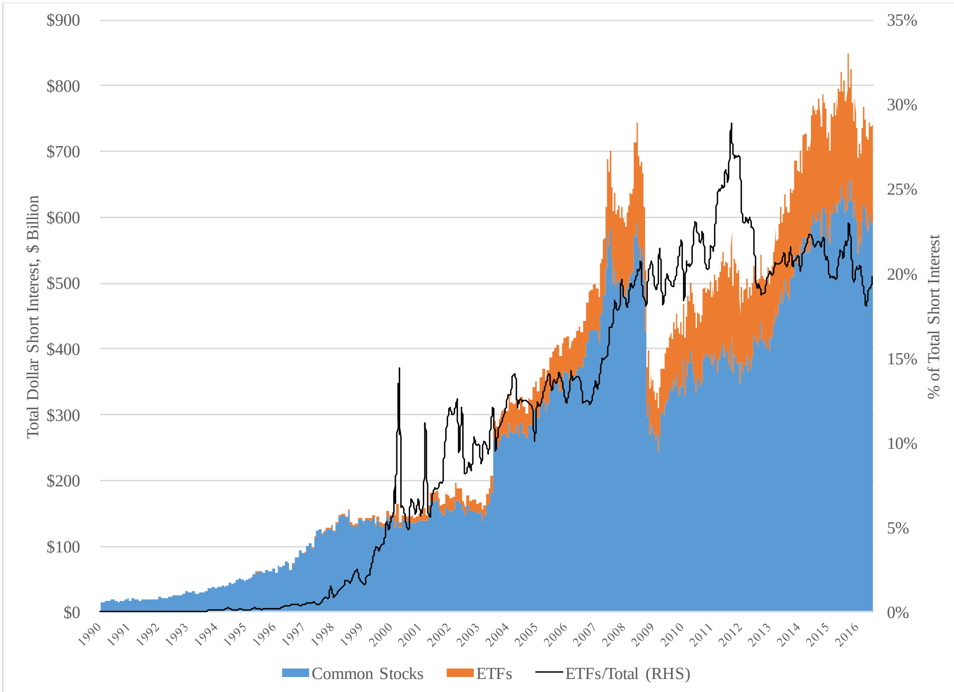

Figure 4. Illustration of the Propagation of Liquidity Shocks via Arbitrage

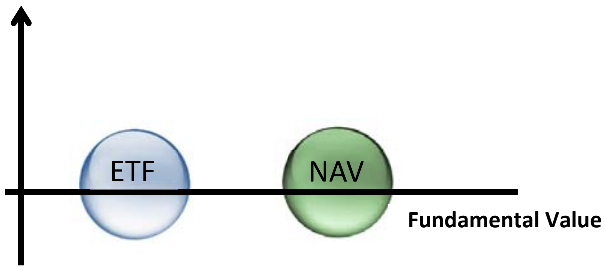

Figure 4a. Initial equilibrium

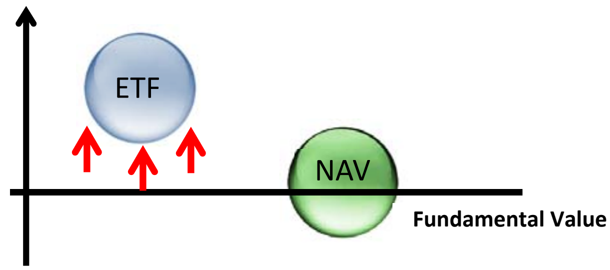

Figure 4b. Liquidity shock to ETF

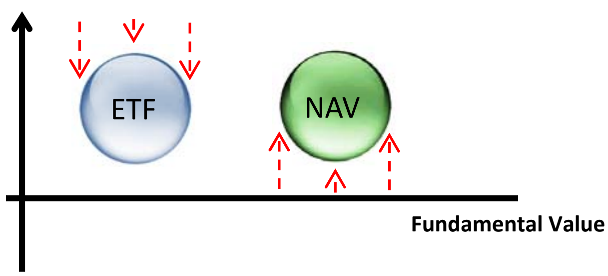

Figure 4c. Initial outcome of arbitrage: the shock is propagated to the NAV, and the ETF price starts reverting to the fundamental value.

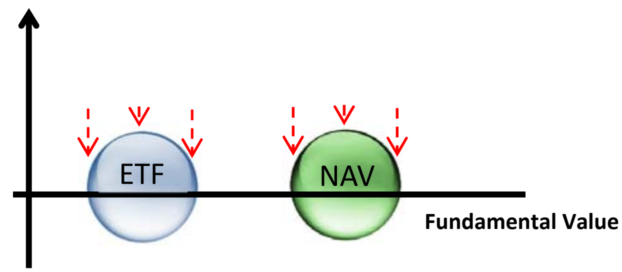

Figure 4d. Equilibrium reestablished: after some time, both the ETF price and the NAV revert to the fundamental value.

Table 1. Time Series of Assets Under Management

The table presents the time series of assets under management in billions of US dollars. Index funds include both traditional index funds and smart-beta index funds. Source: authors' calculations and CRSP.

	US Equity Funds				Foreign Equity Funds				Fixed Income Funds			
	ETFs		Mutual Funds		ETFs		Mutual Funds		ETFs		Mutual Funds	
Year	Index	Active	Index	Active	Index	Active	Index	Active	Index	Active	Index	Active
1999	31.2	-	334.9	2,632.6	2.0	-	19.1	504.3	-	-	20.0	2,181.3
2000	63.0	0.1	327.1	2,586.2	2.0	0.0	19.2	457.5	-	-	23.9	2,403.0
2001	78.7	-	308.3	2,231.8	2.9	-	17.7	364.5	-	-	33.5	2,890.1
2002	91.8	-	255.3	1,708.5	5.3	-	18.3	310.4	3.9	-	42.6	3,007.6
2003	131.0	-	365.1	2,325.1	13.9	-	31.5	448.5	4.7	-	46.1	2,887.2
2004	183.6	0.1	443.6	2,687.7	33.1	-	51.1	601.7	8.5	-	54.3	2,803.5
2005	219.9	0.0	486.3	2,918.1	64.0	-	79.1	791.4	15.0	-	63.6	2,953.1
2006	282.5	0.5	592.0	3,299.1	107.7	-	125.9	1,105.3	20.5	-	75.9	3,364.7
2007	384.3	2.4	665.5	3,532.0	169.7	0.0	177.7	1,396.4	34.3	-	109.5	4,242.7
2008	289.9	11.3	479.2	2,323.7	104.2	0.1	102.4	845.5	55.6	0.0	134.3	5,001.6
2009	435.5	10.5	660.0	2,998.9	199.1	0.3	130.0	1,185.1	100.1	0.0	185.8	4,986.8
2010	565.8	11.6	823.5	3,496.8	260.0	0.8	184.1	1,383.6	132.3	1.5	233.9	4,910.5
2011	612.2	11.7	856.9	3,349.6	223.0	0.0	179.8	1,190.3	183.1	3.8	276.1	4,913.6
2012	755.7	11.3	1,024.5	3,662.9	305.0	0.0	234.6	1,424.3	235.7	9.7	319.8	5,292.1
2013	1,012.7	13.2	1,432.8	4,774.0	378.1	0.0	306.1	1,799.4	227.7	10.9	324.2	5,127.9
2014	1,233.1	19.5	1,706.2	5,065.8	396.7	1.2	357.5	1,778.9	280.5	9.8	397.5	5,282.8
2015	1,235.3	22.5	1,688.7	4,975.7	455.3	0.8	319.5	1,953.4	324.9	12.8	427.9	5,266.5
2016	1,329.4	24.0	1,805.6	5,044.1	434.5	0.9	349.2	1,958.9	381.6	15.5	481.1	5,458.8