Introduction
There is a saying in the markets that liquidity is like oxygen: you only notice it when it is gone. May 6, 2010, the day of the so-called “flash crash,” will thus go down in history as the day when most of the oxygen suddenly disappeared from the markets, and just as suddenly returned, leaving confusion, frustration and cancelled trades – and financial experts, analysts and regulators scratching their heads.

ETFs have become widely accepted investment vehicles for both institutional and retail investors. As of September 30, 2010, there are 1,051 exchange traded products available in the U.S. market, with a total of $902 billion invested in such products. On average, ETFs represent approximately 30% of the total volume traded on national exchanges. Institutional investors use ETFs for a number of strategies, including equitization, hedging and achieving exposure to otherwise difficult-to-access markets. For their part, retail investors also use them in a wide variety of ways: to build an asset allocation, as part of a core/satellite approach, or tactical investing among sectors, to name a few. ETFs’ transparency, low costs and access to a wide range of asset classes have significant advantages that have benefited investors. For example, many investors, both retail and institutional, find enormous value in being able to observe the price of the ETF during the day, and to use trade order types such as stop-loss or limit orders in an attempt to manage the price at which they transact – things that are not possible to do with other investment products such as mutual funds. Ensuring that the securities market works effectively, and allowing investors to reap the inherent benefits of ETFs clearly benefits both institutional and retail investors.

While most ETFs are regulated as registered investment companies, they trade on an exchange. They have a primary listing and one or more designated market makers that are obligated to make two-sided markets to buy or sell the ETF. A designated (or lead) market maker usually is required by exchange rules to provide the “best” price available across the secondary market a specified percentage of time. The market price of the ETF is determined by the market maker based on a variety of factors, including supply-and-demand and the current aggregate value of the underlying securities held by the ETF.

ETFs have had a long history of their market price generally trading in line with their intrinsic value, as determined by comparing the closing market price of the ETF with the value of its underlying securities. Under some circumstances, an ETF may trade at a premium or discount to Net Asset Value (NAV) as seen in some financial sector ETFs in September 2008 (when short-selling of 200+ financial stocks was restricted, disrupting market makers’ ability to hedge exposure to ETFs that held these stocks). These premiums or discounts typically are only a few percentage points of NAV and have not been persistent over time.

Although several months have passed since the flash crash occurred, uncertainty remains on the trigger or triggers for the sudden U.S. equity market free fall (and recovery) in the afternoon of May 6. However, the lesson of the event is clear: better rules are needed to protect investors, and to reflect the tremendous evolution that has occurred in the markets in recent years. Innovations in trading and market structure, aided by technology, have created the ability to trade vast amounts of securities at enormous speeds. By improving liquidity, those innovations have largely benefited investors. But the events of May 6 teach us that speed of execution must be tempered with a focus on quality of execution.

In this paper, we explore what happened on the afternoon of May 6, how it affected investors, and what can be done to lessen the likelihood of similar market disruptions in the future.

Background and Effect on ETFs
As the result of several separate but interconnected disruptions to the U.S. equity market on May 6, prices for many U.S. equities and exchange traded funds (ETFs) holding U.S. equities declined precipitously for a period of approximately one half-hour during afternoon trading, an event that has become known as the “flash crash.” As neither non-U.S. markets nor fixed income trading experienced this price drop, ETFs holding U.S. fixed-income securities and non-U.S. equities were largely unaffected and generally traded at prices that corresponded to underlying asset values. Many ETFs holding U.S. equities, however, did not.

...the lesson of the event is clear: better rules are needed to protect investors, and to reflect the tremendous evolution that has occurred in the markets in recent years.
Proper functioning of ETFs relies on fair and orderly market activity that permits market makers to effectively value an ETF’s holdings and hedge any exposure to ETF shares acquired. This can be disrupted by extreme market volatility in an ETF’s underlying holdings, inability of market makers to access instruments used for hedging, or the risk in extremely volatile market conditions of market makers fearing their hedging trades could be cancelled because of exchange “Clearly Erroneous Trade” rules. These rules break trades that occur at levels later deemed to be outside of normal market parameters.

For the ETF market, market makers need to be confident in the accuracy of their valuations of the ETF’s underlying securities and their ability to sell those securities as a hedge when bidding for the ETF’s shares. In order to aggressively bid for and acquire ETF shares in a declining market, market makers need to feel confident that any hedging trades that they put on their books will stand. At the same time, market participants (both retail and institutional) need to see clear linkage between the ETF market price and the prices of the underlying securities of the fund and expect their orders to be routed to the best market for execution.

The Events of May 6

Although the Greek debt crisis and other concerns may have provided a catalyst, four factors converged simultaneously to significantly disrupt U.S. equity markets on May 6 and cause market prices for hundreds of equity securities and U.S. equity ETFs to diverge from their respective underlying asset values.

First, the sudden market freefall in U.S. equity prices caused market makers in ETFs that seek to track benchmarks heavy in the falling stocks to have difficulty valuing the ETFs’ underlying assets. Almost 25% of the components of the Russell 3000 Index suddenly dropped by more than 10% in a matter of minutes; in the last year the Index had never dropped more than 3% intraday. Market making pricing models began to struggle as stock prices started to plummet at lightning speed. Market makers’ inability to accurately assess the value of ETFs’ underlying holdings caused many market makers to discount their bids for ETF shares, leading ETF market values to then also fall. Next, the NYSE set certain stocks into a “pause” or slow trading mode, which results when trading reaches price bands known as “Liquidity Replenishment Points”. However, trading in these securities continued normally on other markets, causing the potential for price disparities across exchanges and additional price uncertainty.

Second, anxiety over potential trade cancellations caused liquidity providers to fear that normal ETF hedging strategies would be interrupted, which caused them to pull back from bidding for ETF shares. Many market makers assume the chance of cancelled trades increases as the market approaches a 10% loss, and where there are questions as to the cause of the market drop. Since ETF market makers generally sell shares of an ETF’s underlying holdings as a hedge when buying ETF shares, the risk of trades they entered into being cancelled would leave them exposed to being unhedged. As the primary market makers stepped back, other trading firms that normally would base quotes off of the primary market makers had no benchmark, so they too stepped away, especially as the ETFs approached the 10% price decline point. This worsened the liquidity situation.

Third, several other exchanges stopped routing orders to NYSE Arca because they believed the NYSE Arca was not reporting trade executions back in a timely manner. This encouraged market fragmentation, with the potential that trades would not be routed to the market offering the best price. Because ETF trading volume is highly concentrated on NYSE Arca, the disruption in automatic routing of ETF trades to NYSE Arca from other markets with fewer quotes may have made it more difficult for certain ETF orders to access liquidity.

Finally, there was additional selling because stop-loss orders were triggered, which increased the volume of sell orders on affected securities, including ETFs. These stop-loss orders, which turned into orders to sell at “market” prices, were executed significantly below trigger points due to the speed of price freefall. Price declines were exacerbated as increased offers to sell coincided with decreased bids coupled with decreased size of bids as large traders pulled out of the market. Thus, in some instances, the price of the ETF fell farther than the basket of the underlying securities.

Over 90% of the ETFs in the U.S. are listed on the NYSE Arca platform which delivers the National Best Bid and Offer (NBBO) more than 80% of the time for ETFs and handles, on average,
more than one-third of daily trades in ETFs. The percent of trading volume on the NYSE Arca increases to almost 60% for ETFs with lower average daily trading volumes. The disruption of automatic order routing to normal sources of ETF liquidity may have caused a greater proportion of ETF trades than normal to occur in markets with thinner order books, quickly using up any available liquidity.

In fact, at the end of the trading day, the exchanges determined that any trades executed in excess of 60% away from the value of the security at 2:40 PM EST were to be cancelled. Two-thirds of the cancelled trades were in ETFs, overwhelmingly ETFs that invest primarily in U.S. stocks.

The Impact
While we believe the final impact on investors was relatively limited due to widespread trade cancellations, the events of May 6 were nonetheless disturbing.

To better understand exactly the effect on financial advisors, we commissioned a survey of 380 retail financial advisors in late June to learn from these advisors, one of the largest groups of ETF users, what they think about the flash crash.

The survey revealed that the majority of advisors were minimally affected by the market disruption, and they believe that market structure issues, such as an overreliance on computer systems and some types of high frequency trading, were the primary drivers of the crash. Stop-loss orders, market maker activity or lack thereof and exchange routing issues were seen as secondary issues. As it relates to the macro economic environment, the majority of advisors surveyed expect current market volatility will either increase or remain at today’s level over the next six months. Furthermore (and perhaps disappointingly), those surveyed anticipate an event similar to May 6 will likely occur again, no matter what solutions are adopted, underscoring the importance of thoughtful regulatory reform to help prevent future market disruptions.

The survey also indicated that 75% of advisors’ accounts were not affected by the events of May 6. Of those accounts that were touched by the volatile trading on that day, the most common cause was a stop-loss order triggered and executed at a significantly reduced value.

Regardless of the cause of volatility – economic or structural – advisors identified ETFs as important investment vehicles to navigate a volatile market environment, followed by bonds and mutual funds. Continued confidence in ETFs was demonstrated in the weeks following the flash crash when ETF trading volume increased from 27% of daily stock market volume (January 1 to May 6) to 30% (May 7 to June 30).

3 Source: NYSE Arca
The Case for Market Reforms

The SEC had market structure reform on its agenda prior to the flash crash, recognizing that markets had evolved but that the rules may not have kept pace. The events of May 6 have put more emphasis on those efforts, and have highlighted the need for regulators, financial service providers and the exchanges to work together on market structure reforms. We believe those reforms should include:

► Uniform mechanisms to curb extreme price volatility for stocks and ETFs across all exchanges. Such mechanisms could include individual stock circuit breakers or, alternatively, price bands (limits on price movements similar to those employed in futures markets). Such mechanisms should, in theory, help prevent sudden and extreme disruptions.

**Objective:** Prevent market fragmentation by having uniform exchange approaches to curbing excess volatility.

► Making exchange trade error cancellation rules less arbitrary and more transparent in a manner that does not discourage liquidity providers from providing liquidity at times of market stress. While steps have been taken, current rules still contemplate the cancellation of trades following sudden, large price movements. Ideally, trades would not be cancelled, but the prices of trades occurring at extreme price levels would be adjusted to defined levels in the event of market disruptions. This would provide market makers with greater certainty and less incentive to stop quoting.

**Objective:** Participants clearly understand the rules of the road, and the balance between the risks they are taking and the potential opportunities.

► Clearer guidelines for inter-market order routing rules and better coordination among exchanges to reduce likelihood of orders being routed to exchanges with little liquidity or not offering the best price.

**Objective:** Investors achieve best execution of their orders.

► Thoughtfully revisiting the obligations and roles of lead market makers to ensure orderly market functioning. For example, lead market makers could be engaged to reopen a halted security following a “circuit breaker” halt, but must provide consistent depth on normal trading days.

**Objective:** Designated market makers continue to provide liquidity and maintain orderly markets on volatile trading days.

**Recommended Reforms**

1. Uniform mechanisms to curb extreme price volatility for stocks and ETFs across all exchanges.
2. Making exchange trade error cancellation rules less arbitrary and more transparent in a manner that does not discourage liquidity providers from providing liquidity at times of market stress.
3. Clearer guidelines for inter-market order routing rules and better coordination among exchanges to reduce likelihood of orders being routed to exchanges with little liquidity or not offering the best price.
4. Thoughtfully revisiting the obligations and roles of lead market makers to ensure orderly market functioning.

**Conclusion**

U.S. equity market structures as they have developed over the last 10 to 15 years have failed to keep pace with rapid changes in technology and the changed roles of market makers. This has increased the potential for market fragmentation and the potential for temporary disconnects between some equity ETFs and their intrinsic value when market makers react to market volatility by stepping away from providing liquidity.

While it is of some comfort to understand why ETFs were swept into the market instability on the 6 of May, it is encouraging that the ETF industry is working with regulatory and industry partners to help mitigate the effects of similar events in the future and help ensure ETF prices remain stable in the face of liquidity shocks. When our markets do not function in the interests of investors, they need to be fixed. ETF providers are working together with others to move quickly to address this concern.
A year ago, on May 6th 2010, one of the most unusual — and puzzling — events in U.S. stock market history occurred. In the afternoon of a trading day that saw U.S. equity prices trending down within normal ranges, the prices of many stocks effectively collapsed during a period beginning shortly after 2:00pm — and then rebounded approximately a half hour later. Bids for the affected stocks essentially evaporated after a series of events converged to significantly disrupt US equity markets. Within minutes, the market price for many securities dropped sharply while many U.S. equity exchange traded funds (ETFs) that were significantly invested in U.S. equities traded at levels that did not reflect their underlying asset values.

The event, of course, became known as the “Flash Crash.” In the twelve months since it occurred, regulators, the exchanges, market participants, and others have worked hard to understand what exactly happened and what reforms are needed to prevent a similar occurrence. Meanwhile, ETFs continue to flourish, with total assets of ETFs in the U.S. passing $1 trillion by the end of the year.

The lesson of the event was clear from the beginning: better rules are needed to help protect investors, and to reflect the tremendous evolution that has occurred in the markets in recent years. What has happened since the Flash Crash to reform markets to reduce the risk of another?

While the pace of market reform efforts proceeds slowly, much has been accomplished. Can we say for certain that another Flash Crash cannot occur? No. But the chances of a repeat have been considerably reduced.

In this paper, we review what we know about the Flash Crash and discuss the steps that have already been taken and the proposals still being considered to help prevent a re-occurrence.

The Events of May 6th
Although a definitive cause of the events of May 6th is still unknown, we now believe we have reasonable understanding of some of the causes of sudden price declines that afternoon. The convergence of four factors disrupted U.S. equity markets significantly and resulted in sharp drops in market prices for hundreds of equity securities and U.S. equity ETFs trading at levels that diverged from their underlying asset values.

First, the sudden decline in U.S. equity prices caused market makers in ETFs that seek to track benchmarks dominated by the falling stocks to have difficulty valuing the ETFs' underlying assets. Almost 25% of the components of the Russell 3000 Index suddenly dropped by more than 10% in a matter of minutes (in the year before the Flash Crash the Index had never dropped more than 3% intraday). Market making pricing models began to struggle based on unprecedented market volatility. Market makers’ inability to accurately assess the value of ETFs’ underlying holdings caused many market makers to discount their bids for ETF shares, leading the market values of those ETFs to then also fall. Next, the NYSE set certain stocks into a “pause” or slow trading mode, which under the then-prevailing rules of the NYSE resulted when trading reached levels known as “Liquidity Replenishment Points.” However, trading in these securities continued normally on other equity markets that did not have similar “slow trading” processes, causing additional price uncertainty.

Second, liquidity providers began to fear that normal ETF hedging strategies would be subject to abnormally high risks due to exchange trade cancellation rules, which caused the market makers to pull back from bidding for shares of many ETFs. Many market makers assume the chance of exchanges cancelling trades increases as the market approaches a 10% loss – a level specified as a “reference” in exchange trade cancellation rules – and when there are questions as to the cause of the market drop. Because ETF market makers generally sell shares of an
ETF’s underlying holdings as a hedge when buying the ETF’s shares, the risk of hedging trades they entered into being cancelled would leave them exposed to being unhedged if they purchased ETF shares in a falling market. As the primary market makers stepped back, other trading firms that normally would base quotes off of the primary market makers had no benchmark quotation to reference, so they too reduced or stopped bids for ETF shares, especially as the ETF shares approached the 10% price decline point. This worsened the liquidity situation.

Third, several other exchanges stopped routing orders to NYSE Arca because they believed the NYSE Arca was not reporting trade executions back in a timely manner. This increased market confusion and introduced the potential for market fragmentation in the event that traders could not find ways to route trades to the market offering the best price. Because ETF trading volume is highly concentrated on NYSE Arca, the disruption in automatic routing of ETF trades to NYSE Arca from other markets with fewer quotes may have made it more difficult for certain ETF orders to access liquidity from market makers who quoted only on NYSE Arca.

Finally, there was additional selling because stop-loss orders were triggered, which increased the volume of sell orders on affected securities, including ETFs. These stop-loss orders, which turned into orders to sell at “market” prices, were executed significantly below trigger points due to the speed of price freefall. Price declines were exacerbated as increased offers to sell coincided with decreased bids coupled with decreased size of bids as large traders pulled out of the market. Thus, in some instances, the price of the ETF fell farther than the basket of the underlying securities.

Although there is a proliferation of theories regarding the Flash Crash, no single definitive cause has been identified. (A report prepared by CFTC and SEC staff highlighted a single large trade in S&P 500 futures contracts, but many questions remain unanswered.) However, there is widespread agreement on the sequence of events. An early theory which misunderstood the Flash Crash – namely, that ETFs caused it – has now been discounted. In fact, ETFs were a victim of, not a cause of the Flash Crash. After all, the ETFs that were affected in the Flash Crash (which generally were only ETFs that were primarily invested in U.S. stocks, the type of underlying securities that experienced plummeting prices that afternoon) felt the impact only following the start of heavy declines in underlying holdings.

**Update on Market Reforms**

While it took months to sift through the data to determine what actually happened on May 6th – and we still don’t know for certain what triggered the Flash Crash – the lesson of the event was clear from the beginning: better rules are needed to help protect investors, and to reflect the tremendous evolution that has occurred in the markets in recent years. What has happened since the Flash Crash to reform markets to reduce the risk of another Flash Crash?

To answer that question, it is helpful to examine the four reforms we recommended in a previous ViewPoint “Understanding the Flash Crash: What Happened, Why ETFs Were Affected, and How to Reduce the Risk of Another.” In February, the Joint CFTC-SEC Advisory Committee on Emerging Regulatory Issues, a body created by legislation to investigate the Flash Crash, issued a report. The report recommends fundamental changes in U.S. equity market structure and endorsed many of our recommendations. The following is an update on our recommended reforms:

1. Uniform mechanisms to curb extreme price volatility for stocks and ETFs across all exchanges. Such mechanisms could include individual stock circuit breakers or, alternatively, price bands (limits on price movements similar to those employed in futures markets). Such mechanisms should, in theory, help to curb sudden and extreme disruptions.

On April 5th, the SEC in conjunction with FINRA and the exchanges released their “limit up – limit down” proposal to introduce uniform price bands. Each security, depending on whether it is classified as a Tier 1 or Tier 2 security, will have a lower and upper band through which trading cannot take place on any U.S. equities market. For Tier 1 stocks, which include those in the S&P 500 and Russell 1000 Indexes and 344 ETFs, the upper and lower band will be 5% based off of the average price of the security during the preceding 5 minutes. For Tier 2 stocks which are all other securities, the upper and lower band will be 10%. If these bands are reached and all orders on the band limit are not either cancelled or executed within 15 seconds, then there will be a 5 minute trading halt to allow traders to adjust prices and to match buy and sell orders at a new price level.

---

**BlackRock Recommendations for Equity Market Structure Reform**

1. Uniform mechanisms to curb extreme price volatility for stocks and ETFs across all exchanges.
2. Making exchange trade error cancellation rules less arbitrary and more transparent in a manner that does not discourage liquidity providers from providing liquidity at times of market stress.
3. Clearer guidelines for inter-market order routing rules and better coordination among exchanges to reduce likelihood of orders being routed to exchanges with little liquidity or not offering the best price.
4. Thoughtfully revisiting the obligations and roles of lead market makers to help ensure orderly market functioning.

From ViewPoint “Understanding the Flash Crash: What Happened, Why ETFs Were Affected, and How to Reduce the Risk of Another”, November 2010
2. Making exchange trade error cancellation rules less arbitrary and more transparent in a manner that does not discourage liquidity providers from providing liquidity at times of market stress.

For stocks subject to the pilot program as described above, those that are priced under $25 would have their trades canceled when their values came within 10% of the circuit breaker trigger price. For stocks priced between $25-$50, trades would be canceled when their values came within 5% of the trigger, and for stocks above $50, trades would be canceled when their values came within 3% of the trigger. Guidance was also issued for situations when circuit breakers are not applicable and multiple stocks are involved. For events involving 5-20 stocks, trades would be canceled when their values came within 10% of the last traded price. For events involving 20 or more stocks, the band would be 30%.

3. Clearer guidelines for inter-market order routing rules and better coordination among exchanges to reduce likelihood of orders being routed to exchanges with little liquidity or not offering the best price.

The Summary Report by the Joint CFTC-SEC Advisory Committee recommended that the SEC “study the costs and benefits of alternative routing requirements.” Under consideration would be a “trade at” routing regime as well as a review of the “top of book” protection. A “trade-at” rule would mean that any trades executed off an exchange – specifically dark pools and internalization venues – would have to be executed at a better price then the current NBBO (national best bid/best offer). “Top of book” means that only the best bid or best offer on an exchange needs to be honored. “Depth of book” would mean all limit orders on an exchange would have to be honored.

To be clear, currently there is no “trade-at” rule and no “depth of book” protection. This topic is now under consideration with no set time or plan for implementation. However, we believe this proposal should be analyzed closely to ensure that it does not result in unintended consequences.

4. Thoughtfully revisiting the obligations and roles of lead market makers to help ensure orderly market functioning.

The Summary Report by the Joint CFTC-SEC Advisory Committee made two recommendations regarding the incentives and obligations of market makers. One was “to evaluate whether incentives or regulations can be developed to encourage persons who engage in market making strategies to regularly provide buy and sell quotations that are ‘reasonably related to the market.’” The other was to see if it was feasible to build incentives for market makers to continue to bid for securities during times of high volatility. Currently, both of these are only recommendations with no set time or plan for implementation.

It should be noted that the possibility of stocks trading based on “stub quotes” of $0.01 from market makers, which happened during the Flash Crash, has now been greatly reduced. There was previously no guidance around minimum quoting standards for market makers who had to maintain two sided markets. They would thus employ “stub quotes” which are offers to buy or sell a security at a substantial distance away from the NBBO with no intention of execution. For example, for shares of an ETF trading at $40, a market maker could bid $0.01 and ask $1000 for 1000 shares in order to maintain a quote without attracting trading volume. In the absence of any higher bid, many sell orders “at market” were matched against stub quotes during the Flash Crash.

The SEC eliminated stub quotes and implemented new rules forcing market makers to maintain continuous two-side quotations that are within a defined percentage around the NBBO. For the securities that are part of the circuit breaker pilot program, the upper and lower band is 8% during normal trading hours.

Conclusion

The ETF industry, and in particular we at BlackRock, have worked with regulatory and industry partners over the past year to develop a framework for market reforms. Much work has been done, and there is essentially universal agreement on the need to make market structure as modern as the markets themselves. Looking back, it is worth highlighting the progress that has been made.

The SEC proposed a rule for the self-regulatory organizations (SROs) to establish a consolidated audit trail system that would allow regulators to track all of the information related to trading orders received and executed across the securities market. As the SEC noted in its announcement, “this will help the regulators keep pace with the new technology and trading patterns in the markets.”

The new circuit breakers and “limit up – limit down” guidelines are intended to inhibit the steep price drops that were experienced during the Flash Crash. Clearly defined trade cancellation rules will prevent market makers from having to worry that one side of their trade may be broken. A consolidated audit trail will give the regulators the tools necessary to monitor trading patterns across multiple exchanges. However, “mini flash crashes” can still happen today when large market orders are entered without sufficient liquidity on the other side. Thus, it is imperative that the investor understands the product, reviews its market, and enters orders at appropriate price limits – a market order to sell that exceeds the size of the consolidated bid could get executed at any price within the newly defined bands.

Many of the other market reform proposals, including the “trade at” routing regime and the cancellation of high frequency trading are major changes to the current market structure. As such, they need more analysis to ensure that they don’t have unintended consequences.
All in all, the safeguards and reforms that have been implemented will help slow down a potential future market disruption similar to the Flash Crash. However, these changes have not eliminated the possibility that another Flash Crash could occur.

Creating the right balance of reforms going forward will admittedly be challenging. We need a sensible combination of incentives and obligations for market makers, and trading rules that may slow market activity, but limit damage in the event of market disruption. Of course, we will never eliminate risk entirely from the markets – nor should we. But we have come far in preventing another Flash Crash, and if market participants and regulators continue to work together, we can do even more.
BOND MARKET PRICE DISCOVERY: CLARITY THROUGH THE LENS OF AN EXCHANGE

By Matthew Tucker and Stephen Laipply

February 22, 2012

---

1 The authors are grateful to Eric M. Neis for his input and invaluable technical advice. We also thank Ananth Madhavan, Daniel S. Morillo, Christopher T. Downing, Michael Gates, Antti Petajisto, and Marcia Roitberg for their many contributions. Any errors or omissions are our own.
# Table of Contents

- Executive Summary ........................................... 3
- Introduction .................................................. 4
- Price Discovery in the OTC Bond Market ................. 5
- Implications for Investors .................................... 8
- Fixed Income Exchange Traded Funds ....................... 8
- Valuation and Trading Behavior of Fixed Income ETFs ... 9
- Price Discovery Properties of Fixed Income ETFs ....... 11
- Market Signal and Trading Implications .................. 17
- Case Study: HYG ............................................ 18
- Measuring and Valuing Information Content ............... 19
- Conclusions .................................................. 21
- Appendix: Standardized Returns for AGG and HYG .... 22
Executive Summary

The fixed income market is an over-the-counter (OTC), bilateral market. Transactions are conducted privately between parties, and there is often limited information available to other market participants. A fixed income exchange traded fund (ETF) is a basket of bonds that trades on an equity exchange, providing all market participants with visibility into ETF trading volumes and price movements. The existence of fixed income exposure simultaneously trading in both the OTC and exchange markets provides an opportunity to compare pricing behavior.

In general, we observe that ETF prices can diverge from both the ETF net asset value (NAV) and the value of bond market indices. These divergences are partially driven by differences in how value is determined in each market. Net asset values and index levels are based on the value of individual bonds, some of which reflect actual transactions, and others that represent estimates of value. Fixed income ETF prices represent an actual execution at a market clearing level agreed upon by a buyer and a seller.

Our empirical analysis of ETF price, NAV, and index behavior suggests that ETF prices can more readily reflect market movements, particularly in dislocated markets. Our analysis suggests that, while ETF market prices and NAV/index values are cointegrated over time, ETF prices can actually lead NAV and index values, especially during periods of elevated market volatility. The implication is that the behavior of ETF prices can have predictive power with respect to the behavior of index and NAV valuations. This phenomenon may result in opportunities for potential trading strategies that seek to utilize the apparent information content in ETF price behavior. We developed and tested one such hypothetical strategy. The results, contained herein, suggest that the value of the ETF information content can be significant.
Introduction

The fixed income market is an over-the-counter (OTC), bilateral market in which trades are private transactions between counterparties that occur at negotiated prices. As a result, the same bond may trade at the same time in multiple transactions at different prices. Because of the over-the-counter nature of the market, participants are largely unable to observe these price discrepancies in real time. The advent of electronic trading systems for certain fixed income sectors (e.g., Tradeweb for US Treasuries, agencies and mortgages; Market Axess for corporate securities) as well as reporting systems such as TRACE (in the case of corporate bonds) and EMMA (in the case of municipal bonds) have helped improve price transparency but only on a delayed basis.\(^2\)

In less-liquid fixed income sectors, such as the market for high-yield corporate bonds, dealers may be reluctant to simultaneously display actionable bid and offer prices (i.e., two-way markets). When two-way markets are displayed, they are often quite wide (e.g., a point or greater in certain high-yield or municipal bonds). As a result of these attributes, the OTC bond market can be opaque and discontinuously liquid, resulting in poor price discovery, especially during periods of elevated market volatility and dislocation.

The structure of the equity market differs significantly from that of the OTC bond market. The equity market is based on centrally cleared trades that are executed at national best bid- or offer-side prices. Both the size of trades and the prices at which they are executed are almost immediately observable to market participants. Additionally, two-way markets are generally posted for all securities trading on the exchange. As a result, all market participants have nearly the same access to price information and liquidity. Price discovery in equity markets is generally both rapid and transparent. The presence of an exchange reduces counterparty risk, increases transparency, facilitates price discovery, and generally improves liquidity.

The advent of the fixed income exchange traded fund (ETF), a portfolio of bonds that trades throughout the day on a stock exchange, allows for examination of the implications of having a market that simultaneously trades both over the counter and on an exchange. In this paper, we examine the price behavior of the traditional OTC bond market and explore the value of the price information that can be derived from bond ETFs trading on an exchange.

First we compare structures of the bond and equity markets, with a particular focus on the impediments to price discovery in the OTC bond market. We then discuss the structural, valuation, and trading attributes of fixed income index ETFs. An empirical analysis based on historical price data is then presented, which illustrates the cointegrative properties between fixed income ETFs and the underlying OTC market, as proxied by fund net asset values (NAVs). This analysis suggests that liquid fixed income ETFs may actually provide price discovery, evidenced by a leading relationship versus NAV/index values. Finally, we illustrate a simple pairs trading strategy between the ETF market price and the corresponding NAV based on the prior empirical analysis. The results suggest a potentially high level of information content in the ETF market price, particularly in volatile or dislocated markets.

\(^2\) Madhavan and Hendershott [2011].
Price Discovery in the OTC Bond Market

In addition to a lack of price transparency, one of the other attributes that makes price discovery in the bond market challenging is the frequency with which trades occur. In general, not all bonds trade on a given day (Figure 1). For example, within the iBoxx $ Liquid Investment Grade Index, an index of US dollar–denominated investment-grade corporate bonds, less than 30% of the index constituents traded at least 20 days in a given month, on average, during the 12 months ending September 2011 (according to TRACE data for trades of $100,000 or greater). Similarly, within the iBoxx $ Liquid High Yield Index, an index of speculative-grade US dollar–denominated corporate bonds, less than 10% of index constituents traded at least 20 days in a given month (according to TRACE data for trades of $100,000 or greater), on average, during the same period.³

The trading behavior of an individual bond can be driven by the lack of pricing transparency in the OTC market. In the presence of perceived information asymmetry, market makers may display wider bid/offer spreads. In addition, a number of structural factors may impact liquidity, including the available float of the issue (how much of the issue is outstanding and how much of it is “locked away” by hold-to-maturity investors), the structure of the issue (are there any unusual coupon or call features), and the desirability of the exposure (does the issue fit with current patterns of investor demand).

³ The iBoxx $ Liquid High Yield Index contains 144 A-designated issues. The trading activity of such issues may not be fully captured in the TRACE data, thereby potentially understating the percentage of issues traded daily.
During periods of more extreme market volatility and disruption, secondary trading in the OTC bond market can become significantly impaired. Figure 2 illustrates average daily volume in the corporate bond market during 2008 versus the Barclays Capital Liquidity Cost Score (LCS) for the Barclays Capital U.S. Corporate Investment Grade Index. As the chart shows, volume fell sharply in the second half of the year, and spreads widened significantly, as the credit crisis escalated and dealers and clients alike faced severe liquidity and capital constraints.

One consequence of discontinuous liquidity in the bond market is degradation in price discovery. If few bonds are trading or are trading thinly in a given sector or index, it may be much more challenging to estimate a price for securities that did not trade and to derive conclusions on the overall value and direction of that sector or index.

There are a number of fixed income valuation services that provide daily prices on virtually every outstanding bond in the market. These prices are consumed by index providers and asset managers in order to generate index and fund valuations. These services take actual trade information where it exists and apply algorithmic or matrix approaches to estimate prices for securities that have not traded recently. Information used in these estimation approaches include execution prices of similar securities, movements in market interest rates such as US Treasuries and LIBOR, observed changes in credit spreads, and changes in the valuation of derivatives such as credit default swaps. The output of this process is an estimate of the price at which a bond may trade. Importantly, this price may not be actionable by market participants, as the true actionable price for a security cannot, by definition, be fully determined without a transaction taking place. As a result, prices derived through estimation methods may exhibit a

---

4 The Liquidity Cost Score is an estimation calculated by Barclays Capital that serves as a proxy measure for bid/offer spreads. See Dastidar and Phelps [2009].
smoothed behavior and, at times, may lag the behavior of more-liquid securities during fast moving or dislocated markets.\textsuperscript{5}

One way in which we may observe this phenomenon is by examining the behavior of index returns over different observation frequencies. Figure 3 shows the return volatility of a number of different indices (US equities, US Treasuries, investment-grade corporates, high-yield corporates, and municipal bonds) over different observation intervals (daily, weekly, and monthly) from 9/30/08 through 9/30/11.

![Figure 3: Annualized Index Return Volatility](image)

<table>
<thead>
<tr>
<th>Index</th>
<th>Daily</th>
<th>Weekly</th>
<th>Monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>iBoxx $ Liquid HY</td>
<td>8.58%</td>
<td>13.55%</td>
<td>16.51%</td>
</tr>
<tr>
<td>S&amp;P AMT-Free National Muni</td>
<td>4.53%</td>
<td>7.52%</td>
<td>5.08%</td>
</tr>
<tr>
<td>iBoxx $ Liquid IG</td>
<td>7.10%</td>
<td>8.09%</td>
<td>9.31%</td>
</tr>
<tr>
<td>Barclays 20+ Treasury</td>
<td>18.78%</td>
<td>17.91%</td>
<td>19.86%</td>
</tr>
<tr>
<td>S&amp;P 500</td>
<td>32.99%</td>
<td>29.60%</td>
<td>24.44%</td>
</tr>
</tbody>
</table>

Sources: Markit iBoxx, Barclays Capital, Standard & Poor’s, BlackRock, 9/30/08–9/30/11. Past performance does not guarantee future results.

For investment-grade, high-yield, and municipal securities, the return volatilities are smallest when measured by daily observations. Such a pattern is similar to what is observed in smoothed processes.\textsuperscript{6} Indices based on less-liquid and transparent markets, such as those for high-yield and municipal securities, may be slower to reflect market price information (given the lack of trading activity and transparency) and, therefore, may have the appearance of lagging more-active, liquid securities in volatile markets. In the absence of an actionable trade, individual bond prices may remain unchanged or may update more gradually over a number of trading days until clarification of value through an actual trade occurs. As a result, changes in bond valuations and index levels may be dampened when measured daily but may become more apparent when measured over wider intervals (e.g., weekly or monthly). For more-liquid, transparent markets—such as those for large-cap US equities and US Treasuries—the patterns are mixed, exhibiting higher daily volatility than weekly and/or monthly volatility. This intuitively makes sense, as price discovery is relatively more efficient in these markets. As a contrast, Figure 4 shows the market price–based return volatility of fixed income ETFs that correspond with the fixed income indices listed above.

\textsuperscript{5} A similar phenomenon has been observed in hedge fund and private equity portfolios as well as real estate appraisal values. See Getmansky, Lo, and Makarov [2004], Conner [2003], Case and Quigley [1991], and Geltner [1991].

\textsuperscript{6} A cursory analysis of the behavior of the iBoxx $ Liquid HY Index, the iBoxx $ Liquid Investment Grade Index, and the S&P AMT-Free National Municipal Bond Index suggests the presence of potential autoregressive processes of varying orders. In general, conditions of serial correlation, heteroskedasticity, and other violations of normality typical of financial time series may result in inconsistent measurements of variance over different observation frequencies.
The table is interesting in that the volatilities (with the exception of municipals) are relatively more consistent across observation frequencies, indicating the absence of a smoothing process in the behavior of the return series. Note that the volatilities between the index and ETF are most consistent for 20+ Treasuries, which is not surprising given the relative transparency and liquidity of the market for US Treasury securities.

**Implications for Investors**

The absence of continuous liquidity in the OTC bond market can impede price discovery and result in frictions in information transfer. Investors who measure their performance relative to a particular benchmark may be misinformed as to whether they are under- or outperforming the market; that is, the benchmark may not reflect information in a timely manner, due to illiquidity and opacity in the underlying bond market. This can lead to erroneous conclusions. Likewise, if market information is reflected in only the most liquid securities, investors will have an incomplete picture of price evolution across a given market, which can lead to investment decisions that are not fully informed.

Because the market structures for equities and fixed income securities are so different, we might wonder how the OTC bond market would behave if it were valued in a more liquid, continuous trading environment such as an exchange. For example, would there be enhanced liquidity and price transparency? Would two-way markets be observable, and if so, would bid/offer spreads narrow relative to the OTC market?

Many of these questions may be addressed indirectly through observation of the behavior of fixed income ETFs—portfolios of OTC bonds that trade intraday on an equity exchange. We examine bond price behavior in both the OTC and exchange markets to identify the magnitude of OTC price discovery impairment. We also look at fixed income ETF price behavior to determine whether this may be a guide to future price evolution in the underlying OTC bond market.

**Fixed Income Exchange Traded Funds**

Fixed income ETFs are typically 1940 Act open-end fund structures that trade intraday on an equity exchange. The market price of the ETF is driven by the actionable value of the fund’s underlying OTC fixed income securities as well as the balance of ETF share supply and demand on the exchange. Authorized market participants have the ability to exchange shares of the ETF for the underlying fund holdings, generally keeping the ETF price in-line with the actionable value of the bonds held in the fund. For example, an overvaluation of the ETF relative to the underlying portfolio typically leads to the creation of new fund shares, while an
undervaluation typically leads to the redemption of fund shares. This arbitrage activity, implemented either through share creation/redemption or through relative value trading of the ETF versus correlated securities, generally prevents prolonged dislocations between an ETF’s value and that of its underlying bond portfolio. Once fixed income ETFs reach a critical mass of exchange liquidity, they can often become more liquid and efficient to trade than the corresponding underlying OTC bond portfolio.

Index-based fixed income ETFs are passive funds that are designed to track a specific fixed income index (e.g., the Barclays Capital U.S. Aggregate Bond Index). Because fixed income ETFs are essentially bond portfolios that trade intraday in a continuous trading environment, their behavior can provide information on the valuation of the portfolio of bonds held by the fund through the lens of the exchange. As the entire portfolio is trading on the exchange, the individual bond positions that comprise that portfolio are also implicitly trading, even though the individual bonds may not be trading actively in the underlying OTC bond market. The OTC valuation estimate may differ, sometimes significantly, from the price for that bond implied by the exchange value of the ETF portfolio. This immediately begs the question—is it possible to determine the correct price?

One view is that the “correct” price is the price at which a trade actually occurred, as opposed to where it was estimated. Given that fixed income ETFs trade throughout the day, there is a fairly continuous implied exchange price for all portfolio holdings. Note that, in order for there to be any significant information content in these prices, the ETF must be large and liquid enough not to be impacted or distorted by asymmetric trading flows. In liquid, well-functioning fixed income ETFs, the arbitrage function generally prevents ETF prices from persistently diverging from the value of the underlying bond portfolio.

In the following section, we examine the trading behavior of fixed income ETFs and analyze the information content that they may provide about the underlying bond market.

**Valuation and Trading Behavior of Fixed Income ETFs**

In order to understand the price discovery features of fixed income ETFs, we would ideally compare their behavior to the appropriate fixed income indices that they are designed to track (as a proxy for the underlying cash bond market). However, such an analysis would introduce a number of factors that could obscure the relationships that we are trying to measure, such as fund distributions of income, management fees, and differences in bond composition between the ETF and the market index. In order to adjust for these differences, we will instead utilize the ETF net asset value as a proxy for the market index.

Fixed income index valuations and fund NAVs, including both mutual funds and ETFs, are typically calculated using bid-side pricing for the underlying bonds. These prices are generally sourced from a pricing provider and include observed execution levels as well as estimates derived from algorithmic or matrix methods. The index level or NAV is simply the arithmetic market-weighted average of individual bid-side bond prices. Importantly, for US fixed income markets, these prices are usually captured as of 3:00 p.m. eastern time, which is widely viewed

---

7 Although market makers will generally take advantage of differences between the NAV and the trading price of ETFs through arbitrage opportunities, there is no guarantee that they will do so.
8 Throughout the rest of the paper, the term “fixed income ETFs” will refer specifically to unlevered, index-based fixed income ETFs.
9 The net asset value of the specified ETF reflects all fund distributions and expenses, allowing for a more direct comparison to the ETF market price.
as the bond market “close” (even though fixed income securities can continue to trade after 3:00). As fixed income ETFs are exchange traded instruments, official closing prices are calculated as of 4:00, the equity market close. This can lead to some peculiar observations in more-liquid bond markets between the 3:00 calculated NAV and index values and the 4:00 closing price of ETFs that track those markets. In particular, US Treasuries and other liquid rate markets can continue to be quite active post 3:00. Accordingly, a US Treasury ETF that ceases trading at 4:00 will have captured this additional price action relative to the 3:00 calculated NAV and index values. This can lead to the appearance of a dislocation between the closing ETF market price and the index value or NAV, which may be almost entirely attributable to the timing difference between the ETF and bond market close. In order to adjust for this effect, we utilize 3:00 market prices in the analysis of ETF behavior throughout the paper.

Fixed income ETFs trade on an exchange at market clearing prices which can, and often do, differ from NAVs (see Petajisto [2011]). Fixed income ETFs that experience buying pressure and inflows should trade at a premium (i.e., closer to the offer side of the underlying bond market), as a sufficient level of ETF demand will result in the creation of new fund shares. In creating the new fund shares, the bonds are sourced—likely closer to the offered side of the underlying market—by authorized participants. Accordingly, the bid/offer transaction spread that is incurred in the underlying bond market is reflected in the ETF price as a premium to the NAV (since the NAV calculation is based on bid-side prices). Conversely, fixed income ETFs that experience selling pressure and/or outflows should trade closer to NAV (i.e., the bid side of the underlying market).

Under most market conditions, fixed income ETFs trade at a premium to their NAV, the premium being a function of the balance of buy and sell activity on the exchange and the bid/offer spread of the underlying bond market. Additionally, in dislocated, volatile markets, the arithmetic weighted-average bid-side price of the underlying bond portfolio—as represented by NAV—may not correspond to the actionable price for the entire portfolio (i.e., the risk-adjusted price for a large number of bonds based on liquidity and volatility conditions). The difference between the calculated NAV and the actionable portfolio price explains why fixed income ETFs may trade at discounts to NAV or premiums above and beyond the offer side price of the underlying bond portfolio. Such trading behavior in ETFs was pronounced during the 2008 financial crisis across all fixed income sectors and, more recently, during dislocations in the municipal market (November 2010 through January 2011) and the credit market (August and September 2011).

Because of the presence of premiums and discounts to NAV, many market participants erroneously conclude that fixed income ETFs are not functioning properly. Most of the critiques of fixed income ETFs rely on one central premise: that bond prices generated by pricing providers are the most accurate representation of actionable liquidity in the bond market. In the sections that follow, we demonstrate that the market price of an established fixed income ETF and its benchmark (as proxied by the NAV) are cointegrated, and that the market price of the ETF can often lead price movements in the underlying bond market as represented by the NAV or benchmark.\footnote{For more detail on the drivers of fixed income ETF premiums and discounts, see Tucker and Laipply [2010]. Note that similar behavior has been observed between more-liquid instruments and their underlying holdings. For example, Hasbrouck [2003] observes such behavior between S&P 500 futures and the S&P 500 index.}
Price Discovery Properties of Fixed Income ETFs
As discussed in the previous section, the market price of a fixed income ETF can often diverge from the fund's index value or NAV. Figure 5 illustrates the total returns of AGG, a $13 billion index ETF benchmarked to the Barclays Capital U.S. Aggregate Bond Index.

<table>
<thead>
<tr>
<th></th>
<th>NAV Return</th>
<th>Market Price Return</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>YTD</td>
<td>6.41%</td>
<td>6.52%</td>
<td>−0.11%</td>
</tr>
<tr>
<td>1-Month</td>
<td>0.73%</td>
<td>0.76%</td>
<td>−0.03%</td>
</tr>
<tr>
<td>3-Month</td>
<td>3.78%</td>
<td>4.04%</td>
<td>−0.26%</td>
</tr>
<tr>
<td>6-Month</td>
<td>6.06%</td>
<td>6.46%</td>
<td>−0.40%</td>
</tr>
<tr>
<td>1-Year</td>
<td>5.02%</td>
<td>4.99%</td>
<td>0.03%</td>
</tr>
<tr>
<td>3-Year</td>
<td>7.76%</td>
<td>7.89%</td>
<td>−0.13%</td>
</tr>
<tr>
<td>5-Year</td>
<td>6.32%</td>
<td>6.29%</td>
<td>0.03%</td>
</tr>
<tr>
<td>Since Inception</td>
<td>5.26%</td>
<td>5.27%</td>
<td>−0.01%</td>
</tr>
</tbody>
</table>

Note how, over shorter timeframes, the NAV-based total return and market price–based total return differ, as market price movements may not have coincided perfectly with movements in NAV. Over longer time frames, the market price and NAV-based total returns converge. This is initial evidence of a "cointegrated" relationship, one where two time series may diverge in the short term and converge over longer time periods. Figure 6, which depicts the price and NAV relationship of AGG, illustrates this effect. While short-term choppiness in the relationship can occur, the longer term directional relationship is evident.

Figure 6: AGG Market Price Versus NAV

Source: Bloomberg, 9/30/08–9/30/11. Past performance does not guarantee future results.
The long-term price/NAV relationship in an ETF is governed by arbitrage relationships between the ETF and the underlying basket. In order to properly evaluate the longer-term behavior of the fixed income ETF price/NAV relationship, it is necessary to identify a sample set of sufficiently liquid ETFs to test. Smaller, less-liquid ETFs can incur greater price/NAV volatility, as arbitrage trades are potentially more challenging to execute when anomalous behavior occurs. Figure 7 depicts eight established fixed income ETFs that have higher assets under management and experience relatively high average daily dollar trading volumes within their respective sectors.

We can use established statistical procedures to test whether the market price and NAV of a particular fixed income ETF exhibit a cointegrated relationship. Figure 8 illustrates the results of one such procedure, which was performed using log levels-based regressions over a three-year timeframe (09/08 to 09/11) on the daily market price/NAV relationships of the fixed income ETFs highlighted above. The regression has the form of:

\[
\ln(NAV_t) = \alpha + \beta (\ln(PX_t)) + \varepsilon
\]

Where,

- \(\ln(NAV_t)\) is the natural log of the NAV level at time \(t\)
- \(\alpha\) is the intercept term (which is a function of the fund premium/discount)
- \(\ln(PX_t)\) is the natural log of the market price level at time \(t\)
- \(\beta\) is the cointegration coefficient
- \(\varepsilon\) is the error term

Figure 8 shows the test statistics of significance and the corresponding probability (i.e., the p-value) that the variables are not cointegrated. For reference, the cointegration coefficients and standard errors of the regressions are also included.\(^{13}\)

---

12 Utilizing MATLAB, the Engle-Granger test for cointegration was performed on a daily series of NAV and market price values for each ETF in order to assess the null hypothesis of no cointegration among the time series.

13 The expected cointegration coefficient value was 1.0. Actual differences from 1.0 may be attributable to limited sample size as well as ETF premium/discount volatility.
The results strongly suggest the presence of a cointegrated relationship between the market prices and NAVs of the selected fixed income ETFs. That is to say that, despite any short-term (e.g., daily) dislocations, there is a powerful long-term relationship between these variables. This tells us that we can expect short-term dislocations between price and NAV to correct through time.

A natural question is whether the cointegrated relationship between fixed income ETF price and NAV levels is the result of the ETF leading the NAV or the reverse. In order to make this determination, we can examine regressions of coincident NAV returns versus various lags of market price returns, and vice versa. As an example, consider HYG. Figure 9 details the results of coincident NAV returns versus three days of lagged price returns and coincident price returns versus three days of lagged NAV returns.

### Table: Cointegration Test and Log Level Regression

<table>
<thead>
<tr>
<th>Ticker</th>
<th>Cointegration Test</th>
<th>Log Level Regression</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t-Statistic</td>
<td>p-Value</td>
</tr>
<tr>
<td>AGG</td>
<td>−9.20</td>
<td>0.001</td>
</tr>
<tr>
<td>BND</td>
<td>−14.87</td>
<td>0.001</td>
</tr>
<tr>
<td>HYG</td>
<td>−11.18</td>
<td>0.001</td>
</tr>
<tr>
<td>JNK</td>
<td>−14.87</td>
<td>0.001</td>
</tr>
<tr>
<td>MUB</td>
<td>−7.57</td>
<td>0.001</td>
</tr>
<tr>
<td>SHM</td>
<td>−11.26</td>
<td>0.001</td>
</tr>
<tr>
<td>LQD</td>
<td>−9.97</td>
<td>0.001</td>
</tr>
<tr>
<td>TLT</td>
<td>−24.99</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Sources: NYSE ARCA TAQ, Bloomberg, BlackRock, 9/30/08–9/30/11.

### Table: Price vs. NAV Regressions

<table>
<thead>
<tr>
<th>Return</th>
<th>NAV vs. Lagged Price</th>
<th>Price vs. Lagged NAV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>t-statistic</td>
</tr>
<tr>
<td>1-Day Lag</td>
<td>0.14</td>
<td>10.12</td>
</tr>
<tr>
<td>2-Day Lag</td>
<td>0.17</td>
<td>12.54</td>
</tr>
<tr>
<td>3-Day Lag</td>
<td>0.06</td>
<td>4.61</td>
</tr>
<tr>
<td>Adjusted R-Squared</td>
<td>0.238</td>
<td></td>
</tr>
<tr>
<td>Durbin-Watson</td>
<td>1.480</td>
<td></td>
</tr>
</tbody>
</table>

Sources: NYSE ARCA TAQ, Bloomberg, BlackRock, 9/30/08–9/30/11.
The NAV return versus lagged price return regression results in a relatively high adjusted R-square and significant test statistics for the lagged price return variables. The converse regression of price returns versus lagged NAV returns results in a low adjusted R-square measure and statistical significance on only the first lagged NAV return variable. This suggests that lagged price returns have a statistically significant impact on coincident NAV returns, rather than the converse. Note, however, that tests for Granger causality proved inconclusive.\textsuperscript{14}

We now wish to investigate the degree to which the ETF market price may provide information about future NAV and index returns. To answer this question, we expand the methodology described above and regress coincident NAV returns against coincident and five days of lagged market price returns. The regression has the form of:

$$NAVret_t = \alpha + \sum_{i=0}^{n} \beta_i PXret_{t-i} + \epsilon$$

Where,

- $NAVret_t$ is the coincident NAV return
- $\alpha$ is the intercept (approximately zero)
- $\beta_i$ is the market price return coefficient for lag $i$
- $PXret_{t-i}$ is the market price return associated with lag $i$
- $\epsilon$ is the error term

14 The Granger causality tests consisted of comparing restricted and unrestricted regressions on coincident market price and NAV returns versus three trading days of lagged market price and NAV returns over the sample period 9/30/08 to 9/30/11. Note that the F-statistic for the null hypothesis that price returns do not Granger cause NAV returns was 22.3, while the F-statistic for the null hypothesis that NAV returns do not Granger cause price returns was 25.8.
The fitted relationship illustrates that 16.9% of the coincident price return is reflected in the coincident NAV return, 15.2% of the prior day’s ETF price return is reflected in the coincident NAV return, and so on. The individual test statistics for the lagged price variables are highly significant and generally decrease in magnitude relative to the lag. This observed relationship is intuitive, as the most recent ETF price returns have the largest impact on NAV while the further lagged returns have the least impact. The implication of a relationship in which the ETF market price leads index values and NAVs is that the market price of a fixed income ETF contains information content with respect to the level and path of the underlying bond market.

If there does indeed exist a cointegrated relationship between a fixed income ETF’s market price and index value/NAV, and the ETF market price tends to lead movements in index values and NAV, how long might it take for index values/NAVs and ETF market prices to converge? By examining the serial correlations of residuals from levels-based regressions performed on the market price and NAV of each candidate ETF (Figure 8), we may determine the half-life of price/NAV convergence for each fund; that is, the time it takes to close half of the distance between any abnormal divergence between market price and NAV (recall that there can and should exist some difference between market price and NAV due to bid/offer spreads in the underlying bond market, short-term ETF supply/demand imbalances, execution risk, etc.).

The time that it takes for an ETF market price and NAV to revert to a long-term relationship is a function not only of liquidity in the underlying market, but the creation/redemption mechanism as well. As discussed previously, some ETFs employ an in-kind exchange for physical mechanism, in which shares of the ETF are exchanged for a basket of underlying bonds. For ETFs that employ an exchange for physical creation/redemption mechanism, the half-life values can be a reflection of transparency in the underlying market. In less-liquid markets, it may take longer for an abnormal divergence in the market price of an ETF and NAV to reconcile. Because of the lack of daily trading in many securities in less-liquid markets, individual bond prices are slow to update, and it may take longer to close any apparent arbitrage opportunity that does arise.

Alternatively, an ETF may employ a traditional mutual fund creation and/or redemption mechanism, in which cash is exchanged directly for shares rather than the underlying securities. In theory, a cash creation/redemption mechanism would allow for a more rapid adjustment of price/NAV divergence, as a market participant would be able to quickly create or redeem shares and act on a market dislocation without the burden of the underlying OTC bond execution. The tradeoff inherent in such an approach is that the burden of the trade execution falls on the ETF fund manager (as opposed to the authorized participants in the in-kind exchange for physical process), and fund performance may be adversely impacted due to cash drag and the internalization of trading costs. Rather than the liquidity and trading conditions in the underlying market being reflected in the market price of the ETF (as would be the case in a pure exchange for physical transaction), they are instead internalized into the fund and are eventually reflected in the NAV performance (albeit in a slower, more diffuse fashion).

Figure 11 shows the results of half-life calculations across the sample ETFs. Three years of data are examined to compare behaviors during the financial crisis and the years following.

---

15 As of the time of this writing, AGG, HYG, MUB, LQD, and TLT primarily employed an exchange for physical-based creation/redemption methodology. The specific creation/redemption methodology primarily employed by the other ETFs in the sample was not known with certainty.
Some interesting patterns may be observed. Broadly speaking, ETFs that track more-liquid markets (US Treasuries and investment-grade credit) tend to have shorter half-lives than those that track less-liquid markets (municipals and high yield). However, periods of elevated volatility and market dislocation, such as the 2008–09 financial crisis and the 2010 municipal market selloff, can cause aberrations.

As an example, LQD, an investment-grade credit ETF, appears to exhibit some unexpected behavior over the 2008–09 time frame in that its half-life is longer than that of any of the other sample ETFs. We would expect an ETF that tracks the investment-grade credit market to be more efficient than an ETF that tracks the municipal or high-yield markets given the relative transparency of the investment-grade market. The significant elevation in the half-life of LQD during the 2008–09 financial crisis is likely a function of the level of liquidity impairment that existed in the underlying bond market during that time as well as the fund’s exposure to financials, which were particularly dislocated during the crisis. Indeed, by the third sample period (9/30/10–9/30/11), LQD had reverted to a shorter half-life than any of the remaining ETFs, with the exception of TLT (the long-duration Treasury ETF).

The behavior of the municipal ETFs also illustrates the effects of market dislocations. Following the financial crisis, the half-lives of MUB and SHM fell noticeably in 2010. However, the municipal dislocation of late 2010 through early 2011 caused the half-lives to widen back out again, as liquidity in the municipal market became severely impaired.

Interestingly, the trading volumes of ETFs may increase significantly during market dislocations. As an example, LQD average daily volume increased from roughly $20 million to a peak of $270 million during September 2008; MUB average daily volume increased from roughly $12 million to as high as $128 million during November 2010. A strong case can be made that ETFs allowed for the expression of market clearing prices while the liquidity of the underlying market remained impaired during these periods (hence the extension of time for the market price and NAV to converge).

---

16 According to www.iShares.com, LQD’s exposure to financials was approximately 42% as of 9/30/08. As of 9/30/11, LQD’s exposure to financials was 35%. Note that in September 2008, the iBoxx $ Liquid Investment Grade Index was comprised of 100 equally weighted bonds. The index transitioned in mid-2009 to a broader market cap weighted index (refer to www.markit.com for details).
The half-life of TLT, a 20+ year US Treasury ETF, was quite small (less than one day), reflecting the high level of information symmetry between the ETF and the underlying market.

**Market Signal and Trading Implications**

The presence of a cointegrated relationship between NAV and market prices in fixed income ETFs suggests that the ETF price behavior contains information about future index level and NAV behavior. Potential relative value trading opportunities between the ETF and underlying basket (or other correlated securities) may exist, especially given that there does appear to be a leading relationship between the ETF market price and the NAV and index values. The behavior of an established fixed income ETF could serve as a signal for price evolution in the underlying OTC cash market.

In order to identify temporary dislocations between the ETF market price and net asset values, we can determine a “fair value” for NAV returns and then measure actual NAV changes against that fair value. A simple error correction model for NAV-based total returns may be developed from a time series of ETF market price and NAV levels.

To determine the error correction term, we rearrange the levels model that was utilized to test for the presence of a cointegrated relationship:

\[ \varepsilon = LN(NAV_t) - \alpha - \beta(LN(PX_t)) \]  

(3)

The one period lagged error term from Equation 3 is then incorporated into Equation 4.

\[ NAVret_t = \gamma_1 PXret_t + \gamma_2 \varepsilon_{t-1} + \mu \]  

(4)

Where,

- \( NAVret_{t(i)} \) is the coincident ETF NAV return
- \( \gamma_1 \) is the coincident price return coefficient
- \( PXret_{t(i)} \) is the coincident ETF price return
- \( \gamma_2 \) is the lagged error term coefficient
- \( \varepsilon_{t-1} \) is the residual or error term from the prior day’s levels-based regression fit (as determined by Equation 3)
- \( \mu \) is the residual value for Equation 4

The error correction model incorporates both long-term information via the price level versus NAV level (as captured by Equation 3) as well as shorter term information via the daily return and error correction (as captured by Equation 4). As an example, using data from September 2008 through September 2011, we may fit the two models to the trading behavior of HYG:

Equation 3: \[ \varepsilon = LN(NAV_t) - (-0.317 + 1.069LN(PX_t)) \]

Equation 4: \[ \Delta_{t-1}LN(NAV) = 0.181(\Delta_{t-1}LN(PX)) - 0.177(\varepsilon_{t-1}) + \mu \]

For reference, the parameters for Equations 3 and 4 of each sample fund are provided in Figure 12.
Case Study: HYG
We test the methodology above using recent market data. Specifically, we examine the market price and NAV behavior of HYG beginning 8/5/11, the Friday before the downgrade of US sovereign debt by S&P. Risk markets had been selling off since the end of July, and this sell-off accelerated sharply with the downgrade. Figure 13 illustrates predicted and actual NAV returns based on Equations 3 and 4.

For example, as of the 3:00 p.m. market close on 08/05/11, HYG was trading at a 1.41% discount to NAV, based on a market price of $86.69 and a NAV of $87.93. Liquidity in the underlying cash bond market was reportedly impaired, suggesting that HYG’s exchange market price may have been reflecting information that had not yet been incorporated in the underlying bond market (as proxied by the NAV). Using Equation 3, we may calculate a residual, $\varepsilon$, of:

$$
\varepsilon = LN(87.93) - (-0.317 + 1.069LN(86.69)) = 0.023
$$

The fact that $\varepsilon$ differs significantly from zero (based on the standard error 0.0175 of Equation 3) suggests that the differential between the market price and NAV is too high relative to the model.
prediction, indicating that a correction is likely. We may use the value of $\varepsilon$ as an input for Equation 4 in order to predict the NAV return on the following trading day based on that day’s market price return. On the following Monday, 08/08/11, the market price for HYG closed at 82.84. The predicted NAV return for the day would therefore be:

$$\Delta_{t-1}LN(NAV) = 0.181(LN(82.84) - LN(86.69)) - 0.177(0.023) + \mu = -1.23\%$$

The actual NAV return was -1.82% (the NAV declined from $87.93 to $86.34), a relatively small forecast error of -0.59%. However, the forecast errors over the remaining series were fairly noisy and some were quite large. There are a number of potential reasons for this. Daily returns are fairly volatile in general and are subject to a high degree of noise. There are also a number of other factors that drive the price to NAV relationship (e.g., the bid/offer spread in the underlying market, the balance of flows in the ETF, and the level of risk adjustment being reflected in the market price), which may obscure the changes in the relationship due purely to “information convergence.”

**Measuring and Valuing Information Content**

To quantify the value of the information content that may exist in the market price behavior of a fixed income ETF, we develop and test a hypothetical trading strategy. The strategy will be to hold long positions in the ETF and short positions in the underlying market (as proxied by the corresponding index or, equivalently, NAV) any time the ETF price looks significantly cheap to NAV. The reverse trade would be executed when the ETF price appears expensive relative to the NAV. As a threshold for identifying the presence of a trading opportunity, we will compare the absolute value of the residual value given by Equation 3 with a threshold equal to two times the level of the standard error of the Equation 3 regression fits described in Figure 12. (A high threshold was established in an attempt to isolate truly anomalous behavior.) Any trade that is implemented will be reversed once the dislocation falls back below the threshold.

For example, as of the bond market close (3 p.m. ET) on 9/30/08, the NAV of HYG was $84.13 while the market price was $81.65. Inserting these values into Equation 3 results in a residual value of 0.044, which is more than two times the standard error of Equation 3 of 0.0175. As the market price of HYG appears significantly discounted to the NAV (i.e., the underlying bond portfolio), a long position in HYG is initiated at the market price of $81.65, while a short position in the NAV is initiated at $84.13. The following day, 10/1/08, the market price and NAV of HYG were $84.07 and $82.44, respectively, as of 3 p.m. ET. Employing Equation 3 results in a residual value of -0.0075, which is well within the standard error. Accordingly, the position is terminated for a net return of 4.97% (excluding any transactions costs).  

To assess the degree of potential information content across different markets, we examine HYG, JNK, MUB, SHM, LQD, and TLT (high yield, municipals, investment-grade credit, and US Treasuries).

Figure 14 shows the results of $100 invested in the trading strategy (assuming daily rebalancing) using the price of the ETF and the NAV of its underlying bond portfolio from 09/30/08 to 09/30/11. Figure 15 shows key summary statistics of the strategy.

---

17 The return on the ETF long was $84.07/$81.65 -1 = 2.96%, while the return of the NAV bond portfolio short was -(82.44/84.13 -1) = 2.01%. The net return, therefore, was 2.96% + 2.01% = 4.97%. Based on the current market price return and the prior period error term, Equation 4 would have suggested a NAV return of -0.27% versus the realized NAV return of -2.01%.
Figure 14: Trading Strategy Cumulative Profit and Loss of $100 Investment

![Figure 14: Trading Strategy Cumulative Profit and Loss of $100 Investment](image)

Sources: NYSE ARCA TAQ, Bloomberg, BlackRock, 9/30/08–9/30/11. This information is strictly for illustrative and educational purposes only. This information does not represent the actual current, past or future holdings or portfolio of any BlackRock client. Past performance does not guarantee future results.

Figure 15: Summary Statistics for the Trading Strategy

<table>
<thead>
<tr>
<th></th>
<th>HYG</th>
<th>JNK</th>
<th>MUB</th>
<th>SHM</th>
<th>LQD</th>
<th>TLT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average P/L</td>
<td>2.1%</td>
<td>1.3%</td>
<td>0.4%</td>
<td>0.6%</td>
<td>0.5%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Median P/L</td>
<td>2.1%</td>
<td>1.1%</td>
<td>0.2%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>4.2%</td>
<td>2.4%</td>
<td>0.9%</td>
<td>0.8%</td>
<td>1.6%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Maximum P/L</td>
<td>22.0%</td>
<td>10.1%</td>
<td>4.5%</td>
<td>2.6%</td>
<td>5.0%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Minimum P/L</td>
<td>−4.3%</td>
<td>−2.8%</td>
<td>−0.8%</td>
<td>−0.5%</td>
<td>−4.4%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Positive P/L Count</td>
<td>24</td>
<td>29</td>
<td>34</td>
<td>31</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>Negative P/L Count</td>
<td>9</td>
<td>11</td>
<td>18</td>
<td>5</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Total P/L Events</td>
<td>33</td>
<td>40</td>
<td>52</td>
<td>36</td>
<td>34</td>
<td>20</td>
</tr>
<tr>
<td>Total Trading Days</td>
<td>752</td>
<td>752</td>
<td>752</td>
<td>752</td>
<td>752</td>
<td>752</td>
</tr>
</tbody>
</table>

Sources: NYSE ARCA TAQ, Bloomberg, BlackRock, 9/30/08–9/30/11. This information is strictly for illustrative and educational purposes only. This information does not represent the actual current, past or future holdings or portfolio of any BlackRock client. Past performance does not guarantee future results.
As Figures 14 and 15 illustrate, such a strategy (were it to be actionable) could have generated significant returns over the three-year period, particularly during the peak of the financial crisis (fourth quarter of 2008) and the immediate aftermath (first half of 2009). We note other periods of dislocation that resulted in strong strategy performance, such as the “Flash Crash” (May 2010), the municipal market sell-off (November 2010 through January 2011), and the intensification of fiscal pressure in the US and eurozone (August and September 2011). The pattern of returns is also intuitive in that the highest information opportunities seem to reside in high yield, followed by municipals, investment-grade credit, and US Treasuries. During the latter half of 2009 and the majority of 2010, we saw lower market volatility that resulted in a relatively stable price to NAV relationship and few opportunities for the trading strategy.

The back-test assumes that all transactions occur at 3 p.m. closing prices and ignores a number of important sources of friction such as trading costs, which can be quite large in the municipal and high-yield markets. In reality, it is not possible to transact efficiently at fund NAV or index levels, as many of the individual bond prices are estimates of value and may not be actionable as discussed previously. Additionally, it would be difficult to quickly and efficiently trade the underlying OTC bond portfolio, which, in the example of MUB, is comprised of more than 1,500 municipal bonds. (The ability to trade such a portfolio as a basket is one of the benefits of the ETF itself.) Nonetheless, the exercise is useful in illustrating that ETF market price does appear to contain information content relative to estimates of the underlying market based on NAV, and that it may be possible to utilize this information to form the basis for a more realistic trading strategy.

Conclusions

The growth of the fixed income ETF market has provided investors with a valuable new tool for understanding and measuring movements in the OTC bond market. Bond market price discovery creates challenges for investors of all sizes. By bringing the OTC market onto an exchange through the ETF structure, we can now more readily observe the impact of new information on fixed income markets. The presence of the creation/redemption mechanism (in which physical securities are exchanged for shares), along with exchange liquidity, results in price information being reflected more readily in ETF prices than in estimated prices of individual bonds that trade less frequently. Not only does the ETF price move in-line with the bond market over time, it appears to absorb price information more rapidly. As a result, price movements in fixed income ETFs can often lead price movements in individual bonds and market indices.

These developments have potentially powerful implications for investors. First, the ETF may more quickly capture and value changes in investor sentiment and, therefore, serve as a guide to price evolution in the underlying OTC market; for more opaque fixed income sectors, true market price discovery and volatility may be becoming observable for the first time in the form of an exchange traded, cash bond–based instrument. Second, these findings shed light on the misperception of ETF premiums and discounts. An apparent dislocation between ETF price and NAV may be the result, not of ETF mispricing, but of actual price discovery on the part of the ETF. This opens up a variety of applications from hedging to asset allocation, including potential opportunities to capture differences in the speed of price discovery between ETFs and the OTC bond market and related instruments.
Appendix

Standardized Returns for AGG and HYG, as of 12/31/11

<table>
<thead>
<tr>
<th>Fund Name</th>
<th>Inception Date</th>
<th>30-Day SEC Yield (as of 12/30/2011)</th>
<th>1-Year</th>
<th>5-Year</th>
<th>10-Year</th>
<th>Since Inception</th>
</tr>
</thead>
<tbody>
<tr>
<td>iShares Barclays Aggregate Bond Fund</td>
<td>9/22/2003</td>
<td>2.07%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fund NAV Total Return</td>
<td></td>
<td>7.58%</td>
<td>6.29%</td>
<td>--</td>
<td></td>
<td>5.23%</td>
</tr>
<tr>
<td>Fund Market Price Total Return</td>
<td></td>
<td>7.79%</td>
<td>6.30%</td>
<td>--</td>
<td></td>
<td>5.26%</td>
</tr>
<tr>
<td>Index Total Return</td>
<td></td>
<td>7.84%</td>
<td>6.50%</td>
<td>5.78%</td>
<td></td>
<td>5.46%</td>
</tr>
<tr>
<td>iShares iBoxx $ High Yield Corporate Bond Fund</td>
<td>4/4/2007</td>
<td>7.53%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fund NAV Total Return</td>
<td></td>
<td>5.89%</td>
<td>--</td>
<td>--</td>
<td></td>
<td>5.36%</td>
</tr>
<tr>
<td>Fund Market Price Total Return</td>
<td></td>
<td>6.79%</td>
<td>--</td>
<td>--</td>
<td></td>
<td>5.74%</td>
</tr>
<tr>
<td>Index Total Return</td>
<td></td>
<td>5.94%</td>
<td>6.07%</td>
<td>--</td>
<td></td>
<td>5.88%</td>
</tr>
</tbody>
</table>

Source: BlackRock, as of 12/31/11.

The performance quoted represents past performance and does not guarantee future results. Investment return and principal value of an investment will fluctuate so that an investor’s shares, when sold or redeemed, may be worth more or less than the original cost. Current performance may be lower or higher than the performance quoted. Performance data current to the most recent month end may be obtained by visiting www.iShares.com. Index returns are for illustrative purposes only and do not represent actual iShares Fund performance. Index performance returns do not reflect any management fees, transaction costs or expenses. Indexes are unmanaged and one cannot invest directly in an index. Shares of iShares Funds are bought and sold at market price (not NAV) and are not individually redeemed from the Fund. Brokerage commissions will reduce returns. Market returns are based upon the midpoint of the bid/ask spread at 4:00 p.m. eastern time (when NAV is normally determined for most iShares Funds), and do not represent the returns you would receive if you traded shares at other times.
References


Carefully consider the iShares Funds' investment objectives, risk factors, and charges and expenses before investing. This and other information can be found in the Funds' prospectuses, which may be obtained by calling 1-800-iShares (1-800-474-2737) or by visiting www.iShares.com. Read the prospectus carefully before investing.

Investing involves risk, including possible loss of principal. Bonds and bond funds will decrease in value as interest rates rise.

Shares of the iShares Funds may be sold throughout the day on the exchange through any brokerage account. However, shares may only be redeemed directly from a Fund by Authorized Participants, in very large creation/redemption units. There can be no assurance that an active trading market for shares of an ETF will develop or be maintained.

This material represents an assessment of the market environment at a specific time and is not intended to be a forecast of future events, or a guarantee of future results. This information should not be relied upon by the reader as research or investment advice regarding the funds or any security in particular. Past performance does not guarantee future results.

This material is solely for educational purposes and does not constitute an offer or solicitation to sell or a solicitation of an offer to buy any shares of any fund (nor shall any such shares be offered or sold to any person) in any jurisdiction in which an offer, solicitation, purchase or sale would be unlawful under the securities law of that jurisdiction.

The information included in this material has been taken from trade and other sources we consider to be reliable. We do not represent that this information is accurate and complete, and should not be relied upon as such. Any opinions expressed in this material reflect our judgment at this date, are subject to change and should not be relied upon as the basis of your investment decisions. No part of this material may be reproduced in any manner without the prior written permission of BlackRock.

In Canada, this material is intended for accredited investors only. In Latin America, this material has been provided by BlackRock in a private and confidential manner to institutional investors upon request. This material is provided for informational purposes only and is not an offer to sell, nor an invitation to apply for any particular product or service in any jurisdiction. In Latin America, this material is intended for institutional and professional investors only. If any funds are mentioned or inferred to in this material, it is possible that some or all of the funds have not been registered with the securities regulator of Brazil, Chile, Colombia, Mexico and Peru or any other securities regulator in any Latin American country and thus might not be publicly offered within any such country. The securities regulators of such countries have not confirmed the accuracy of any information contained herein. No information discussed herein can be provided to the general public in Latin America.

The iShares Funds registered with the United States Securities and Exchange Commission under the Investment Company Act of 1940 (“Funds”) are distributed by SEI Investments Distribution Co. (“SEI”). BlackRock Fund Advisors (“BFA”) serves as the investment advisor to the Funds. BlackRock Execution Services (“BES”) and BlackRock Investments, LLC (“BRIL”), assist in the marketing of the Funds. BFA, BES and BRIL are affiliates of BlackRock, Inc., none of which is affiliated with SEI.

The iShares Funds are not sponsored, endorsed, issued, sold or promoted by Markit Indices Limited or Standard & Poor’s, nor are they sponsored, endorsed or issued by Barclays Capital. None of these companies make any representation regarding the advisability of investing in the funds. Neither SEI, nor BlackRock Institutional Trust Company, N.A., nor any of their affiliates, are affiliated with the companies listed above.

©2012 BlackRock, Inc. All rights reserved. iShares® and BlackRock® are registered trademarks of BlackRock, Inc., or its subsidiaries. All other trademarks, servicemarks or registered trademarks are the property of their respective owners. IS-6234-0212

Not FDIC Insured * No Bank Guarantee * May Lose Value

FOR INSTITUTIONAL USE ONLY—NOT FOR PUBLIC DISTRIBUTION
HIGH YIELD ETFs IN STRESSED MARKETS

CASE STUDY

By Matthew Tucker, CFA and Stephen Laipply

Introduction

In 2012, we published a working paper (“HY ETF Behavior in Stressed Markets”) on how high-yield (HY) ETFs would likely behave under stressed market conditions.1 As a follow up to that publication, we will examine the behavior of HYG, the iShares iBoxx $ High Yield Corporate Bond ETF, during the recent bout of market volatility from May 1st, 2013 through July 5th, 2013.

There is still confusion in the market place with respect to how ETFs function versus the over the counter (“OTC”) bond market. In the bilateral, OTC bond market, transactions between investors are private which can make it difficult to source liquidity and determine current market clearing prices. In contrast, fixed income ETFs hold bonds but are bought and sold on an exchange in a visible, two-way market, just like listed equity securities. This differs from mutual funds and other pooled vehicles in which investors place direct subscription and redemption orders with a fund manager. Conversely, creations or redemptions of fixed income ETF shares, which allow the fund to increase or decrease in size, typically occur via an exchange of fund shares for a basket of fixed income securities through “APs”, or Authorized Participants (institutions which are authorized by the ETF provider to create/redeem ETF shares). As a result, creations and redemptions will generally only occur if APs believe that there is an economically efficient trade. That is to say, an AP is never forced to create or redeem. In order for a creation to occur, the ETF should be trading at or above the actionable sourcing cost for the underlying bonds (i.e., so that an AP could buy the bonds, exchange them for shares and then sell the shares for a flat to net profit, taking advantage of the arbitrage opportunity). In order for a redemption to occur, the ETF should be trading at or below the actionable disposition cost of the bonds (i.e., so that an AP could purchase the ETF, exchange it for bonds and then liquidate the bonds for a flat to net profit).

As a consequence, even if the underlying bond market is impaired, risk may still be transferred on exchange through purchases and sales of the ETF. This differs from a traditional pooled vehicle where investors can choose to purchase or redeem shares, but where ultimately all net flows need to be satisfied via purchases or sales in the underlying OTC market.

During periods of increased market volatility, overall OTC bond market liquidity generally declines as trading becomes concentrated in a subset of larger and more liquid issues and investors encounter difficulty transacting in less liquid names.2 Prices for securities that are not trading may not fully reflect new market information. As a result, many OTC quotes – and therefore index values and net asset values (NAVs) – may not be representative of actionable trades and investors may therefore observe larger price “discounts” to NAV in fixed income ETFs during these periods. However, due to the arbitrage mechanics described above, we believe that a significant amount of observed discounts are more attributable to price discovery rather than true valuation discrepancies between the exchange and OTC market.3

Analyzing the “Tapering Selloff” – Fund Flows

The period from May 1st through July 5th was marked by a sharp rise in interest rates coupled with significant spread widening in both investment grade and high yield corporate bonds. 10-year US Treasury yields jumped from 1.63% to 2.74% while high yield spreads widened by about 15 bps and high yield spreads widened by nearly 50 bps. ETFs were often claimed to have exacerbated the credit market selloff through “feedback loops” or “spirals” driven by redemptions that supposedly forced ETFs to sell securities, which resulted in declines in securities prices and subsequent declines in ETF values. In reality, fixed income ETFs represented a small part of the overall liquidation in risk assets over this time period, and their presence actually served to enhance total available market liquidity.

We first note that redemptions in US HY ETFs totaled $5 billion ($2.3 billion of which was represented by HYG) over this period vs. $19.5 billion for HY mutual funds. In other words, mutual fund outflows were nearly 4x the outflows of ETFs. Figure 1 (next page) shows a time series of HYG flows vs. broader HY mutual fund flows. The actual statistics are contrary to the disproportionate blame that ETFs received with respect to impacting the underlying bond market.

2. Based on analysis of data from TRACE and MarketAxess.
Analyzing the “Tapering Selloff” – Fund Flows (continued)

Many market participants observe ETF exchange volumes and assume a direct, 1:1 translation into OTC bond trades. In fact, much of the selling pressure in fixed income ETFs is accommodated on exchange as opposed to transactions in the OTC bond market via actual redemptions. In April 2013, the average daily volume for HYG was approximately $283 million vs. average daily net creation or redemption activity of $23 million, resulting in a secondary (exchange) to primary (OTC bond market) trading ratio of 12:1. For every $12 of exchange volume that occurred in HYG, only $1 of bonds may have ultimately traded as a result of creation/redemption activity. This ratio illustrates why investors are often able to execute high yield transactions more efficiently through HYG than individual bonds: 92% of all investor trading activity during this period occurred on exchange, rather than the less liquid, more costly underlying OTC bond market.

In Figure 2, we can see that during the period covering May 1st through July 5th, average daily volume soared to $538 million. There were five days in which HYG traded over $1 billion. As many investors were moving out of the high yield market during this period, we saw a predominance of selling activity on the exchange, which resulted in increased share redemptions from HYG. If we examine the dollar exchange volume for HYG on days in which actual redemptions occurred over this entire period, we find that the ratio was roughly 6:1 (total exchange volume of $13.4 billion vs. $2.3 billion in actual fund redemptions). In other words, for every $6 of trading activity on exchange, only $1 resulted in redemption activity that could impact the OTC bond market. In Figure 3 (next page) we can see how this ratio has moved through time. Even on the largest trading days during 2013, the ratio remained high.
Analyzing the “Tapering Selloff” – Fund Flows (continued)

On May 29th, the first day that HYG traded over $1 billion, we saw $1.03 billion of exchange volume and only $180 million of redemptions, a ratio of ~6:1. This highlights the trading efficiency that HYG provided, even in a market that saw pronounced outflows from HY ETFs and mutual funds. In other words, buyers and sellers were able to meet and cross $848.5 million of HY exposure on exchange away from the OTC market, while only residual selling of $180 million resulted in actual redemptions and potential OTC bond transactions. We observed a similar pattern on other large volume days (Figure 4 below).

This is an important structural benefit of the ETF that we highlighted in the first piece that is absent from other pooled vehicles. As hypothesized, the exchange did indeed provide a significant buffer between selling pressure and the underlying OTC market. As OTC liquidity became challenged, exchange liquidity accelerated and provided investors with another medium in which to transfer risk.

<table>
<thead>
<tr>
<th>Date</th>
<th>Redemptions ($MM)</th>
<th>Exchange Volume ($MM)</th>
<th>Secondary to Primary Ratio</th>
<th>Amount Crossed on Exchange ($MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/29/2013</td>
<td>-$180.06</td>
<td>$1,028.63</td>
<td>5.71</td>
<td>$848.57</td>
</tr>
<tr>
<td>6/3/2013</td>
<td>-$216.15</td>
<td>$1,320.47</td>
<td>6.11</td>
<td>$1,104.32</td>
</tr>
<tr>
<td>6/6/2013</td>
<td>-$64.57</td>
<td>$1,088.42</td>
<td>16.86</td>
<td>$1,023.85</td>
</tr>
<tr>
<td>6/20/2013</td>
<td>$0.00</td>
<td>$1,009.32</td>
<td>N/A</td>
<td>$1,009.32</td>
</tr>
<tr>
<td>6/24/2013</td>
<td>-$18.17</td>
<td>$1,079.23</td>
<td>59.39</td>
<td>$1,061.05</td>
</tr>
</tbody>
</table>

Sources: BlackRock and Bloomberg, as of 7/31/13.
Analyzing the “Tapering Selloff” – Price Discovery

In our original piece, we developed a framework for the likely price behavior of HYG vs. other instruments including the high yield index (as proxied by the Barclays US High Yield Index), the on-the-run 5-year high yield CDX contract, and closed end funds (as proxied by HYT, a BlackRock closed-end HY fund). We posited that, under periods of stress:
- HYG would likely trade at a discount to NAV as it exhibits price discovery vs. OTC bond prices;
- HYG would lie somewhere between the Index and a closed-end fund; and
- HYG would correlate well with HY CDX. CDX is another instrument that tends to exhibit rapid price discovery, since the on-the-run contract trades much more than its underlying single name constituents.

Figure 5 (below) validates this conceptual framework. As the selloff accelerated, HYG tended to trade below the slower pricing index but above the closed end fund. We would expect the closed-end fund to decline more rapidly in a selloff because of fund leverage and the fact that an arbitrage vs. the underlying bonds is not actionable due to the absence of the creation/redemption mechanism that is present in the ETF. Finally, HYG exhibited a correlation of 0.79 with CDX.HY.

---

Analyzing the “Tapering Selloff” – Price Discovery (continued)

The most interesting aspect of HYG’s behavior during this period of volatility was price discovery. As discussed, liquid fixed income ETFs have been shown to exhibit leading behavior vs. underlying cash bond indices. This leading behavior tends to become more pronounced during periods of market dislocation as liquidity in the ETF accelerates while liquidity in the underlying OTC market becomes more asymmetric. This difference in the speed of price discovery is often visible in the form of ETF “discounts” to NAV. As we have posited, the appearance of discounts is often more reflective of lagged pricing in cash bond indices and NAVs rather than true dislocations between the ETFs and “fair value”. This phenomenon can be observed when we examine the recent trading behavior of HYG and frequently traded fund holdings.

Figure 6 (next page) illustrates the behavior of HYG’s market price, HYG’s NAV, and a subset of HYG’s fund holdings over the 9-day period from 6/18/13 to 6/28/13, which was a period of significant volatility in the high yield market. The HYG fund holdings selected were the most actively traded bonds held in HYG over the period (i.e., those bonds which traded each day over the period). They represent approximately 10% of the total number of fund positions. Two observations may be made. First, the chart reveals that the price behavior of the more frequently traded holdings was more in line with HYG’s market price than HYG’s NAV, reinforcing the concept that liquidity (whether expressed on exchange or OTC) leads to more rapid price discovery. Second, visual inspection of the chart reveals that HYG’s leading behavior was evident in this period even with respect to the more frequently traded holdings. HYG’s market price provides a powerful signal with respect to where the portfolio as a whole – including less liquid holdings – is valued, particularly during periods of elevated volatility.
## Conclusion

In a prior publication, "HY ETF Behavior in Stressed Markets", we suggested the following:

- Unlike conventional pooled vehicles, HY ETFs are not “forced sellers”. Rather redemptions usually only occur in the context of actionable trades in the bond market.
- Unlike conventional pooled vehicles, HY ETFs actually have access to a buffer between sellers and the OTC bond market: the exchange.
- Even during stressed markets, HY ETFs trade in context with mutual funds, closed end funds, CDX and other high yield exposure vehicles. Differences in price performance are explainable by the differences in the vehicle structures.
- Because all of the fund holdings are implicitly trading on exchange through the ETF wrapper while many may not be trading in the OTC market, the ETF market price can be a source of price discovery for the underlying OTC market.

The ratio of exchange volume to actual redemptions for HYG was roughly 6:1. HYG also behaved very much in line with the framework outlined in the prior publication and, as expected, provided robust price discovery.

The behavior of HYG during this most recent bout of market stress, in conjunction with other periods of elevated volatility (e.g., 2011 US Treasury downgrade, 2008/2009 Financial Crisis) serves as further evidence that the ETF structure – even in less liquid markets – can be a robust vehicle for managing and transferring risk. It is because of these exchange liquidity and price discovery attributes that liquid fixed income ETFs, such as HYG, have become a go-to indicator of cash bond market movements.

---

4. HYG market price based on Bloomberg closing prices; NAV as reported by BlackRock and Bloomberg. Prices for frequently traded bonds consist of the last trade of the day (in order to better align timing with the closing market price and NAV of HYG) for a transaction (buy or sell) of $1MM face value or greater as reported by TRACE. Prices were then weighted and normalized by the security’s representative weight in HYG.
Why iShares?

- **Professional quality**—iShares delivers quality products that can help you navigate today’s volatile markets.

- **Individual choice**—As your partner, iShares helps you execute investment ideas with insights and support.

- **Responsible innovation**—iShares is an industry leader in making investing clear, fair, and efficient for you.

Carefully consider the iShares Funds’ investment objectives, risk factors, and charges and expenses before investing. This and other information can be found in the Funds’ prospectuses and, if available, summary prospectuses, which may be obtained by calling 1-800-iShares (1-800-474-2737) or by visiting www.iShares.com. Read the prospectus carefully before investing.

Investing involves risk, including possible loss of principal.

Bonds and bond funds will decrease in value as interest rates rise and are subject to credit risk, which refers to the possibility that the debt issuers may not be able to make principal and interest payments or may have their debt downgraded by ratings agencies. High yield securities may be more volatile, be subject to greater levels of credit or default risk, and may be less liquid and more difficult to sell at an advantageous time or price than higher-rated securities of similar maturity.

Shares of funds are bought and sold at market price (not NAV) and are not individually redeemed from the Fund. Brokerage commissions will reduce returns. Market returns are based upon the midpoint of the bid/ask spread at 4:00 p.m. eastern time (when NAV is normally determined for most funds) and do not represent the returns you would receive if you traded shares at other times.

Information on the BlackRock Corporate High Yield Fund VI is provided strictly for illustrative purposes and should not be deemed an offer to sell or a solicitation of an offer to buy shares of any funds or security other than the iShares Funds that are described in this material. Although market makers will generally take advantage of differences between the NAV and the trading price of iShares Fund shares through arbitrage opportunities, there is no guarantee that they will do so. Investment comparisons are for illustrative purposes only and are not meant to be all-inclusive. To better understand the similarities and differences between investments, including investment objectives, risks, fees, and expenses, it is important to read the products’ prospectuses or other offering documents.

The iShares Funds are not sponsored, endorsed, issued, sold or promoted by Markit Indices Limited; nor does this company make any representation regarding the advisability of investing in the Funds. BlackRock is not affiliated with the company listed above.

The iShares Funds are distributed by BlackRock Investments, LLC (together with its affiliates, “BlackRock”).

©2013 BlackRock. All rights reserved. iSHARES and BLACKROCK are registered trademarks of BlackRock. All other marks are the property of their respective owners.

Not FDIC Insured • No Bank Guarantee • May Lose Value