INNOVATIONS IN EXCHANGE-TRADED FUNDS: A COMPREHENSIVE ANALYTICAL OVERVIEW

ABSTRACT

A review of the prior innovations in ETFs including arbitrage trading, price discovery process, short selling, hedging, and leveraged ETFs. An examination of the latest innovation, single-stock ETFs, provides preliminary insights. Approved for trading by the SEC in the summer of 2022, single-stock ETFs are based on highly liquid stocks. They appear to track the promised leveraged daily returns with an average deviation of one basis point. Single-stock ETF liquidity could be a concern going forward as financial institutions continue to create more of these ETFs.

Keywords: Exchange-Traded Funds, Leveraged, Innovation.

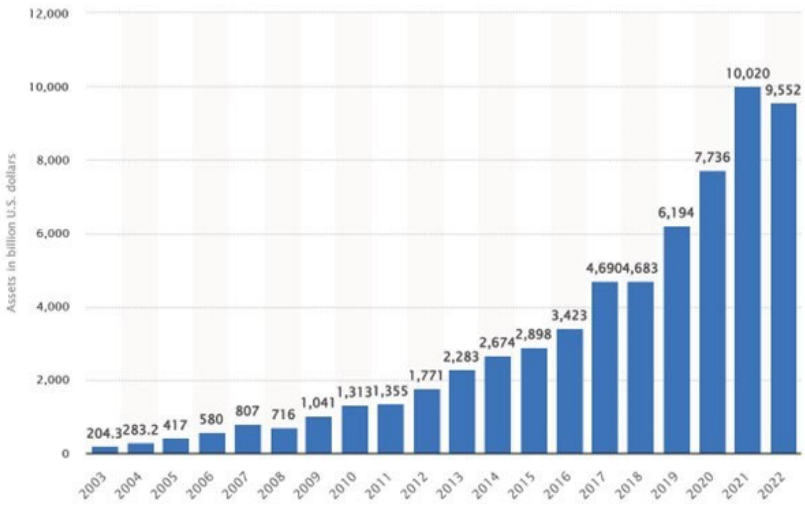
JEL Classification Numbers: G10, G14

INTRODUCTION

In recent years, the financial landscape has witnessed a significant shift towards passive investment strategies, with exchange-traded funds (ETFs) rapidly gaining prominence among retail and institutional investors alike. The total global size grew from $1.7 trillion in 2012 to $9.5 trillion in 2022 (Figure 1). These investment vehicles have revolutionized the way investors gain exposure to a wide array of asset classes. With an increasing number of financial institutions launching new ETFs, the industry is experiencing an unprecedented wave of innovation, resulting in a broad range of sophisticated investment options that go beyond traditional index tracking.

FIGURE 1: GLOBAL EXCHANGE-TRADED FUNDS ASSETS 2003-2022

This figure graphs the global ETF assets measured in billions of dollars from 2003 to 2022. The data is from Statista (2023).



Before discussing the innovations in ETFs, it is essential to understand the fundamental concept of an ETF. An ETF is a type of investment fund that is traded on stock exchanges, enabling investors to gain exposure to a diversified portfolio of assets while enjoying the liquidity and flexibility of individual stocks. Typically, ETFs track the performance of a particular index, allowing investors to invest in a basket of securities without having to hold each underlying security individually. The initial concept of ETFs was introduced in the early 1990s with the launch of the Standard & Poor's Depositary Receipts (SPDRs). However, it was not until the early 2000s that ETFs gained significant traction as investors increasingly sought low-cost, efficient, and transparent investment alternatives to traditional mutual funds.

Broadly speaking, there are four main types of ETFs: index, strategic beta, fixed income, and alternative/derivative. The earliest ETFs were designed to track traditional broad-market indices such as the S&P 500 or Dow Jones Industrial Average. Today, however, there has been a proliferation of ETFs that provide exposure to a wide range of indices, including sector-specific, country-specific, and regional indices. This expansion has allowed investors to tailor their investment allocations to their specific preferences and investment strategies. Another notable innovation in the ETF space is the introduction of strategic beta ETFs. These ETFs aim to outperform traditional market cap-weighted indices by employing alternative weighting methodologies, such as equal weighting, factor weighting, or momentum weighting. Strategic beta ETFs provide investors with an opportunity to incorporate specific investment themes or factors into their portfolios, potentially enhancing risk-adjusted returns. While the initial focus of ETFs was predominantly on equity markets, the industry has expanded to include fixed-income ETFs in response to investor demand for diversified and efficient exposure to the bond markets. Fixed-income ETFs provide investors with access to a broad spectrum of bonds, ranging from government bonds to corporate bonds and even specialized areas such as high-yield bonds or municipal bonds. This innovation has increased transparency and liquidity in the traditionally opaque bond market, allowing investors to adjust their fixed-income portfolios more easily. In recent years, another innovation in the ETF space has been the introduction of alternative and derivative-based ETFs. These ETFs provide exposure to non-traditional investments, such as commodities, currencies, or real estate, through the use of derivative instruments. These ETFs offer investors the opportunity to gain exposure to less liquid and harder-to-access markets, diversifying their portfolios beyond traditional asset classes.

The innovations in ETFs have significantly enhanced investor access to previously inaccessible asset classes, providing retail investors with opportunities once reserved for institutional investors. The liquidity, cost efficiency, and ease of trading associated with ETFs have democratized access to a diverse range of assets. Investors can now construct sophisticated portfolios tailored to their investment objectives, formerly available only to high-net-worth individuals or institutional investors. In this paper, we review various innovative aspects of ETFs, including their mechanics, arbitrage trading, impact on price discovery, effect on hedging strategies, short selling, and the rise of leveraged and single-stock ETFs.

PRIOR INNOVATIONS

Before discussing the innovations in ETFs, it is important to first explain the mechanics of ETFs, which encompass more than just access to intraday trading. An ETF is a portfolio of assets managed by sponsors, such as Vanguard and Fidelity. These sponsors, also known as ETF managers, collaborate with large financial institutions, known as Authorized Participants (APs), in the creation and redemption process. The first US-listed ETF was created in January 1993 by State Street Corporation [1]. The fund, known as SPDR

[1] see https://www.ssga.com/us/en/intermediary/etfs/about-us/who-we-are/our-history

S&P 500 ETF Trust (ticker symbol: SPY), is designed to track the Standard & Poor's 500 Index, a benchmark for U.S. stocks.

The creation process of ETFs often starts with investors providing cash or cash equivalents to the APs, who then utilize that cash to buy securities in the capital markets. The basket of securities purchased can be traded with the sponsors for ETF creation units. Subsequently, the APs distribute the ETF shares to the investors.

The redemption process operates in the opposite direction. Investors sell their ETF shares to the APs in exchange for cash. The APs can either sell these ETF shares or combine them into large blocks to trade with sponsors for cash or a basket of securities. In both the creation and redemption processes, arbitrage opportunities may arise if there are differences in security prices, allowing APs to capitalize on these brief price discrepancies. As one would expect in efficient markets, this arbitrage process helps to keep the price of the ETFs closer to the intrinsic value of the underlying securities.

Arbitrage

The presence of these arbitrage trading opportunities, as explained by Marshall *et al*. (2013), generally occurs when the market is more one-sided and less liquid. The authors find robust evidence that a decrease in liquidity (i.e., higher spread) and an increase in liquidity risk (i.e., higher standard deviation of spread changes) contribute to an increase in arbitrage opportunities. These trading conditions seem to be robust signals of arbitrage opportunities when there is mispricing in the underlying assets and/or funds. As fund prices and the intrinsic values of their stocks adjust from arbitrage trading, researchers question the impact these activities have on the relationship between the funds and their stocks. Da and Shive (2017) uncovered an interesting finding that the arbitrageurs' activity could potentially cause return co-movement. More specifically, both high ETF turnover and ownership of the portfolio stocks can increase the co-movement of the stocks in the portfolio.

In a working paper by Bhattacharya and O'Hara (2018), they explain that the mechanics of ETFs can cause market fragility for the underlying stocks. The deviations from their fundamental values can be persistent, which may subsequently decrease the information efficiency of the underlying stocks. This persistence is elaborated upon by Brown *et al*. (2021), who argue that while APs do their parts to correct the relative mispricing, their activities do not correct the fundamental mispricing in the short run. This distortion lasts long enough that traders can earn up to 2% per month in excess return by taking a long position in low-flow ETFs (funds with limited creation and redemption activities), and a short position in high-flow ETFs.

Another research direction entails identifying factors that can either impede or enhance the price-correcting process of arbitrage trading. In a related study, Gehricke and Zhang (2021) explain that in contrast to ETFs VIX futures Exchange-Traded Products do not effectively track their intrinsic values at the daily, weekly, and monthly levels. This is attributed to the limitation on arbitrage activities, such as early redemption, close-out options, and maturity dates. Traders must deal not only with normal limitations like the minimum units for redemption but also the additional derivative-related hurdles.

While these additional hurdles may further complicate the arbitrage price correcting process, Jain *et al*. (2021) use different proxies for algorithmic trading and find that algo trading can decrease fund price deviations and lessen the persistence of any such deviations from net asset values. Their findings suggest that algorithmic traders provide intraday liquidity that facilitates arbitrage trading.

In summary, understanding the mechanics of ETFs and the impact of arbitrage activities is crucial for assessing their effectiveness and potential risks in the financial markets. Researchers continue to explore these aspects to shed light on the dynamics of ETFs and their interactions with underlying assets.

Price Discovery

Considering the potential deviations in value between ETFs and their underlying stocks, which can lead to profitable arbitrage opportunities, researchers question whether ETFs improve the price discovery of the underlying stocks. Israeli *et al*. (2017) examine ETF ownership and find evidence suggesting that EFTs may not necessarily improve the price discovery process. They discover that an increase in ownership is related to higher trading costs in the form of larger bid-ask spreads and lower market liquidity as uninformed traders switch to owning ETFs instead of the underlying stocks. As these uninformed noise traders turn to the ETF market, there are fewer of them to trade with informed traders, which can subsequently disincentivize these informed traders from participating in the trade of the underlying stocks. Notably, the migration of noise traders to ETFs does not enhance price discovery as outlined by the authors. They also find that stock return synchronicity, which measures how much the stock return variation can be explained by market and related industry returns, increases with the ownership of ETF. In addition, a decrease in firm-specific information impounded into the stock price impedes the price discovery process. The authors also reveal that firms with higher levels of ETF ownership experience long-term challenges in firm-specific information discovery, with a one percent increase in ownership reducing the future earnings response coefficient by 14%. Consequently, it appears that ETF ownership could negatively affect the price discovery process of the underlying stocks. In contrast, Glosten *et al*. (2021) find that ETF activity increases the short-term informational efficiency, particularly for stocks with a weaker information environment, and they suggest that ETF trading activity could lead to higher information efficiency in the securities that are part of the ETF.

Recent research expands on this line of inquiry by exploring other ETF factors that can influence price discovery. Bhojraj *et al*. (2020) explain that ETFs should not be treated as a homogenous group and suggest that there is a difference in information efficiency between broad-based and sector ETFs, particularly around earnings announcements. Broad ETFs, which are funds that cover the S&P 500, have a negative impact on price efficiency due to their lower responsiveness to industry and idiosyncratic information. On the other hand, sector ETFs seem to be more effective at incorporating these types of information, particularly related to future earnings. Intuitively, earnings announcements from firms within the same sector will help reduce any over-extrapolation of industry information. The information is focused and is not spread out over several sectors as in the broad-based ETFs. Easley *et al*. (2021) also examine ETFs as a non-homogenous group, and they find that actively managed ETFs with high turnover can enhance the price discovery of individual stocks through the creation/redemption and arbitrage mechanism. Additionally, Duffy *et al*. (2021) find that the diversification benefits of ETFs, especially when asset dividends are negatively correlated, can improve price discovery and liquidity.

Besides the type of ETFs, it appears that extreme price movements, or jumps, can enhance price discovery as new information is impounded into the stock price. Jurdi (2020) explains that the realizations of intraday jumps and simultaneous ‘co-jumps’ of two ETFs, can increase price discovery through the post-realization order flow. The author finds evidence of a significant positive correlation between order flow and prices of the two EFTs, SPDR Spiders and SPRD Gold. Extending the research on jumps and gold, Sehgal *et al*. (2021) find that the jumps in futures prices have an asymmetric impact on enhancing price discovery, with

positive jumps having a greater impact than negative ones. The authors also find evidence that during 2016 and 2018 ETFs backed by physical gold challenged futures prices in price discovery. This leadership in price discovery by physical-gold-backed ETFs can be attributed to high inflows from both retail and institutional investors.

Short Selling and Hedging

In addition to the possibility of improving the price discovery process, ETFs have also impacted short-selling and hedging strategies. More specifically, ETFs offer investors an alternative to derivatives. Unlike mutual funds, investors can short ETFs. Mohamad *et al*. (2016) explain that short positions in ETFs are mostly taken by hedgers. It appears that hedging via shorting ETFs is a more advantageous strategy than using derivatives since the hedging period could outlast the derivative's maturity, thereby providing more flexibility to hedgers. Moreover, hedging by shorting ETFs avoids costs associated with derivative contract rollout and price risk (Chovancova *et al*., 2019).

According to Huang *et al*. (2021), hedge funds use the strategy of longing the stock and shorting the ETF before earnings announcements and post-earnings announcement drifts. Specifically, these hedge funds use industry ETFs to hedge against industry risks while capitalizing on the positive information from the underlying stocks. Other hedging strategies involve non-ETF assets. For instance, Kang *et al*. (2021) show evidence that oil can be used as an effective hedge for sector ETFs both in the short and long run. Salisu and Obiora (2021) come to a similar conclusion but for non-energy ETFs, and they explain that non-energy ETFs can be used to hedge market risk for oil and such a strategy could improve risk-adjusted returns. Based on these findings, it seems that hedgers short using non-broad-based ETFs. Madura and Ngo (2008) argue that these non-broad-based ETFs are more susceptible to overpricing due to their lack of diversification, making them susceptible to significant price swings in response to information related to a specific large company within the category. Hence, non-broad-based ETFs are more likely to be temporarily overvalued, making them a better candidate for shorting.

Non-hedgers can also benefit from examining short-interest data. Using the daily short-interest ETF data from the London Stock Exchange, Mohamad *et al*. (2016) find evidence that large increases in the short interest in ETFs lead to over-performance. As such, non-hedgers can profit from subsequent overperformance by taking long positions in ETFs when ETF short interest increases. The authors note, however, that this strategy may have only worked before the financial crisis in 2008. The resulting decline in ETFs and ban on short selling eliminated these opportunities. The United States also temporarily banned selling financial stocks short in 2008 although the ban did not include ETFs. Notably, during this period, Karmaziene and Sokolovski (2022) find that the ability to short ETFs reduced some of the adverse effects of the ban on stock liquidity.

Beyond crisis times, there are other unexpected relationships between ETFs and their underlying stocks with shorting activities. Bansal *et al*. (2012) identify that stocks that are short-sale constrained (i.e., demand for stock shorting is higher than the supply from stock lenders) can benefit from ETF inclusion. ETFs relax the constraint by lowering the stock lender search costs and recall risks for short sellers due to their well-publicized holdings and their tendency to be long-term holders of the underlying stocks. Therefore, when a stock is added to an ETF, there is an increased shorting activity of that underlying stock.

Leveraged ETFs

Since their introduction in the United States in 2006, leveraged exchange-traded funds (LETFs) have gained popularity among investors. These funds use borrowing and derivatives to increase their exposure to some specific indices, such as the S&P 500 or NASDAQ. While these funds offer potentially higher returns for investors, they also come with increased levels of risk. Typically, an LETF maintains a fixed leverage ratio, such as 2:1 or 3:1, through the use of derivatives like options, futures, and swaps. This allows the fund to yield 2 or 3 times the daily return of the underlying security. However, the use of derivatives can result in increased costs for the fund, as well as increased tracking errors - the divergence between the fund's returns and its stated objective. Furthermore, LETFs may also use daily rebalancing to maintain their leverage ratio, which can also lead to tracking errors over longer periods (Aggarwal and Schofield, 2013). Examining LETFs and inverse LETFs, Jain *et al*. (2022) find evidence that rebalancing has a moderating or amplifying effect on the underlying's and market's return volatility particularly during crisis time.

The performance of LETFs, measured by the tracking error or the deviation between the returns of the net asset value and the returns of the underlying assets, has piqued scholarly interest. Giannetti (2017) finds that inverse, international equity, bonds, and commodities LETFs tend to underperform due to daily leveraging costs. LETFs, in general, struggled during the 2007-08 financial crisis. Some studies suggest that LETFs can provide the target returns over shorter periods. Charupat and Miu (2011) find that LEFTs are popular mostly with short-term oriented retail investors, who hold the LEFTs for approximately 15 days on average. Lu *et al*. (2012) posit that LETFs can yield the intended returns if the holding period is less than six months. Rompotis (2016) discovers that in emerging markets the typical leveraged ETF is capable of achieving its targeted return over a maximum time frame of one week. Meanwhile, the average inverse ETF has been found to successfully deliver its intended return only within a considerably shorter 2-day period.

Performance can vary depending on the holding periods, and Pessina and Whaley (2021) argue that not all investors fully understand the increased risk associated with these funds. Both the Financial Regulatory Industry Authority (FINRA) and the Securities and Exchange Commission (SEC) have cautioned investors about the additional risks of holding LEFTs for longer periods. The use of LETFs for long-term investment strategies may not be appropriate due to their tendency to underperform over longer periods. Rather, LETFs may be better suited for short-term trading strategies or investors with a higher risk tolerance (Bansal and Marshall, 2015). Giannetti (2017) goes further to argue that LEFTs are speculative in both the direction (positively or negatively leveraged) and volatility of the underlying assets. Hence, their use should be reserved for sophisticated investors who possess advanced understanding and expertise in market dynamics.

In addition to measuring performance, researchers examine various factors that affect tracking error. Charupat and Miu (2014) propose that management effects (advisory and management service fees, and transaction costs), financing effects (borrowing and shorting costs), and compounding effects (rebalancing the fund exposure to the underlying assets to keep the same leverage ratio over periods longer than one day) can all impact tracking error. Tang and Xu (2013) suggest that the daily deviation primarily arises from the non-compounding effects of management tracking errors in reaching the target return and market frictions. Furthermore, both compounding and non-compounding deviations could potentially increase in size as the holding period increases. In a related study, Shum and Kang (2013) decompose the return deviation into three components: compounding effects from longer holding periods, managers' ability to replicate daily returns, and ETF trade premiums and discounts. They find that a low or negative correlation between deviations is due to compounding and management factors. Thus, a portfolio that combines one-

day and multi-day holding periods could provide diversification benefits. These studies indicate that several factors can affect performance. Consequently, investors are more likely to benefit from LEFTs if they were to keep their investment horizon short to minimize the exposure to these factors.

Connecting Prior Innovations

Arbitrage, price discovery, short selling, hedging, and leveraged ETFs are all important concepts within the realm of exchange-traded funds. Each of these topics plays a significant role in the functioning and dynamics of ETFs. Understanding the implications of these topics is vital for investors looking to navigate the complex landscape of ETFs and make informed investment decisions.

Arbitrage involves exploiting differences between the market price of an ETF and the net asset value (NAV) of its underlying assets. Arbitrage activity keeps the market price of the ETF in line with its NAV, ensuring efficient price discovery. In the context of ETFs, price discovery involves the continuous interplay of supply and demand in the market, which ultimately determines the ETF's trading price ensuring that the market price accurately reflects the value of the underlying assets.

One way ETF prices can be updated is through the trading activities of short sellers. Short selling can be particularly beneficial if an investor believes that a particular sector or market will decline in value, they can short sell an ETF that tracks that sector or market. This allows investors to profit from a decline in the ETF's price, as they can buy it back at a lower price later and pocket the difference. Additionally, these trades will contribute to the price discovery process. Short selling in ETFs also provides opportunities for investors to hedge their portfolios, reducing or offsetting potential losses from exposure to specific assets or market conditions. For instance, an investor with a high exposure to a particular sector can hedge their risk by investing in an ETF that tracks a different sector.

Finally, LETFs seek to amplify the returns of an underlying index or asset class through the use of financial derivatives and borrowing. They are designed for short-term trading and may not be suitable for long-term investors due to compounding effects and potential tracking errors. Innovations in LEFTs have paved the way for the latest innovation: single-stock ETFs.

RECENT INNOVATION: SINGLE-STOCK ETFS

ETFs serve a multitude of purposes for traders, as highlighted by extensive research. A recent innovative use of ETFs is the ability to leverage or inversely trade a single stock via single-stock ETFs (SSETFs). SSETFs were first launched by AXS investments in the US market in 2022 [2] and were held mostly by retail investors [3]. These SSETFs track the daily return of one stock, such as Tesla or Apple, and they are created by using derivatives, such as swaps, and treasury products to deliver +1.5, +2, -1.5, or -2 times the daily return, thereby facilitating short shelling without the need for traders to directly short the shares. Additionally, because of how these SSETFs are structured to provide multiples of the daily return, they are significantly influenced by the time decay of the derivative securities and are not meant for medium and long-term holding periods.

[2] See https://www.axsinvestments.com/axs-single-stock-etfs

[3] See Recommendation of the Market Structure Subcommittee of the SEC Investor Advisory Committee on Single Stock ETFs and Leveraged ETFs https://www.sec.gov/files/20230616recommendation-single-stock-etfs-and-leveraged-etfs.pdf

Similar to other leveraged instruments, the opportunities for higher returns come with greater risks. Both the SEC and FINRA have cautioned traders about the novel and complex nature of these instruments. In particular, the SEC expressed concerns that due to the inherent risks and features of these products, it might be difficult for investment professionals to recommend them to retail investors while also fulfilling their fiduciary duties or complying with Regulation Best Interest.[4] We believe SSETFs are popular with retail investors because they have another avenue to pursue their speculative strategies with 1.5x or 2x the return without significantly more money invested. Hence, the demand for SSETFs continues to increase as speculative interest increases in popular stocks, such as Tesla, Nvidia, and Apple.

To provide more information about these new SSETF products, we collect data from CRSP and the respective financial institutions. Our date range from the inception date to December 31, 2022. Table 1 provides some descriptive statistics for 23 available single-stock ETFs based on Alphabet Inc. (GOOG), Amazon.com Inc. (AMZN), Apple Inc. (AAPL), Coinbase Global Inc. (COIN), Microsoft Corporation (MSFT), Nike Inc. (NKE), Nvidia Corporation (NVDA), Paypal Holdings Inc. (PYPL), Pfizer Inc. (PFE), and Tesla Inc. (TSLA). These 23 single-stock ETFs are managed by four financial institutions: Direxion, AXS, GraniteShares, and Innovator, listed in order of highest to lowest net asset value.

Direxion's ten SSETFs have a combined net asset of approximately $751 million with Direxion Daily TSLA Bull 1.5X Shares accounting for more than 75% of the combined value. In second place based on asset value, AXS Investments' eight single-stock ETFs have a combined net asset of approximately $262 million. Its largest ETFs are AXS TSLA Bear Daily ETF and AXS 1.25X NVDA Bear Daily ETF, accounting for 98% of the net asset value. Next, GraniteShares has almost $14 million in assets equally distributed amongst its four ETFs. Lastly, Innovator's sole single-stock ETF on Tesla has a net asset value of nearly $2 million. Together these 23 ETFs have a combined value of $1 billion.

Although the interest in these ETFs has increased since their inception in the summer of 2022, their average daily volume is quite small at approximately 225,000 shares relative to their underlying stocks' average daily volume of 50 million shares. As more single-stock ETFs become available, we will continue to see new products based on well-traded stocks similar to Tesla, Amazon, and Apple. In terms of their expense ratio, these single-stock ETFs average around 1.10%, which is high given the average expense ratio for equity ETFs is 0.16% and for bond index ETFs is 0.12% in 2021 (Thune, 2023). In dollar terms, for every $10,000 invested in a single-stock ETF, management keeps $110. Given their combined assets of $1 billion, these financial institutions earn approximately $11 million annually.

When we look at their performance, these ETFs target daily returns ranging from -2x to +1.5x the underlying daily returns. Excluding one outlier, these ETFs tend to track their underlying stock well with an average deviation of one basis point. The top three largest daily returns are based on Tesla and Amazon with Direxion Daily TSLA Bear 1X Shares (TSLS) at 0.77%, GraniteShares 1x Short TSLA Daily ETF (TSLI) at 0.76%, and Direxion Daily AMZN Bear 1X Shares (AMZD) at 0.51% shown in Table 2.

[4] See SEC statement on single-stock ETFs https://www.sec.gov/news/statement/crenshawsingle-stock-etfs-20220711

While these ETFs track their objectives well providing traders with the promised target daily returns, a prominent concern is their longevity. Of these 23 ETFs, six of them are closed as of June 16, 2023. These closed ETFs have lower liquidity than their competitors.

Table 3 shows that out of the top 10 lowest liquidity ETFs, six are from the closed funds with an average spread of 0.0111 compared to an average spread of 0.0032. From our data, we see a statistically negative correlation between spread and trading volume. Without additional data, we cannot definitively determine if higher spreads lead to less trading activity or vice versa. However, the current data suggest that there is a strong relationship between the trading volume of both SSETFs and their underlying stocks with liquidity. Going forward as financial institutions create more SSETFs, liquidity could become an issue as multiple SSETFs on the same underlying stock compete for investors.

CONCLUSION

Innovations in ETFs have exerted substantial financial impacts on the investment industry. The rise of ETFs has democratized investment access, provided cost efficiencies, and impacted market dynamics. The industry continues to innovate, and at the moment, single-stock ETFs are the latest product evolution. Single-stock ETFs offer traders the opportunity to execute novel strategies. However, due to the limited data available, comprehensively evaluating their impact remains a challenge. As more single-stock ETFs become available and the data expands for existing ones, further research opportunities about the impact of single-stock ETFs on the market will undoubtedly arise. Furthermore, researchers can examine how single-stock ETFs can be utilized in risk management, particularly during periods of high market volatility. These advancements also bring forth regulatory challenges, necessitating a balanced approach to ensuring investor protection and market stability.

REFERENCES

Aggarwal, R. and Schofield, L. (2013), "The growth of global ETFs and regulatory challenges", *Advances in Financial Economics,* Vol. 16, pp. 77–100.

Bansal, N., McKeon, R. and Svetina, M. (2012), "Short-sale constraints and securities lending by exchange-traded funds", Managerial Finance, Vol. 39 No. 5, pp. 444–456.

Bansal, V. K. and Marshall, J. F. (2015), "A tracking error approach to leveraged ETFs: Are they really that bad?" Global Finance Journal, Vol. 26, pp. 47–63.

Bhattacharya, A. and O'Hara, M. (2018), "Can ETFs increase market fragility? Effect of information linkages in ETF markets", working paper, The City University of New York, Cornell University, 17 April.

Bhojraj, S., Mohanram, P. and Zhang, S. (2020), "ETFs and information transfer across firms", Journal of Accounting and Economics, Vol. 70 No. 2-3, pp. 1–20.

Brown, D., Davies, C.S.W. and Ringgenberg, M.C. (2021), "ETF arbitrage, nonfundamental demand, and return predictability", Review of Finance, Vol. 25 No. 4, pp. 937–972.

Charupat, N. and Miu P. (2011), "The pricing and performance of leveraged exchange traded funds", Journal of Banking Finance, Vol. 35 No. 4, pp. 966–977.

Charupat, N. and Miu, P. (2014), "A new method to measure the performance of leveraged exchange-traded funds", Financial Review, Vol. 49, pp. 735–763.

Chovancova, B., Dorocakova, M. and Linnertova, D. (2019), "Two investment options for bearish ETF investors: Inverse ETF and shorting ETF", International Journal of Financial Studies, Vol. 7 No. 2, pp. 1–14.

Da, Z. and Shive, S. (2017), "Exchange traded funds and asset return correlations", European Financial Management, Vol. 24, pp. 136–168.

Duffy, J., Rabanal, J. P. and Rud, O. A. (2021), "The impact of ETFs in secondary asset markets: Experimental evidence", Journal of Economic Behavior and Organization, Vol. 188, pp. 674–696.

Easley, D., Michayluk, D., O'Hara, M. and Putnin, T. J. (2021), "The active world of passive investing", Review of Finance, Vol. 25 No. 5, pp. 1433–1471.

Gehricke, S. A. and Zhang, J. E. (2021), "Tracking performance of VIX futures ETPs", Journal of Empirical Finance, Vol. 61, pp. 103–117.

Giannetti, A. (2017), "The dynamics of leveraged ETFs returns: A panel data study", Quantitative Finance, Vol. 17 No.5, pp. 745–761.

Glosten, L., Nallareddy, S. and Zou, Y. (2021), "ETF activity and informational efficiency of underlying securities", Management Science, Vol. 67 No. 1, pp. 22–47.

Huang, S., O'Hara, M. and Zhong, Z. (2021), "Innovation and informed trading: Evidence from industry ETFs", Review of Financial Studies, Vol. 34, pp. 1280–1316.

Israeli, D., Lee, C.M.C. and Sridharan, S.A. (2017), "Is there a dark side to exchange traded funds? An information perspective", Review of Accounting Studies, Vol. 22, pp. 1048– 1083.

Jain, A., Jain, C. and Jiang, C.X. (2021), "Active trading in ETFs: The role of high-frequency algorithmic trading", Financial Analysts Journal, Vol. 77 No. 2, pp. 66–82.

Jain, P., Mishra, S., Pagano, M. and Rodriguez, I. (2022), "Of seesaws and swings: The market-wide impact of levered ETF rebalancing during stressful times", working paper, University of Memphis, Florida International University, Villanova University, Eastern Michigan University, 8 April.

Jurdi, D.J. (2020), "Intraday jumps, liquidity, and U.S. macroeconomic news: Evidence from exchange traded funds", Journal of Risk and Financial Management, Vol. 13 No. 6, pp. 1–20.

Kang, S., Hernandez, J.A., Sadorsky, P. and McIver, R. (2021), "Frequency spillovers, connectedness, and the hedging effectiveness of oil and gold for US sector ETFs", Energy Economics, Vol. 99, pp. 1–16.

Karmaziene, E. and Sokolovski, V. (2022), "Short-selling equity exchange traded funds and its effect on stock market liquidity", Journal of Financial and Quantitative Analysis, Vol. 57 No. 3, pp. 923–956.

Lu, L., Wang, J. and Zhang, G. (2012), “Long term performance of leveraged ETFs”, Financial Services Review, Vol. 21, pp. 63–80.

Madura, J. and Ngo, T. (2008), “Short interest in exchange-traded funds”, Financial Markets and Portfolio Management, Vol. 22, pp. 381–402.

Marshall, B.R., Nguyen, N.H. and Visaltanachoti, N. (2013), “ETF arbitrage: Intraday evidence”, Journal of Banking & Finance, Vol. 37, pp. 3486–3498.

Mohamad, A., Jaafar, A. and Goddard, J. (2016), “Short selling and exchange-traded funds returns: Evidence from the London Stock Exchange”, Applied Economics, Vol. 48 No. 2, pp. 152–164.

Pessina, C.J. and Whaley, R.E. (2021), “Levered and inverse exchange-traded products: Blessing or curse?”, Financial Analysts Journal, Vol. 77 No. 1, pp. 10–29.

Rompotis, G. (2016), “Return and volatility of emerging markets leveraged ETFs”, Journal of Asset Management, Vol. 17, pp. 165–194.

Salisu, A.A. and Obiora, K. (2021), “Covid-19 pandemic and the crude oil market risk: Hedging options with non-energy financial innovations”, Financial Innovation, Vol. 7, pp. 1– 19.

Sehgal, S., Sobti, N. and Diesting, F. (2021), “Who leads in intraday gold price discovery and volatility connectedness: Spot, futures, or exchange-traded fund?”, Journal of Futures Markets, Vol. 41, pp. 1092–1123.

Shum, P. M. and Kang, J. (2013), “Leveraged and inverse ETF performance during the financial crisis”, Managerial Finance, Vol. 39 No. 5, pp. 476–508.

Statista (2023), “Development of assets of global exchange-traded funds (ETFs) from 2003 to 2022”, available at: https://www.statista.com/statistics/ 224579/worldwide-etf-assets-under-management-since-1997/ (accessed 1 July 2023).

Tang, H. and Xu, X.E. (2013), “Solving the return deviation conundrum of leveraged exchange-traded funds”, Journal of Financial and Quantitative Analysis, Vol. 48 No. 1, pp. 309–342.

Thune, K. (2023), “ETF expense ratios: Everything you need to know”, available at: https://www.etf.com/etf-education-center/etf-basics/etf-expense-ratios (accessed 29 June 2023).

TABLE 1: SUMMARY OF THE SINGLE-STOCK ETF

This table summarizes the basic characteristics of the 23 single-stock ETFs in our analysis. The leverage, open date, closed date, net assets, and expense ratio are from Yahoo! Finance. The ETF and underlying daily volumes are from CRSP.

Single-Stock ETF	Single-Stock ETF Ticker	Underlying Stock (Ticker)	Leverage	Opened	Closed	Net Assets ($million)	Expense Ratio (%)	ETF Daily Volume	Underlying Daily Volume	% of ETF to Underlying Vol.
Direxion Daily GOOGL Bull 1.5X Shares	GGLL	ALPHABET INC. (GOOG)	1.5	9/6/2022	N/A	21.13	1.06	1,475	8,147,189	0.02%
Direxion Daily GOOGL Bear 1X Shares	GGLS	ALPHABET INC. (GOOG)	-1	9/6/2022	N/A	4.64	1.06	2,610	8,147,189	0.03%
Direxion Daily AMZN Bear 1X Shares	AMZD	AMAZON.COM, INC. (AMZN)	-1	9/6/2022	N/A	6.94	1.07	51,809	53,578,150	0.10%
Direxion Daily AMZN Bull 1.5X Shares	AMZU	AMAZON.COM, INC. (AMZN)	1.5	9/6/2022	N/A	28.98	1.06	1,012	19,478,776	0.01%
GraniteShares 1.75x Long AAPL Daily ETF	AAPB	APPLE INC. (AAPL)	1.75	8/8/2022	N/A	1.77	1.15	704	19,478,776	0.00%
Direxion Daily AAPL Bear 1X Shares	AAPD	APPLE INC. (AAPL)	-1	8/8/2022	N/A	30.93	1.07	2,958	14,513,276	0.02%
Direxion Daily AAPL Bull 1.5X Shares	AAPU	APPLE INC. (AAPL)	1.5	8/8/2022	N/A	23.15	1.06	2,874	14,513,276	0.02%
GraniteShares 1.5x Long COIN Daily ETF	CONL	COINBASE GLOBAL, INC. (COIN)	1.5	8/8/2022	N/A	4.79	1.15	1,340,955	75,480,470	1.78%
Direxion Daily MSFT Bear 1X Shares	MSFD	MICROSOFT CORP. (MSFT)	-1	9/6/2022	N/A	9.52	1.07	1,892	78,858,741	0.00%

Direxion Daily MSFT Bull 1.5X Shares	MSFU	MICROSOFT CORP. (MSFT)	1.5	9/6/2022	N/A	24.90	1.06	4,056	84,138,277	0.00%
AXS 2X NKE Bull Daily ETF	NKEL	NIKE, INC. (NKE)	2	7/13/2022	6/16/2023	0.46	1.15	154,751	84,138,277	0.18%
AXS 2X NKE Bear Daily ETF	NKEQ	NIKE, INC. (NKE)	-2	7/13/2022	6/16/2023	0.86	1.15	62,316	84,138,277	0.07%
AXS 1.25X NVDA Bear Daily ETF	NVDS	NVIDIA CORP. (NVDA)	-1.25	7/13/2022	N/A	127.37	1.15	88,466	13,029,995	0.68%
AXS 1.5X PYPL Bear Daily ETF	PYPS	PAYPAL HOLDINGS, INC. (PYPL)	-1.5	7/13/2022	6/16/2023	1.11	1.15	13,962	83,653,150	0.02%
AXS 1.5X PYPL Bull Daily ETF	PYPT	PAYPAL HOLDINGS, INC. (PYPL)	1.5	7/13/2022	N/A	0.82	1.15	5,799	83,653,150	0.01%
AXS 2X PFE Bull Daily ETF	PFEL	PFIZER INC. (PFE)	2	7/13/2022	6/16/2023	0.50	1.15	2,962,618	83,653,150	3.54%
AXS 2X PFE Bear Daily ETF	PFES	PFIZER INC. (PFE)	-2	7/13/2022	6/16/2023	0.89	1.15	299,267	83,653,150	0.36%
GraniteShares 1.25x Long Tsla Daily ETF	TSL	TESLA, INC. (TSLA)	1.25	8/8/2022	N/A	4.92	1.15	21,396	26,625,878	0.08%
Innovator Hedged TSLA Strategy ETF	TSLH	TESLA, INC. (TSLA)	1	7/25/2022	N/A	1.95	0.79	83,491	75,748,829	0.11%
GraniteShares 1x Short TSLA Daily ETF	TSLI	TESLA, INC. (TSLA)	-1	8/8/2022	6/16/2023	2.22	1.15	9,492	26,625,878	0.04%

Direxion Daily TSLA Bull 1.5X Shares	TSLL	TESLA, INC. (TSLA)	1.5	8/8/2022	N/A	569.36	1.08	16,546	29,591,165	0.06%
AXS TSLA Bear Daily ETF	TSLQ	TESLA, INC. (TSLA)	-1	7/13/2022	N/A	130.27	1.15	31,422	75,748,829	0.04%
Direxion Daily TSLA Bear 1X Shares	TSLS	TESLA, INC. (TSLA)	-1	8/8/2022	N/A	31.63	1.07	15,118	29,591,165	0.05%

TABLE 2: SUMMARY OF SINGLE-STOCK ETF RETURNS

This table summarizes the returns of the 23 single-stock ETFs in our analysis. The leverage, open date, and closed date are from Yahoo! Finance. The ETF and underlying daily returns are from CRSP. The target ETF daily return is calculated as the leverage times the underlying daily returns.

Single-Stock ETF	Single-Stock ETF Ticker	Underlying Stock (Ticker)	Leverage	Opened	Closed	N	ETF Daily Return	Target ETF Daily Return	Underlying Stock Daily Return
Direxion Daily GOOGL Bull 1.5X Shares	GGLL	ALPHABET INC. (GOOG)	1.5	9/6/2022	N/A	80	-0.38%	-0.36%	-0.24%
Direxion Daily GOOGL Bear 1X Shares	GGLS	ALPHABET INC. (GOOG)	-1	9/6/2022	N/A	80	0.25%	0.24%	-0.24%
Direxion Daily AMZN Bear 1X Shares	AMZD	AMAZON.COM, INC. (AMZN)	-1	9/6/2022	N/A	80	0.51%	0.50%	-0.50%
Direxion Daily AMZN Bull 1.5X Shares	AMZU	AMAZON.COM, INC. (AMZN)	1.5	9/6/2022	N/A	80	-0.77%	-0.75%	-0.50%
GraniteShares 1.75x Long AAPL Daily ETF	AAPB	APPLE INC. (AAPL)	1.75	8/8/2022	N/A	100	-0.40%	-0.37%	-0.21%
Direxion Daily AAPL Bear 1X Shares	AAPD	APPLE INC. (AAPL)	-1	8/8/2022	N/A	100	0.22%	0.21%	-0.21%
Direxion Daily AAPL Bull 1.5X Shares	AAPU	APPLE INC. (AAPL)	1.5	8/8/2022	N/A	100	-0.34%	-0.32%	-0.21%
GraniteShares 1.5x Long COIN Daily ETF	CONL	COINBASE GLOBAL, INC. (COIN)	1.5	8/8/2022	N/A	100	-1.15%	-1.11%	-0.74%
Direxion Daily MSFT Bear 1X Shares	MSFD	MICROSOFT CORP. (MSFT)	-1	9/6/2022	N/A	80	0.08%	0.06%	-0.06%
Direxion Daily MSFT Bull 1.5X Shares	MSFU	MICROSOFT CORP. (MSFT)	1.5	9/6/2022	N/A	80	-0.11%	-0.09%	-0.06%
AXS 2X NKE Bull Daily ETF	NKEL	NIKE, INC. (NKE)	2	7/13/2022	6/16/2023	118	0.27%	0.30%	0.15%
AXS 2X NKE Bear Daily ETF	NKEQ	NIKE, INC. (NKE)	-2	7/13/2022	6/16/2023	118	-0.29%	-0.30%	0.15%
AXS 1.25X NVDA Bear Daily ETF	NVDS	NVIDIA CORP. (NVDA)	-1.25	7/13/2022	N/A	118	-0.02%	-0.04%	0.03%
AXS 1.5X PYPL Bear Daily ETF	PYPS	PAYPAL HOLDINGS, INC. (PYPL)	-1.5	7/13/2022	6/16/2023	118	-0.10%	-0.11%	0.07%
AXS 1.5X PYPL Bull Daily ETF	PYPT	PAYPAL HOLDINGS, INC. (PYPL)	1.5	7/13/2022	N/A	118	0.09%	0.11%	0.07%
AXS 2X PFE Bull Daily ETF	PFEL	PFIZER INC. (PFE)	2	7/13/2022	6/16/2023	118	0.05%	0.04%	0.02%
AXS 2X PFE Bear Daily ETF	PFES	PFIZER INC. (PFE)	-2	7/13/2022	6/16/2023	118	-0.08%	-0.04%	0.02%
GraniteShares 1.25x Long TSLA Daily ETF	TSL	TESLA, INC. (TSLA)	1.25	8/8/2022	N/A	100	-0.98%	-0.95%	-0.76%
Innovator Hedged TSLA Strategy ETF	TSLH	TESLA, INC. (TSLA)	1	7/25/2022	N/A	110	-0.08%	-0.60%	-0.60%

GraniteShares 1x Short TSLA Daily ETF	TSLI	TESLA, INC. (TSLA)	-1	8/8/2022	6/16/2023	100	0.76% 0	.76%	-0.76%
Direxion Daily TSLA Bull 1.5X Shares	TSLL	TESLA, INC. (TSLA)	1.5	8/8/2022	N/A	100	-1.17%	-1.14%	-0.76%
AXS TSLA Bear Daily ETF	TSLQ	TESLA, INC. (TSLA)	-1	7/13/2022	N/A	118	0.49%	0.48%	-0.48%
Direxion Daily TSLA Bear 1X Shares	TSLS	TESLA, INC. (TSLA)	-1	8/8/2022	N/A	100	0.77%	0.76%	-0.76%

TABLE 3. SUMMARY OF SINGLE-STOCK ETF SPREADS

This table summarizes the returns of the 23 single-stock ETFs in our analysis. The leverage, open date, and closed date are from Yahoo! Finance. The ETF and underlying stock spread are calculated as the difference between the ask and bid prices divided by the ask price from CRSP. The spread difference is calculated as the ETF spread minus the underlying stock spread. Variables with a statistical significance at the .01% level are denoted with *.**

Single-Stock ETF	Single-Stock ETF Ticker	Underlying Stock (Ticker)	Leverage	N	ETF Spread	Stock Spread	Spread Difference	t-Value
Direxion Daily GOOGL Bull 1.5X Shares	GGLL	ALPHABET INC. (GOOG)	1.5	80	0.0025	0.0002	0.0023***	11.02
Direxion Daily GOOGL Bear 1X Shares	GGLS	ALPHABET INC. (GOOG)	-1	80	0.0022	0.0002	0.0021***	8.95
Direxion Daily AMZN Bear 1X Shares	AMZD	AMAZON.COM, INC. (AMZN)	-1	80	0.0019	0.0002	0.0017***	11.20
Direxion Daily AMZN Bull 1.5X Shares	AMZU	AMAZON.COM, INC. (AMZN)	1.5	80	0.0024	0.0002	0.0021***	11.20
GraniteShares 1.75x Long AAPL Daily ETF	AAPB	APPLE INC. (AAPL)	1.75	100	0.0037	0.0001	0.0036***	41.10
Direxion Daily AAPL Bear 1X Shares	AAPD	APPLE INC. (AAPL)	-1	100	0.0021	0.0001	0.0020***	10.91
Direxion Daily AAPL Bull 1.5X Shares	AAPU	APPLE INC. (AAPL)	1.5	100	0.0023	0.0001	0.0021***	16.07
GraniteShares 1.5x Long COIN Daily ETF	CONL	COINBASE GLOBAL, INC. (COIN)	1.5	100	0.0043	0.0008	0.0034***	15.79
Direxion Daily MSFT Bear 1X Shares	MSFD	MICROSOFT CORP. (MSFT)	-1	80	0.0025	0.0002	0.0023***	8.86
Direxion Daily MSFT Bull 1.5X Shares	MSFU	MICROSOFT CORP. (MSFT)	1.5	80	0.0025	0.0002	0.0023***	10.04
AXS 2X NKE Bull Daily ETF (**CLOSED**)	NKEL	NIKE, INC. (NKE)	2	118	0.0126	0.0002	0.0125***	7.95
AXS 2X NKE Bear Daily ETF (**CLOSED**)	NKEQ	NIKE, INC. (NKE)	-2	118	0.0099	0.0002	0.0098***	7.91
AXS 1.25X NVDA Bear Daily ETF	NVDS	NVIDIA CORP. (NVDA)	-1.25	118	0.0055	0.0002	0.0053***	10.64
AXS 1.5X PYPL Bear Daily ETF (**CLOSED**)	PYPS	PAYPAL HOLDINGS, INC. (PYPL)	-1.5	118	0.0109	0.0002	0.0107***	6.90
AXS 1.5X PYPL Bull Daily ETF	PYPT	PAYPAL HOLDINGS, INC. (PYPL)	1.5	118	0.0123	0.0002	0.0121***	8.09
AXS 2X PFE Bull Daily ETF (**CLOSED**)	PFEL	PFIZER INC. (PFE)	2	118	0.0141	0.0002	0.0139***	9.43
AXS 2X PFE Bear Daily ETF (**CLOSED**)	PFES	PFIZER INC. (PFE)	-2	118	0.0138	0.0002	0.0136***	7.81
GraniteShares 1.25x Long TSLA Daily ETF	TSL	TESLA, INC. (TSLA)	1.25	100	0.0038	0.0002	0.0035***	24.38
Innovator Hedged TSLA Strategy ETF	TSLH	TESLA, INC. (TSLA)	1	110	0.0045	0.0002	0.0043***	25.01
GraniteShares 1x Short TSLA Daily ETF (**CLOSED**)	TSLI	TESLA, INC. (TSLA)	-1	100	0.0030	0.0002	0.0027***	25.38
Direxion Daily TSLA Bull 1.5X Shares	TSLL	TESLA, INC. (TSLA)	1.5	100	0.0014	0.0002	0.0012***	22.09
AXS TSLA Bear Daily ETF	TSLQ	TESLA, INC. (TSLA)	-1	118	0.0019	0.0002	0.0016***	8.01
Direxion Daily TSLA Bear 1X Shares	TSLS	TESLA, INC. (TSLA)	-1	100	0.0017	0.0002	0.0014***	11.77