Title
Essays on Exchange Traded Notes

Author
Johnson, Brian A.

Publication Date
2016

Peer reviewed|Thesis/dissertation

Essays on Exchange Traded Notes

by

Brian A. Johnson

A dissertation submitted in partial satisfaction of the
requirements for the degree of
Doctor of Philosophy

in

Business Administration

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Gustavo Manso, Chair

Professor Dmitry Livdan

Professor Prasad Krishnamurthy

Summer 2016

Essays on Exchange Traded Notes

by

Brian A. Johnson

Abstract

Essays on Exchange Traded Notes

by

Brian A. Johnson

Doctor of Philosophy in Business Administration

University of California, Berkeley

Professor Gustavo Manso, Chair

Exchange traded products ("ETPs") have been experiencing tremendous growth as a class of financial products for the past twenty years. One of the more recent innovations in the ETP market is the exchange traded note ("ETN"), which first came into existence in 2006. An ETN is an unsecured debt liability of the issuing financial institution that provides an investor economic exposure to a variety of asset classes, trading strategies, and markets with the convenience that comes with trading on an exchange. As the ETN market has grown, a number of phenomena have developed that pose interesting asset pricing questions. The chapters in this dissertation will describe ETNs and the ETN market, highlight a variety of stylized facts about ETNs, and provide an explanation for one of the most prominent ETN puzzles.

The first chapter provides a detailed description of ETNs as a financial product, including an outline of their defining institutional features. The growth of the ETN market from the inception of the first product in June 2006 to a $23 billion market by the end of 2013 is documented throughout the chapter. Since financial industry references and discussions of ETNs often comingle ETNs with exchange traded funds ("ETFs"), the chapter offers a comparison of ETNs and ETFs, highlighting key similarities between the two classes of ETP and, more importantly, the key differences. A main contribution of this chapter is a documentation of the "ETN premium puzzle." As derivatively-priced products, the market price of an ETN should align with its fundamental value. This chapter shows that on average the market prices of ETNs exceed their fundamental values by 31 basis points with certain individual ETNs trading at premiums well above 100 basis points. ETNs trading at a discount are far less likely and the absolute magnitude of discounts are far lower than those of premiums. Collectively, these stylized facts constitute the "ETN premium puzzle."

The second chapter presents a number of selected ETN case studies that motivate a preliminary explanation for the ETN premium puzzle. The first case study focuses on the ETNs that were issued by Lehman Brothers. As unsecured debt obligations of Lehman Brothers, those ETNs suffered substantial losses as a result of Lehman's failure. The case

study highlights that two of the three Lehman ETNs continued to trade at premiums up until the day of bankruptcy despite the generally increasing market concern about Lehman's solvency. The chapter also uses the Lehman failure to study the ETN market's general consideration of counterparty credit risk in ETN pricing, finding that the market became more attentive to the credit risk of ETNs after the failure, but that such attention did not last beyond a couple months. The chapter also uses case studies to demonstrate the effects of the two most significant factors that explain the ETN premium puzzle: (i) the suspension of new share creation by the issuer and (ii) the degree of competition that an ETN faces in providing exposure to its targeted asset class or market. The first factor serves as a limit to arbitrage, while the second factor contributes to the overall demand for the ETN.

The third chapter presents a full explanation of the ETN premium puzzle. The chapter motivates the story of the explanation through the noise trader / arbitrager framework of De Long, et al. (1990) and Shleifer and Summers (1990). As applied to the ETN market, it is more appropriate to label *noise traders* as *demand traders*, since the noise trader definition presumes irrationality, while in the ETN context, there are rational non-arbitrageur market participants. The results of this chapter show that many of the institutional features of ETNs lead to substantial limits to arbitrage, which alone explain much of the ETN premium puzzle. The chapter conducts a cross sectional regression of ETN arbitrage speeds (i.e. the daily error correction rate for ETNs with stationary premiums) on various factors that limit arbitrage, showing which factors weaken the arbitrage mechanisms the most. The chapter then adds a number of factors that account for the demand of ETNs. In a panel regression that combines the limits to arbitrage with the demand factors, the chapter provides a fuller explanation of the ETN premium puzzle.

Chapter 1

Exchange Traded Notes: A Survey and Market Overview

1.1 Introduction

The menu of financial products available to investors has exploded over the past twenty years. Financial product innovation has led to the growth of a number of novel securities, including structured products and exchange traded products ("ETPs"). ETPs are a class of financial product that trade on exchanges and are derivatively priced, deriving fundamental value from an underlying index or investment security, such as a commodity, currency, interest rate, or equity product. Exchange traded products have experienced particularly significant growth over the past twenty years, mostly as result of the popularity of one class of ETPs, exchange traded funds ("ETFs"). ETFs have grown from 113 funds with $102 billion of net assets in 2002 to 1,675 funds with $1.7 trillion of net assets in 2013.[1] Industry experts estimate that the ETP industry could grow to $15.5 trillion by 2023 and overtake the mutual fund industry in aggregate market capitalization.[2] Along with the growth of ETFs, another growing class of ETPs is the exchange trade note ("ETN"). As the younger and smaller cousin of ETFs, ETNs have not received as much attention in the literature, but present a number of interesting open questions. This chapter will be an introduction to this fledgling financial product.

Exchange traded notes first came into existence in 2006 with the creation of two products issued by Barclays. Over the following seven years, the ETN market ballooned to over 200 distinct ETN products, constituting an aggregate market capitalization of $23 billion.[3] While the ETN market is still much small than its ETF counterpart, by comparison ETFs were first introduced in 1993 and did not reach $20 billion in market capitalization

---

[1] Investment Company Fact Book 2014 at 56.

[2] Forecast by ETF.com

[3] As of 12/31/2013

until 1999. Therefore, while the ETN market is the younger and much smaller of the two ETP markets, it is growing rapidly and may experience a similar “hockey stick” growth pattern as its ETP cousin going forward. The growing importance of ETNs as both an asset class, as well as a source of funding for financial institutions, makes them of particular importance for study. As such, the ETN market is ripe for in depth examination and could prove a formidable asset class in years to come. This chapter provides a survey of ETNs as a financial product and aims to further the relatively sparse academic literature on exchange traded notes by discussing the various institutional features of the ETN structure as well as highlighting stylized facts about the market pricing of ETNs over the first seven years.

In general, ETNs provide an investor many of the same benefits as ETFs provide. ETNs given investors exposure to a variety of asset classes, indices, and trading strategies, including access to otherwise segmented markets, with all the conveniences and efficiencies of trading on a national exchange. In this way, ETNs along with all ETPs combine the attractive features of open-ended mutual funds (e.g. a mechanism for the creation and redemption of units of the fund or product) with the trading benefits of closed-end funds by trading continuously throughout the day on exchanges, unlike open-ended mutual funds which only trade once per day. Another attractive feature of ETPs over mutual funds is that the exchange trading allows ETPs to be sold short and purchased on margin. As part of the generalized class of ETPs, ETFs and ETNs both share these attractive features; however, the two products are also structurally different from each other with important distinctions that impact their respective markets and should be considered by investors. First and foremost is the fact that ETNs technically are not separate investment vehicles at all, but are debt products of the issuer. While an ETF uses the funds of the ETF investors to purchase and hold the appropriate underlying securities for purposes of that ETF’s objective, ETNs purchase and hold nothing. ETNs are debt securities. More specifically, ETNs are senior unsecured debt of the issuing financial institution (e.g. Barclays) in which the debtor has contractually promised to make a payment on the debt at maturity, the principal amount of which fluctuates with a reference index. ETNs contrast significantly with ETFs, which are primarily investment companies that purchase and hold underlying securities and issue shares to investors that represent an undivided interest in the ETF’s portfolio of securities.[4] ETN’s have no portfolio of securities. The investor in an ETN is therefore simply an unsecured creditor of the issuing financial institution, as opposed to an investor in an ETF who is an equity investor in a legally separate investment company with ownership rights to a fractional share of the underlying securities. With such vastly different structures and institutional features, the risks of holding an ETN are quite different from holding an ETF, despite the fact that investors in each case are primarily seeking inexpensive and efficient exposure to an asset

[4] ETFs can also be structured as trusts that are also registered under the Investment Company Act of 1940.

class or index with general indifference to the actual structure. Even the Wall Street Journal continues to comingle ETNs with ETFs in its daily ETF market data release (e.g. "ETF Gainers, Decliners and Most Actives" contains ETNs).[5]

Given the important structural distinction between ETNs and ETFs, this chapter provides a comparison of the two financial products. A detailed history and overview of the ETN market is also provided from the inception date of the first product through the end of 2013. A primary contribution of this chapter is the discussion of the pricing of ETNs. The fundamental value of an ETN is its indicative value, similar to the net asset value of an ETF. The indicative value represents the principal amount owed by the issuer to the noteholder at any given point in time. However, the market price of an ETN is determined by secondary market forces and can trade at a premium or discount to the indicative value. Given the counterparty risk inherent in ETNs as unsecured debt securities, the expectation is that ETNs would typically trade at a slight discount to the indicative value to take account of the credit risk. This chapter examines the trading of ETNs from the inception of the industry in June 2006 through December 2013, highlighting a number of empirical facts and collectively representing an ETN pricing puzzle:

(1) Overall ETNs trade at an average daily premium of 31 basis points over their indicative value with many ETNs trading at average daily premiums above 50 basis points. Conversely, of those ETNs that trade at average daily discounts, none trade below 40 basis point discounts and only one trades at a discount below 30 basis points.

(2) Average daily premiums of ETNs vary across issuers of ETNs and across asset classes of ETNs. Volatility-based ETNs trade at the highest average daily premium at 61 basis points and currency-based ETNs trade at the lowest average daily premium at -16 basis points (i.e. a discount). Currency-linked ETNs are the only asset class to trade at an average daily discount.

(3) Premium percentages are persistent with a daily autocorrelation of 0.94 at a 1-day lag and 0.89 at a 4-day lag. Premium levels are less persistent with a daily autocorrelation of 0.67 at a 1-day lag and 0.49 at a 4-day lag.

(4) Trading patterns in the ETN market introduce tracking error for ETNs that would otherwise be absent by design. Overall, the daily volatility of an ETN's indicative value accounts for only 95% of the daily volatility of the ETN's market price, meaning 5% of the volatility is due to the daily change in premium, thus introducing significant tracking error. Minimized tracking error should result in a volatility

[5] http://www.wsj.com/mdc/public/page/2_3052.html

contribution much closer to 100% with premium variation contributing almost nothing.

The rest of the chapter proceeds as follows: Section 1.2 gives a review of the prior literature on the ETN market. Section 1.3 provides a structural and institutional comparison of ETNs and ETFs. Section 1.4 describes the history of the ETN market and provides a more current overview. Section 1.5 describes the collections of the ETN pricing data. Section 1.6 gives the summary statistics of ETN pricing and introduces a number of stylized facts. Section 1.7 discusses additional institutional features of ETNs. Section 1.8 concludes.

1.2 Prior Literature on ETNs

The current literature focusing on exchange traded notes is relatively sparse. Wright et al. (2010) is the first to provide an introduction to ETNs, outlining some of the defining characteristics of ETNs, providing a few examples of ETNs, and giving brief summary statistics of the ETN market up to that point. Diavatopoulos et al. (2011) examine ETN prices, finding that many ETNs trade at a premium to their indicative value. In this chapter, I also study and confirm the indicative value-price puzzle and contribute to the literature in a couple respects. First, the summary statistics in Diavatopoulos et al. (2011) on average premiums in the ETN market cover June 2006 through December 2009. This chapter significantly expands the examination window, determining ETN premiums from June 2006 through December 2013, thus providing an updated and richer data set. Second, I believe my method for calculating ETN premiums may be more accurate than the method employed in Diavatopoulos. To determine the premium of an ETN at a given time, it is necessary to compare an ETN's market price with its contemporaneous indicative value. Indicative values are published every 15 seconds throughout the trading day concluding with a closing indicative value at the end of the trading day. Therefore, closing indicative values should be compared to closing market prices. It is the determination of the closing market price where my method differs from Diavatopoulos. For completeness, I replicated the June 2006-2009 summary statistics outlined in Diavatopoulos and discovered that the authors calculated premiums using an ETN's published closing price as the closing market price. The problem with this is that the published closing price is the last trade price of the ETN and may be relatively stale for purposes of calculating premiums and discounts, particularly for ETNs that do not trade frequently. Given the modest liquidity of most ETNs, there are many instances of the last trade occurring many minutes prior to the market close, while the indicative value continues to fluctuate. For example, the last trade of XYZ may have been $10.05 at 3:57pm when the indicative value was $10.06. If no trade occurs again before the close, then the published closing price will be $10.05. However, it may be that the indicative value declined in that time and closed at $10.02. The Diavatopoulos method would show a premium of $0.03, even though the ETN in fact traded at a discount. Therefore, in those cases the published closing price should not be compared to the closing indicative value calculated at the market close.[6] It is my belief that the midpoint of the closing bid and ask quotes of an ETN is a better indicator of the market price of the ETN at the close. While matching closing quotes with the closing indicative value is more time consuming from a data collection perspective, I believe using the midpoint of the ETN at close ultimately captures a more accurate look at ETN premiums.

Since ETNs are senior unsecured debt of the issuer, it is important to consider counterparty risk in the pricing of ETNs. Cserna et al. (2013) examine the role of counterparty risk as a risk factor in ETNs from both a normative and positive perspective, finding both that a significant risk of default should be priced into ETNs but empirically the market fails to appropriately account for such risk. This paper expands upon the analysis conducted in Cserna et al. (2013) by looking at a broader data set – Cserna et al. (2013) considers 17 ETNs – and by examining how default-risk as a price factor evolves over time in Chapter 2. For example, I examine whether the Lehman Brothers bankruptcy served as an inflection point for the pricing of credit risk. Pahl (2012) examines the tax treatment of ETNs, including a discussion of various tax-related issues. Alexander and Korovilas (2012) provide an examination of volatility-based ETNs and Harper (2009) examines various issues revolving around currency-based ETNs. Finally, Geman et al. (2012) examine a sample of precious metal-ETNs as a comparison with precious-metal ETFs.

1.3 A Comparison of ETNs and ETFs

The popularity in ETFs has arisen in part due to their providing a relatively low-cost method for investors to gain access to a particular asset class or segmented market. For example, the most heavily-traded ETF, the State-Street-sponsored SPY, known as "spiders" allows investors exposure to the S&P 500 index without purchasing every stock in the index individually. The SPY ETF is a registered investment company, regulated under the 1940 Investment Company Act. The SPY investment company purchases and holds shares of the underlying S&P 500 equities and issues SPY equity shares to investors that represent an undivided interest in the assets of the fund, which are the ETF shares that trade on exchanges. As the value of the underlying assets fluctuate, the value of the holdings of the SPY ETF fluctuate correspondingly along with the fundamental value of a SPY ETF share (the net asset value or "NAV"). In this manner, the value of the SPY ETF is highly correlated with the S&P 500 index, providing investors in SPY the desired economic exposure to the S&P 500 index. Investors can trade shares of SPY on national stock exchanges, such as the NYSE, with the same conveniences that accompany trading

[6] It would be possible to determine the time of the last trade and compare the indicative value of the ETN at that same time, but this was not done.

in NYSE securities. These conveniences include low transactions costs, high liquidity, and the ability to sell short and purchase on margin.

ETNs also provide investors with exposure to a particular asset class or access to an otherwise segmented market with the same trading convenience and efficiency as ETFs provide. For example, one of the most heavily traded ETNs, the iPath MSCI India Index ETN (ticker: INP) issued by Barclays, allows investor exposure to an underlying index that tracks the top 71 companies by market capitalization on the National Stock Exchange of India.[7] INP provides convenient exposure to a segmented Indian equity market that presents significant barriers to entry for foreign participants. Units of INP are listed on the NYSE and trade in the same manner as other NYSE securities, similar to the shares of an ETF. However, the similarity between ETNs and ETFs ends there. As discussed above, ETNs are not registered investment companies, but rather are senior unsecured debt of the ETN issuer. While most ETFs are regulated under the 1940 Investment Company Act,[8] ETNs are regulated as debt securities registered under the 1933 Securities Act. A unit of INP does not represent an undivided interest in the underlying securities that make up the index. Instead, a unit of INP is an unsecured senior debt claim on Barclays Bank, that pays no interest, but whose face value fluctuates with the movements in the equity index tracking the selected companies on the National Stock Exchange of India.

The different structures of ETFs and ETNs have important implications for the investor upon the failure of the ETF sponsor or the ETN issuer. First consider the case of the failure of an ETF sponsor (note, the ETF itself does not fail, but rather the management firm). If State Street Global Advisors were to enter bankruptcy, the SPY ETF that it sponsors would largely be unaffected as the ETF is a separate legal entity with direct ownership of the underlying assets, unconnected to the sponsoring firm, State Street, despite the licensed name. The board of directors of the SPY investment company would merely find a new sponsor to manage the operations, perhaps becoming the Fidelity-sponsored SPY ETF. SPY ETF investors would suffer little, if any, losses since the underlying assets owned by the ETF have been unaffected. Alternatively, consider the case of the failure of an ETN issuer. If Barclays were to enter bankruptcy, the investors in its INP ETN would likely lose a substantial portion of their investment, since a unit of INP would be reduced to an unsecured claim against Barclays's assets, treated *pari passu* with all general senior creditors of Barclays. INP investors would not have recourse to any underlying Indian equities, since there are no underlying assets backing the INP investment. While Barclays may have hedged its INP liabilities by purchasing the underlying equities for its own balance sheet, these assets are held on the Barclays balance

---

[7] As of 12/31/2013.

[8] According to ICI, 96% of ETF assets under management are regulated under the '40 Act. The remaining 4% are regulated by the CFTC or under the '33 Act. See Investment Company Factbook 2014.

sheet, not earmarked for INP investors. In this respect, any hedging done by Barclays is immaterial to the INP noteholders.

Another important institutional difference between ETFs and ETNs is the creation and redemption process for shares/units. ETFs make use of authorized participants, generally financial institutions with large balance sheets, who standby ready to create and redeem ETF shares. For creation of ETF shares, the authorized participant purchases the underlying basket of securities and exchanges the securities with the ETF for a new share. The redemption process is the reverse, whereby the authorized participant exchanges a share of the ETF for the underlying basket of securities. This creation and redemption process keeps the ETF "open-ended," similar to mutual funds and distinct from closed-end funds. It is an important arbitrage mechanism for keeping ETF market prices from deviating too far from the net asset value of the ETF. An ETN has a similar process for redemption, but not for creation. For redemption, ETN issuers typically mandate in the ETN prospectus that an investor can redeem ETN units directly with the issuer in exchange for the indicative value, subject to various rules including a redemption fee, a minimum number of units, and a lag between an investor's commitment to redeem and the finalization of the indicative value. For creation, the ETN issuer retains complete and sole discretion over new ETN units. An investor has no mechanism for mandating the issuance of new ETN units, in contrast to the authorized participant in the case of an ETF. Therefore, ETNs and ETFs are similar in regard to redemption, but quite different in regard to creation.

Based on the different structures of ETFs and ETNs, investors in each face vastly differing risks and are afforded significantly different protections. As illustrated in the prior examples, investment companies are distinct entities from their sponsor, so each ETF has a board of directors with fiduciary duties owed to ETF investors. Among other fiduciary duties owed by the board of directors to ETF shareholders, there is a responsibility of the board to ensure that only a reasonable fee is charged to the ETF shareholders by the ETF sponsors. While there is separate literature discussing the conflict of interests inherent in investment company boards of directors (since most investment company sponsors have de facto control of the board), the SCOTUS has recently ruled that boards of directors must ensure that sponsor fees are calculated at an arms distance.[9] Conversely, ETN investors do not have comparable protections. Since an ETN is simply a debt obligation of the issuer, an ETN investor is only afforded the protections of any debt holder. As with any debt holder, those protections are primarily enumerated in the debt security's prospectus through protective covenants. However, there are few covenants that provide any protection to ETN investors. The board of directors of the ETN issuer does not owe any fiduciary duties to the ETN holder other than would otherwise be owed to any debt holder. For the most part, fiduciary duties are only owed to debt holders when the debt issuer approaches insolvency, in which case the economic interests of debt holders begin to resemble that of equity holders. As compared to ETFs, ETNs have no requirement that fees

[9] *See* Jones v. Harris Associates, 2009.

be reasonable. Furthermore, there are no fiduciary duties owed to the ETN investors that would otherwise curb detrimental activity conducted by the issuer as a result of the inherent conflicts of interest.

ETFs and ETNs can also be distinguished by the tracking error of the product in relation to the underlying index. In many cases, an ETF does not directly replicate the exact components of the underlying index, but rather purchases a subset of assets that should be highly correlated with the index. However, given this imperfection, tracking error does arise for many ETFs. Some estimates have gauged ETF tracking error to be roughly 59 basis points across the ETF industry.[10] That is, the performance of the ETF's net asset value may deviate from the performance of the underlying index. In the case of ETNs, however, there is no such tracking error as the calculation of the indicative value of the ETN is directly linked to the underlying index. That being said, the volatility of the premiums and discounts experienced in the ETN market often exceed the 59 basis-point tracking error seen in the ETF market, effectively negating the ETN advantage in this respect. In addition, section 1.6 provides empirical evidence that counters the claim that ETNs are entirely devoid of tracking error.

A final distinction between ETNs and ETFs that weighs in favor of ETNs is the tax treatment of the products. In general, ETNs receive preferred tax treatment as opposed to their ETF counterparts. Other than currency-linked ETNs, all ETNs currently are characterized by the IRS as prepaid forward contracts, whereby gains and losses are treated as capital gains, taxable only upon the sale, redemption, or maturity of the ETNs. This favorable tax treatment allows investors to defer taxation on ETN holdings and pays taxes at a lower capital gains rate, rather than a higher ordinary income rate. Many ETFs, however, receive materially different tax treatment. Investors in commodity ETFs that purchase precious metals in the spot market are subject to higher ordinary income rates, while many energy ETFs that are structured as limited partnerships issue investors a schedule K-1 annually, requiring the ETF investor to pay ordinary income tax on any gains to the ETF each year. Similar suboptimal tax treatment is imposed on volatility ETFs, as opposed to volatility-linked ETNs. The one class of ETNs not treated favorably for tax purposes are currency-linked ETNs, which have been deemed by the IRS as debt instruments in which annual gains are considered as interest, subject to annual ordinary income tax. The material tax change for currency-linked ETNs occurred in December 2007, subsequent to the issuance of many currency-linked ETN products.[11]

---

[10] Anna Bernasek, In Exchange Traded Funds, a Variable Worth Watching, NY Times, Apr.6, 2013.

[11] IRS Revenue Ruling 2008-1, available at https://www.irs.gov/irb/2008-02_IRB/ar08.html.

1.4 History and Overview of the ETN Market

The first ETNs were issued by Barclays Bank PLC in June 2006: the iPath Dow Jones-UBS Commodity Index Total Return (ticker: DJP) and the iPath S&P GSCI Index Total Return (ticker: GSP).[12] DJP and GSP both offer investors exposure to broad-based commodities indices with diverse commodity components including energy (e.g. oil), precious metals (e.g. gold), industrial metals (e.g. copper), softs (e.g. sugar), livestock (e.g. cattle) and grains oilseeds (e.g. corn). Table 1.1 shows representative index weightings by sector for DJP and GSP. Barclays imposed an annual management fee on each ETN of 0.75% accruing daily. Each ETN had a maturity of 30 years from the date of issuance and pays no interest. With the issuance of these two notes, Barclays established the beginning of the ETN market in the US.

[12] DJP's tracking index has since changed names to the "Bloomberg Commodity Index Total Return"

Table 1.1
Sample Index Weightings for DJP and GSP ETNs

The table reports a sample of the index weightings for the components of the Dow Jones-UBS Commodity Index for DJP and for the S&P GSCI Index for GSP. The weightings are as of February 27, 2015 found on the iPath product website, ipathetn.com.

Bloomberg Commodity Index Total Return (ticker: DJP)	
Index Sector	Index Weighting %
Energy	34.55%
Grains Oilseeds	21.82
Industrial Metals	16.03
Precious Metals	15.96
Softs	7.02
Livestock	4.62

S&P GSCI Total Return Index (ticker: GSP)	
Index Sector	Index Weighting %
Energy	62.07%
Grains Oilseeds	12.39
Industrial Metals	9.07
Livestock	8.25
Softs	4.35
Precious Metals	3.86

By the end of 2006, Barclays had issued two more ETNs: the iPath S&P GSCI Crude Oil Total Return Index (ticker: OIL) and the iPath MSCI India Index (ticker: INP), resulting in an ETN market consisting of four actively traded ETNs with an aggregate market capitalization of $1.2 billion at the end of 2006. The INP ETN was groundbreaking in becoming the first ETN to give investors access to a previously unavailable segmented market, i.e. broad exposure to the Indian stock market, which historically has been difficult for foreign investors to access due to local restrictions. Unlike the other ETN products which did not provide unique exposure--investors could alternatively gain the exposure provided by the other ETNs to broad-based commodity portfolios and oil through existing ETFs or closed end funds--INP was the first product in the US to open access to investors to a *passive* index-linked investment in Indian equities.[13] As explained in further detail in Chapter 3, this exclusive exposure to the MSCI India Index likely caused INP to trade at

[13] Two closed-end funds, IIF and IFN, as well as a mutual fund, MINDX, existed at the time, but all three are actively managed funds.

significant premiums from its inception until the introduction of a competing ETF that replicated the same index.

Barclays issued four more ETNs in the beginning of 2007 and remained the sole issuer of ETNS until a second financial institution entered the ETN market in mid-2007. Bear Stearns issued the BearLink Alerian MLP (ticker: BSR) in July 2007 offering exposure to master limited partnerships (or "MLPs"), which are companies engaged in various business lines involving natural resources.[14] JPMorgan later assumed the liability for BSR ETNs when it purchased Bear Stearns in March 2008. However, JPMorgan delisted BSR in June 2009 after issuing its own MLP ETN in April 2009, the JPMorgan Alerian MLP Index (ticker: AMJ).

Table 1.2 illustrates the progression of the ETN market, listing the first ETN inception date for the fourteen financial institutions that have issued ETNs. Goldman Sachs was the third entrant to the ETN market in July 2007, issuing another broad-based commodity ETN, the Goldman Sachs Connect S&P GSCI Enhanced Commodity Total Return (ticker: GSC). The Swedish Export Credit Corporation, a state-owned financial institution backed by the government of Sweden, became the first multiple issuer of ETNs other than Barclays, issuing an equity ETN in August 2007 and four commodity ETNs in October 2007. Deutsche Bank entered the market in October 2007, followed by Lehman Brothers in February 2008, seven months before entering bankruptcy proceedings and providing the first instance of an ETN default. From mid-2008 until the end of 2010, no new ETN issuer emerged, which is understandable given the financial crisis that ensued during that time period in the U.S. In all, in the first four years of the existence of the ETN market, thirteen financial institutions issues ETNs. After RBS issued its first ETN in December 2010, no new ETN issuers entered the market through the end of 2013.

[14] Alerian defines the MLP business lines to be (i) transportation, (ii) storage, (iii) processing, or (iv) production of natural resources.

Table 1.2
Issuer Entrance to ETN Market

This table presents the progression of new entrants to the ETN market. Listed are the inception date for the first ETN of each issuer along with the ETN ticker and the asset class associated with the ETN's underlying index. In some cases, the ETN issuer launched multiple ETNs as part of their entrance to the market, so each ETN is listed for that issuer. Data is as of December 31, 2013.

Issuer	Inception of First ETN	Ticker	Asset Class
Barclays	Jun 6, 2006	DJP	Commodity
		GSP	Commodity
Bear Stearns	Jul 20, 2007	BSR	Equity
Goldman Sachs	Jul 31, 2007	GSC	Commodity
Swedish Export Credit Corp	Aug 2, 2007	EEH	Equity
Deutsche Bank	Oct 18, 2007	WMW	Equity
Lehman Brothers	Feb 20, 2008	EOH	Commodity
		PPE	Equity
		RAW	Commodity
Morgan Stanley	Mar 17, 2008	CNY	Currency
		INR	Currency
UBS	Apr 1, 2008	FUD	Commodity
		UAG	Commodity
		UBC	Commodity
		UBG	Commodity
		UBM	Commodity
		UBN	Commodity
		UCI	Commodity
		USV	Commodity
Credit Suisse	Apr 2, 2008	GWO	Equity
JPMorgan	May 22, 2008	JFT	Equity
HSBC	Jun 10, 2008	LSC	Commodity
Citigroup	Nov 15, 2010	CVOL	Volatility
Royal Bank of Scotland	Dec 7, 2010	TRND	Equity

By the end of 2013, the ETN market had grown to 204 active ETNs with an aggregate market capitalization of $23 billion. Figure 1.1 illustrates the evolution of the ETN market from inception through 2013, showing a steady increase in aggregate market capitalization for the ETN industry. The largest growth in aggregate ETN market capitalization was seen in 2013, in which $6.8 billion was added to the industry with the second largest increase coming in 2010 at $5.6 billion. The leanest year for market capitalization growth was 2008, which saw an ETN market contraction of $449 million despite the fact that the number of ETNs outstanding grew from 23 to 80 during 2008, the most new issuances in any year. However, all of the 57 ETNs issued in 2008 were issued prior to Lehman Brothers' collapse in September 2008.

Figure 1.1
Size of ETN Market by Number and Market Capitalization

This figure presents a times series of the size of the ETN market by number of ETNs and total market capitalization. The bar graph illustrates the number of ETNs in existence for the given time period (left axis). The line graph illustrates the aggregate market capitalization of the ETN industry for the given time period (right axis). The market capitalization is the total number of ETN units multiplied by the indicative value of the ETN.

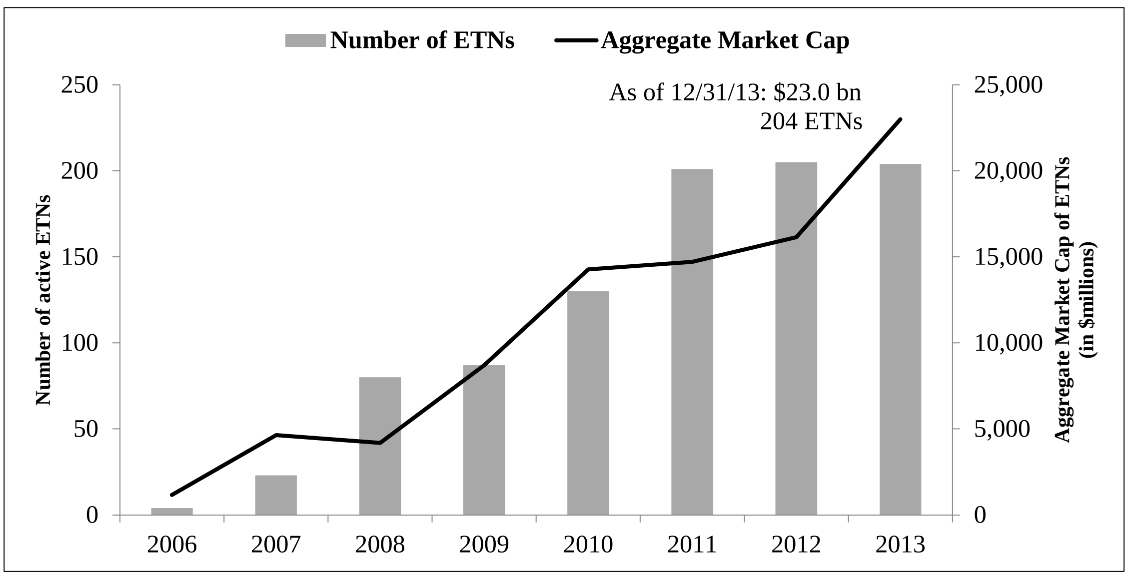


Table 1.3 shows a breakdown of the ETN market by issuer and by asset class, listing for each (i) the total number of ETNs outstanding, (ii) the market capitalization broken down by total amount, percentage of the overall market, and average per ETN, and (iii) the average management fee charged to investors. Clearly illustrated is that European financial institutions dominate the ETN market as issuers of ETNs with Barclays alone accounting for eighty ETNs and an aggregate market capitalization of $8.2 billion or nearly 36% of the total $23 billion ETN market. Deutsche Bank has 35 active ETNs listed, but its total market capitalization of the ETNs only amount to $820 million or 3.6% of the industry total. This contrasts with UBS's 32 ETNs that account for $4 billion or 17.4% of the industry total. The fact that UBS's ETNs are larger on average than Deutsche Bank's by a factor of five suggests a greater market demand for the UBS ETNs. As a group, European financial institutions constitute 192 of the 204 ETNs that were active as of the end of 2013, accounting for $16.7 billion of the $23 billion total market capitalization, or 73%. U.S.

financial institutions constitute the remainder of the market with JPMorgan dominating U.S. issuers with its single ETN accounting for $5.9 billion of market capitalization (the other U.S. issuers—Citigroup, Goldman Sachs, and Morgan Stanley—only account for $425 million of market capitalization in aggregate).

Table 1.3
Summary Statistics of ETN Market by Issuer and Asset Class

This table present summary statistics of the ETN market by issuer in panel A and by asset class in panel B. Column 1 shows the total number of unique ETNs issued by the respective category. Columns 2-4 give market capitalization statistics with the column 2 showing the aggregate market capitalization, column 3 showing the percentage of market capitalization relative to the entire ETN market, and column 4 showing the market capitalization per unique ETN. The final column shows the average fee charged across ETNs in the respective category.

		Market Capitalization			
	No. of ETNs	Total	% of all ETNs	Avg	Avg Fee
Panel A: Issuer					
Barclays	80	$8,186,886	35.6%	$102,336	0.77%
Deutsche Bank	35	820,237	3.6	23,435	0.75
UBS	32	4,008,848	17.4	125,277	0.72
Credit Suisse	25	1,968,867	8.6	78,755	1.24
Royal Bank of Scotland	13	536,577	2.3	41,275	0.97
Swedish Export Credit Corp	7	1,153,092	5.0	164,727	0.75
Morgan Stanley	6	144,218	0.6	24,036	0.67
Goldman Sachs	2	252,966	1.1	126,483	1.10
Citigroup	2	28,562	0.1	14,281	1.05
JPMorgan	1	5,863,275	25.5	5,863,275	0.85
HSBC	1	28,399	0.1	28,399	0.75
Panel B: Asset Class					
Commodity	100	$5,879,561	25.6%	$58,796	0.83%
Currency	13	110,198	0.5	8,477	0.68
Equity	56	14,785,523	64.3	264,027	0.82
MLP	12	8,957,847	39.0	746,487	0.86
Other Equity	44	5,827,677	25.3	132,447	0.81
Fixed Income	22	457,168	2.0	20,780	0.76
US Treasuries	12	307,167	1.3	25,597	0.78
Other Fixed Income	10	150,001	0.7	15,000	0.73
Volatility	13	1,759,475	7.7	135,344	1.10
Total	204	$22,991,926	100	$112,706	0.83%

Table 1.3 also shows the relative prevalence of ETNs by asset class. Commodity ETNs make up the largest number of ETNs with 100 of the 204 total being linked to commodity indices. Given that commodity ETNs enjoy preferential tax treatment over their ETF counterparts, it is not surprising that commodity ETNs have been the most popular issuance among financial institutions. However, equity-based ETNs are the largest asset class by market capitalization, constituting $14.8 billion of the $22.9 billion total, or 64%. Furthermore, within the class of equity ETNs, MLP ETNs account for nearly $9 billion of market capitalization across twelve tickers, giving MLP ETNs an average market cap of $746 million. Volatility ETNs have the second highest average at $135 million per ETN. Not surprisingly, the least prevalent ETN asset class is currency, making up only 0.5% of the total industry. This is likely due to the IRS's adverse tax ruling against currency ETNs in late 2007, in which the tax advantaged status of currency ETNs was terminated. The effects of this tax ruling on currency ETNs will be examined in more detail in chapter 3. Table 1.3 also highlights the average management fees charged across asset classes. Volatility ETNs have the highest average fee by a substantial margin at 110 basis points, arguably due to the significant frictions involved in investing in VIX futures as opposed to other asset classes. The least expensive ETN class is currency, again likely due to the unattractive tax treatment of currency ETNs and due to the efficiency with which large financial institution issuers can hedge their currency-ETN liabilities in the liquid currency markets.

As discussed above, ETNs have an advantage over ETFs in reducing tracking error. Tracking error can be particularly prominent in ETFs that seek to provide a leveraged position in an index, since such ETFs offer a leveraged return on a daily basis only, resulting in increased tracking errors over longer holding periods. Given that the inherent structure of ETNs eliminates tracking error entirely, leverage is featured relatively prominently in ETNs as it becomes a more attractive alternative to ETF counterparts. Although far from ubiquitous, leverage does factor into many ETN offerings. Therefore, an examination of ETNs based on the leverage offered provides insight into an important aspect of the ETN market. Table 1.4 shows a summary of the ETN market based on the leverage employed in the ETNs.

Table 1.4
Summary Statistics of ETN Market by Leverage Employed

This table present summary statistics of the ETN market by the level of leverage employed by the ETN. Column 1 shows the total number of unique ETNs issued by the respective category. Columns 2-4 give market capitalization statistics with column 2 showing the aggregate market capitalization, column 3 showing the percentage of market capitalization relative to the entire ETN market, and column 4 showing the market capitalization per unique ETN. The final column shows the average fee charged across ETNs in the respective category.

		Market Capitalization			
	No. of ETNs	Total	% of all ETNs	Avg	Avg Fee
No Leverage	138	$16,800,983	73.1%	$121,746	0.79%
2x Long	25	4,592,548	20.0	183,702	0.85
3x Long	13	322,084	1.4	24,776	0.99
1x Short	14	737,588	3.2	52,685	0.85
2x Short	7	253,024	1.1	36,146	0.74
3x Short	7	285,699	1.2	40,814	1.26
Total	204	$22,991,926	100%	$112,706	0.83%

Overall, 66 of the 204 ETNs (32%) offer leveraged exposure to the underlying index, constituting 27% of the total market capitalization of the ETN industry. As a percentage of the entire industry, this is much higher than the roughly 14% of ETFs employing leverage of any kind.[15] Most of the leveraged ETN products provide twice (2x) the exposure to a long position in the underlying index. In particular, 24 ETNs provide a 2x long position, 13 ETNs provide a 3x long position, 14 ETNs provide a 1x short position, 8 ETNs provide a 2x short position, and 7 ETNs provide a 3x short position. By market capitalization, 2x long products constitute $4.5 billion of market cap, or nearly 20% of the total ETN market. The remaining leveraged products in total only account for $1.7 billion of market capitalization, or 7.4%. As a result, the average market cap of 2x long ETNs at $187,272 is much higher than the other leveraged products ($52,685 for 1x short being the second highest). The average market cap of 2x long ETNs is also substantially higher than non-leverage ETNs, having a market cap of $121,746. Table 1.4 also shows the average fees for leveraged products. As expected, the greater the leverage employed, the higher the management fees for the ETN product. ETNs with 3x short leverage have the highest average fee of 1.26%, compared to 2x long ETNs with an average fee of 0.75%. The higher fees associated with greater leverage are likely due to the increased costs imposed on the issuer of hedging the leveraged exposures.

[15] Bloomberg ETF screener.

ETN Termination

Just as ETFs and mutual funds can be closed or liquidated, ETNs can also suffer the same fate. However, since ETNs are debt instruments, the closure of ETNs differs from the closure of investment companies. The closure of an ETN, often referred to as an early redemption, arises due to the callability of the debt instrument. The specific terms of the call option are outlined in the ETN's prospectus.

The call features of each ETN differ across issuers and across classes of ETNs issued by the same financial institution. As a result, ETN's can be called by the issuer under a variety of conditions. In the case most favorable to the issuer, some ETN terms give complete discretion to the issuer and can be called early at any point in time for any reason. The discretionary option that issuers retain to call an ETN early highlight the absence of a fiduciary duty owed to ETN noteholders. Other ETN prospectuses provide the issuer complete discretion to call the ETN after a specified amount of time, such as one year after the inception. For example, a series of UBS volatility ETNs with 30-year maturities issued in September 2011 gave UBS a call option on the notes that triggered after only 1 year. UBS did indeed exercise its call option on the entire series in September 2012, exactly one year after issuance.[16] Other ETNs include automatic termination provisions, under which the ETN is automatically called under certain conditions. The most prevalent condition is if the indicative value falls below a pre-determined level for an extended period of time. A number of ETNs also contain call options that are triggered in the case of an ambiguously defined "regulatory event." One such regulatory event occurred when the CFTC imposed position limits on certain commodity trading in 2009, thus inhibiting the ability of issuers to hedge against their ETN liabilities. Deutsche Bank's leveraged oil ETN, the PowerShares DB Crude Oil Double Long (ticker: DXO) was instantly too popular to survive, i.e. since Deutsche Bank was limited in its ability to hedge, it sought to reduce the market capitalization of DXO. As a result, Deutsche Bank declared that a "regulatory event" had occurred and it exercised its option to call the DXO notes, redeeming them in September 2009, despite the fact that the ability of the issuer to hedge is immaterial to the ETN investors.

As unsecured debt instruments, ETNs can also close as a direct result of the issuer's insolvency. The first ETNs to close did so as a result of Lehman Brothers' bankruptcy in September 2008. These three ETNs were the Opta Lehman Brothers Commodity Index Pure Beta Agriculture (ticker: EOH), the Opta S&P Listed Private Equity Index (ticker: PPE), and the Opta Lehman Brothers Commodity Index Pure Beta (ticker: RAW). Holders of these ETNs have been paid out as general unsecured creditors as part of the Lehman bankruptcy process. As illustrated in detail in chapter 2, investors in EOH, PPE, and RAW

[16] The series included long volatility-based ETNs (tickers: VXAA, VXBB, VXCC, VXDD, VXEE, and VXFF) and short volatility-based ETNs (ticker: AAVX, BBVX, CCVX, DDVX, EEVX, and FFVX); each had an inception date of Sept. 8, 2011 and were called on Sept. 7, 2012.

did not appear to adequately consider the default risk of Lehman Brothers in pricing the ETNs, even on the last trading day before it filed for bankruptcy.

ETNs can also be delisted from the exchanges, which is effectively an early termination, although without the accelerated tax implications. The first ETNs to close in this manner were a series of currency ETNs issued by Deutsche Bank in February 2008. The IRS had only recently issued its adverse tax ruling for currency ETNs in December 2007 (published in January 2008) prior to Deutsche Bank's issuance of new currency ETNs, suggesting that Deutsche Bank was unaware that an adverse ruling against its upcoming products was on the horizon. Given the resulting lack of demand for currency ETNs, the Deutsche Bank series only lasted until November 2008 when Deutsche Bank delisted them from the exchange.

Table 1.5 shows the number of ETNs that have been closed, terminated or delisted for any reason since the inception of the industry in June 2006. In total, 265 ETNs have been issued in the U.S. over the history of the ETN market. Of those 265, 61 have been closed or delisted prior to maturity. The average life of a terminated ETN is twenty months, suggesting that the issuer decides relatively quickly whether to maintain an ETN issue. The shortest life of an ETN prior to termination was 99 days, while the longest life of an ETN prior to termination was nearly 6 years. While ETNs have closed for a variety of reasons, listed above, given the relatively brief history of ETNs, no ETN has expired as a result of reaching maturity. Most ETNs have a maturity of 20 years, so the market is at least 10 years away from seeing an ETN maturing. The net result of the ETNs closures was an active ETN market of 204 issues as of the end of 2013.

Table 1.5
Terminated ETNs by Issuer and by Asset Class

This table presents summary statistics for the number of ETNs terminated or delisted by issuer in panel A and by asset class in panel B. Column 1 shows the number of active ETNs as of December 31, 2013. Column 2 shows the number of ETNs that had been terminated or delisted from an exchange as of December 31, 2013. Column 3 shows the percentage of terminated or delisted relative to the total number of ETNs issued. Column 4 shows the total number of ETNs issued as of December 31, 2013.

	No. of Active ETNs	Terminated / Delisted ETNs	% Terminated	Total No. Issued ETNs
Panel A: Issuer				
Barclays	80	11	12%	91
Citigroup	2	0	0%	2
Credit Suisse	25	12	32%	37
Deutsche Bank	35	9	20%	44
Goldman Sachs	2	0	0%	2
HSBC	1	0	0%	1
JPMorgan	1	4	80%	5
Lehman Brothers	0	3	100%	3
MacroMarkets	0	2	100%	2
Morgan Stanley	6	0	0%	6
Royal Bank of Scotland	13	0	0%	13
Swedish Export Credit Corp	7	0	0%	7
UBS	32	20	38%	52
Panel B: Asset Class				
Commodity	100	16	14%	116
Currency	13	5	28%	18
Equity	56	23	29%	79
MLP	12	1	8%	13
Other Equity	44	22	33%	66
Fixed Income	22	2	8%	24
US Treasuries	12	2	14%	14
Other Fixed Income	10	0	0%	10
Volatility	13	15	54%	28
Total	204	61	23%	265

UBS has terminated the most ETNs prior to maturity, having redeemed 20 of the 52 ETNs it has issued, or 38%. Credit Suisse has also terminated a relatively high percentage of its ETNs, redeeming 12 of the 37 (32%) it has issued. The largest ETN issuer, Barclays, has terminated 11 of the 91 ETNs (12%) it has issued since 2006. Table 1.5 also shows the number of terminated ETNs by asset class. Volatility-based ETNs have experienced the highest percentage of closure with 15 of 28 (54%) ETNs having been terminated. Non-MLP equity ETNs have also experienced substantial closures with 22 of 66 being terminated. Given the adverse tax treatment of currency ETNs, it would be expected that currency-based ETNs saw a wave of closures. However, currency ETNs fall in the middle with only 5 of 18 having been terminated. All 5 terminated currency ETNs were issued by Deutsche Bank as a series in February 2008, shortly after the IRS tax ruling, as described above. The other currency ETN issuers, Barclays and Morgan Stanley, have not terminated any currency ETNs.

1.5 Pricing Data

The intrinsic value of an ETN is known as its “indicative value” (IV), which is the current value of the note based on the reference index that it tracks less accumulated management fees owed to the issuer. The IV represents the liability of the issuer to the ETN holder at that moment, reflecting both the performance of the underlying reference index net of management fees and any financing fees. The IV of an ETN represents a value similar to the net asset value (NAV) of an ETF or mutual fund. The IV of ETNs are calculated by Bloomberg and disseminated every 15 seconds with a closing IV published at the end of the trading day.

The ETN data set was collected for 262 ETNs for the period beginning on the inception date of the first ETNs in June 2006 through the end of December 2013. Daily quotation data was collected from the Trade and Quote (TAQ) database. To obtain the closing national best bid and best offer (NBBO), I used a modified version of an NBBO algorithm provided by WRDS to extract the closing NBBO for each ETN. Using my modified algorithm, I collected the national best bid and best ask quotes as of 4:00pm (Eastern Time) for all ETNs over the specified time period. I also collected data from Bloomberg, including (i) the daily indicative value as of 4:00pm, (ii) the daily volume of shares traded, (iii) daily total shares outstanding, (iv) fees, (v) leverage amounts for the ETN, and (vi) minimum shares required to redeem each ETN with the issuer. Daily credit default swap prices for the ETN issuers were also collected from Bloomberg. These included CDS prices on the 5-year senior unsecured corporate bonds for Barclays, Citi, Credit Suisse, Deutsche Bank, Goldman Sachs, HSBC, JPMorgan, Lehman Brothers, Morgan Stanley, RBS, and UBS. CDS prices on the 5-year senior unsecured debt of the Swedish government was also collected since the Swedish Export Credit Corporation (SECC) is an ETN issuer backed by the Swedish government.

As mentioned above, the market price for an ETN may deviate from the ETN’s indicative value, such that the ETN trades at a premium or discount. For ease of notation, the premium/discount will simply be referenced as a premium, where a negative premium represents a discount. Unlike the methodology used in Diavatopoulos et al. (2011) which calculated ETN premiums based on the price of the last trade of the ETN, I used the midpoint of the closing bid and ask quotes as the closing market price for purposes of calculating the ETN premium. Using this methodology, I constructed daily premiums for each ETN.

In levels, the definition of the ETN premium is the following:

$$\text{Premium}_t = P_t - IV_t \qquad (1)$$

where P_t is the market price of the ETN, determined by calculating the midpoint of the bid and ask quotes for the ETN at time t and IV_t is the indicative value per note at time t.

As a percentage of the ETNs indicative value, the premium becomes:

$$\text{Premium }\%_t = \text{Premium}_t / IV_t = (P_t - IV_t) / IV_t \qquad (2)$$

It will often be most convenient to quote the ETN premium percentage in basis points, given the range of premiums. In that case the ETN premium becomes:

$$\text{Premium }\%_t \text{ (bps)} = (P_t - IV_t) / IV_t \times 10{,}000 \qquad (3)$$

Another version of the ETN premium was also calculated, which can be considered an arbitrage premium (the prior version will be considered the standard premium). Rather than calculating the daily premium for an ETN using the midpoint of the closing bid and ask prices, arbitrage premiums were calculated in the following manner:

$$\text{Arbitrage Premium}_t = \begin{cases} Bid_t - IV_t \text{ , if } Bid_t > IV_t \\ Ask_t - IV_t \text{ , if } IV_t > Ask_t \\ 0 \text{ , otherwise} \end{cases} \qquad (4)$$

where Bid_t is the closing bid price and Ask_t is the closing ask price. This version of the premium captures the arbitrage opportunity available in the market. While most of the results and subsequent analysis will focus on the prior standard version of the premium, inclusion of the arbitrage premium will illustrate that the premiums and discounts are not solely existing within the bid-ask spread.

1.6 Empirical Results

This section presents the various results of the ETN premiums and discounts across issuers and across asset classes. Table 1.6 shows the individual mean daily premiums for the top 5 ETNs by average premium and the bottom 5 ETNs by average premium. As illustrated in the top panel of the table, certain ETNs trade at substantial premiums. The iPath Dow Jones-UBS Natural Gas Subindex Total Return (ticker: GAZ) trades at the highest average daily premium at 814 basis points (8.14%) on average volume of 176,423 units daily. Two other ETNs trade at average daily premiums above 100 basis points: the VelocityShares 2x VIX Short-Term (ticker: TVIX) trades at a 416 basis point premium and the ETRACS CMCI Long Platinum Total Return (ticker: PTM) trades at a 112 basis point premium. The top five are rounded out by the PowerShares DB Agriculture Double Long (ticker: DAG) trading at an average daily premium of 97 basis points and the iPath MSCI India Index (ticker: INP) trading at an average daily premium of 67 basis points. Each of the positive average daily premiums in the top panel are significant at the 1% level.

The bottom panel of Table 1.6 illustrates the average daily premiums on the other end of the spectrum. In general, the results in the bottom panel clearly show that while some ETNs do trade at negative average daily premiums (i.e. discounts), the levels of discount are substantially lower than the levels of premiums seen in the top panel. The ETRACS CMCI Food Total Return (ticker: FUD) trades at the lowest average daily premium at -37 basis points on average volume of 5,272 units daily. However, the FUD average discount is only significantly different from zero at a 10% significance level. While FUD is the only ETN that trades at an average daily premium below -30 basis points, only two additional ETNs trade below -20 basis points: the Credit Suisse Commodity Rotation (ticker: CSCR) trades at a 29.9 basis point discount and the Morgan Stanley S&P 500 Crude Oil Linked (ticker: BARL) trades at a 29.59 basis point discount. The bottom five are rounded out by the ETRACS Monthly Pay 2x Leveraged Diversified High Income (ticker: DVHL) trading at an average daily discount of 15 basis points, significant at a 10% level, and the Market Vectors Renminbi/USD (ticker: CNY) trading at an average discount of 12 basis points, significant at a 1% level.

Table 1.6
ETN Premiums and Discounts

This table presents individual mean daily premiums for selected ETNs by premium percentage. Panel A shows the premiums for the ETNs that trade with a premium in the top 5 of all ETNs. Panel B shows the premiums for the ETNs that trade with a premium in the bottom 5 of all ETNs. Average daily trading volume for each ETN is also listed in the final column.

Ticker	Name	Issuer	Mean Premium (basis points)	Avg. Daily Volume
Panel A: Top 5 Premiums				
GAZ	iPath Dow Jones-UBS Natural Gas Subindex Total Return	Barclays	814.32***	176,423
TVIX	VelocityShares 2x VIX Short-Term	Credit Suisse	415.90***	2,551,248
PTM	ETRACS CMCI Long Platinum Total Return	UBS	111.92***	37,232
DAG	PowerShares DB Agriculture Double Long	Deutsche Bank	97.13***	110,275
INP	iPath MSCI India Index	Barclays	67.07***	379,728
Panel B: Bottom 5 Premiums				
CNY	Market Vectors Renminbi/USD	Morgan Stanley	-12.20***	12,964
DVHL	ETRACS Monthly Pay 2xLeveraged Diversified High Income	UBS	-15.17*	13,479
BARL	Morgan Stanley S&P 500 Crude Oil Linked	Morgan Stanley	-29.59**	328
CSCR	Credit Suisse Commodity Rotation	Credit Suisse	-29.92***	4,029
FUD	ETRACS CMCI Food Total Return	UBS	-36.74*	5,272

***significant at 1% level, **significant at 5% level, *significant at 10% level

A couple key insights into the ETN market can be gleaned from the snapshot provided in Table 1.6. First, the levels of premiums reached by ETNs can be quite substantial, while the levels of discounts reached by ETNs are much more modest. Each of the top 5 ETNs trades at a premium higher than 60 basis points with three ETNs above 100 basis points, while only 1 ETN trades at a discount below 30 basis points (and only significant at a 10% level). There are clear market forces at play that push premiums to high levels that are not matched on the downside. Second, the average daily trading volume of the ETNs trading at a premium are substantially higher than the average daily trading volume of the ETNs trading at a discount. Other than PTM, each of the top 5 ETNs trade at volumes above 100,000 units per day, while none of the bottom 5 ETNs trades at volume above 14,000 units per day (even PTM trades at an average daily volume over 37,000). The correlation between premium and average volume is not surprising, since the market demand forces that push up premiums are likely the same demand forces that contribute to daily liquidity. The demand explanation holds regardless of any attempt at a causal link between the two.

ETN Premiums by Issuer

Overall, ETNs trade at an average daily premium of 31 basis points, illustrated in Table 1.7. The table also shows the average daily premiums/discounts for each individual issuer averaged across all ETNs of a given issuer. The table lists average premiums calculated as both the standard premium from equation (3) above and the arbitrage premium. The table also shows the average daily trading volume per ETN of the issuer and shows the average CDS price of the ETN's issuer over the life of the ETN.

Table 1.7
Mean ETN Premiums by Issuer

This table presents the mean ETN premiums by issuer averaged across all ETNs of the given issuer. Column 1 shows the standard premium in basis points, as express in equation (3) above. Column 2 shows the arbitrage premium in basis points, also as defined above. Column 3 shows the average daily volume for a given ETN of the issuer and column 4 shows the average CDS price for the issuer over the time period. The time period of the table is June 2006 through December 2013.

	Mean Premium			
Issuer	Standard	Arbitrage	Avg. Daily Volume	Avg. CDS Price
Barclays	46.04***	44.76***	585,991	146
Citigroup	25.95***	12.32***	3,478	159
Credit Suisse	36.51***	36.79***	1,263,522	123
Deutsche Bank	8.07***	9.33***	387,500	123
Goldman Sachs	4.99***	1.90***	16,017	176
HSBC	63.61***	48.21***	59,206	86
JPMorgan	21.11***	22.25***	912,146	103
Lehman Brothers	28.51***	17.68***	1,097	277
Morgan Stanley	-10.13***	-5.45***	21,062	237
Royal Bank of Scotland	3.45***	2.13***	17,127	207
Swedish Export Credit Corp	10.18***	6.90***	298,026	41
UBS	19.85***	18.18***	31,621	133
Total	30.89***	30.09***	480,465	151

***significant at 1% level, **significant at 5% level, *significant at 10% level

As illustrated in the results of Table 1.7, the average daily premiums vary widely among the ETN issuers. The ETN issued by HSBC trades at the highest average daily premium at 64 basis points for the standard premium and 48 basis points for the arbitrage premium on daily volume of 59,206 units. However, HSBC only has one active ETN in the market. Apart from the lone HSBC ETN, the ETNs issued by the largest ETN issuer, Barclays, trade at the highest average premium at 46 basis points for the standard premium and 45 basis points for the arbitrage premium on average daily volume of 585,991 per ETN. The ETNs issued by Credit Suisse also trade at a relatively high average premium with an average standard premium and arbitrage premium of 37 basis points. The average Credit Suisse ETN also trades with substantial daily volume at 1.26 million units per day.

At the low end of average daily premiums is Morgan Stanley, whose ETNs trade at an average daily premium of -10 basis points for the standard premium and -5 basis points for the arbitrage premium on relatively low volume of 21,062 units per day. As would be expected due to the inherent credit risk of ETNs, Morgan Stanley also has the highest average CDS price, other than Lehman Brothers. All other issuers have ETNs trading at average premiums somewhere between -3 and 29 basis point for the standard premium. Of particular note are the ETNs issued by Lehman Brothers, which also traded at positive premiums, averaging 29 basis points for the standard premium and 18 basis points for the arbitrage premium, even in the face of the solvency issues. A more detailed look at the Lehman Brothers ETNs will be presented in Chapter 2.

The results in Table 1.7 highlight a number of interesting facts about the ETN market. First, all ETN issuers have ETNs trading at an average daily positive premium for both the standard premium and the arbitrage premium, except for Morgan Stanley. The ETNs of Morgan Stanley trade at an average daily discount of 10 basis points for the standard premium and 5 basis points for the arbitrage premium. Second, as pointed out above, in aggregate ETNs trade at an average daily premium of 31 basis points for the standard premium and 30 basis point for the arbitrage premium. Third, given that the results are effectively unchanged whether examining the standard premium or the arbitrage premium, it is clear that the existence of ETN premiums is not wholly contained within the bid-ask spread of an ETN. For purposes of explaining the ETN premium puzzle, it is apparent that use of the standard premium would not lead to spurious results.

Finally, the cross sectional dispersion of premiums is partially explained by average CDS prices, as expected given the inherent credit risk of ETNs. An issuer’s CDS price is a good proxy for the credit risk of the issuer’s debt liabilities with higher CDS prices corresponding to increased credit risk. The clear anomaly in the table is Lehman Brothers, which exhibits the highest average CDS price with a relatively high average premium. However, Lehman Brothers is an outlier since the premiums and CDS prices for the other issuers are not limited to the relatively small window of time that Lehman Brothers participated in the ETN market. Therefore, excluding Lehman Brothers, the issuers with the three highest average CDS prices also have the three lowest average premiums, ranked in exact order. The correlation between the average standard premium and the average CDS price in the cross section is -0.326. While it will be shown in Chapter 2 that the ETN market does not, in general, price the credit risk inherent in ETNs when considering a time series of premiums, the sign of the correlation in the cross sectional results of Table 1.7 is consistent with expectations.

ETN Premiums by Asset Class

Cross sectional dispersion of ETN premiums is also evident across ETN asset classes. Table 1.8 shows the average daily premiums of ETNs sorted by the asset class of the underlying index. The table shows both the average daily standard premium and the average daily arbitrage premium. Average daily trading volumes are also includes by asset class. For the commodity, equity, and fixed income asset class, breakdowns by subclass are also included since cross-section variation in premiums also occurs at the subclass level.

Table 1.8
Mean ETN Premiums by Asset Class

This table presents the mean ETN premiums by asset class averaged across all ETNs that belong to the given asset class. Subclass statistics are also shows for the commodity, equity, and fixed income asset classes. Column 1 shows the standard premium in basis points, as express in equation (3) above. Column 2 shows the arbitrage premium in basis points, also as defined above. Column 3 shows the average daily volume for a given ETN in the asset class. The time period of the table is June 2006 through December 2013.

	Mean Premium		
Asset Class	Standard	Arbitrage	Avg. Vol
Commodity	40.62***	39.25***	217,019
Agriculture	8.61***	7.48***	92,231
Broad Based	5.86***	3.81***	156,436
Energy	58.49***	60.92***	366,041
Industrial Metal	6.23***	4.89***	100,289
Livestock	6.03***	4.74***	61,221
Precious Metal	25.11***	23.41***	342,477
Currency	-16.45***	-7.64***	27,106
Equity	10.60***	10.94***	105,307
MLP	0.27***	1.67***	194,675
Non-MLP Equity	18.87***	18.38***	74,235
Fixed Income	4.90***	3.95***	17,655
Treasuries	1.07***	0.75***	18,792
Non-Treasuries Fixed Income	14.17***	11.70***	16,600
Volatility	60.62***	59.29***	4,011,323
Total	30.89***	30.09***	480,465

***significant at 1% level, **significant at 5% level, *significant at 10% level

As illustrated in the results of Table 1.8, the average daily premiums also vary widely among the various asset classes of the underlying index and even within asset class among the particular subclasses. Volatility-based ETNs trade at the highest average premium at 61 basis points for the standard premium and 60 basis points for the arbitrage premium, on substantial volume of over 4 million units per day. Commodity-based ETNs also trade at a high average premium at 41 basis points for the standard premium and 39 basis points for the arbitrage premium. At the other end of the spectrum are the currency-based ETNs that trade at the lowest average daily premium at -16 basis points for the standard premium and -8 basis points for the arbitrage premium, on relatively low volume of 27,106 units per day. The remaining asset classes fall in the middle with equity-based ETNs trading at 11 basis points for both the standard and arbitrage premiums and fixed-income-based ETNs trading at 5 basis points and 4 basis points for the standard premium and arbitrage premium, respectively.

The results of Table 1.8 highlight an important distinction among ETNs that contribute to the relative pricing of ETN products: tax treatment. The tax implications of an ETN is an important factor in an investor's demand for an ETN. As discussed above, the demand for currency-based ETNs suffered a permanent negative shock due to an adverse IRS ruling regarding their tax treatment. Therefore, it is not surprising that currency-based ETNs not only trade at the lowest average daily premium, but also are the only asset class whose ETNs trade at a discount. The relatively low trading volume of currency ETNs is also a byproduct of the unfavorable tax treatment. The breakdown of the commodity asset class by subclass also provides insight into the importance of tax treatment. The tax discussion above in section 1.3 points out the favorable tax treatment enjoyed by energy-based and precious metal-based ETNs over their ETF counterparts. Therefore, it is also not surprising that energy-based ETNs trade at an average daily standard premium of 58 basis points and precious metal-based ETNs trade at an average daily standard premium of 25 basis points, while the other commodity subclasses trade at average daily standard premiums below 9 basis points.

ETN Premiums by Leverage

Given that one value of ETNs is the ability to gain exposure to otherwise expensive market positions, it is natural to expect that ETNs providing higher levels of leverage to exhibit higher average premiums. However, Table 1.9 illustrates that this is not uniformly the case for leveraged ETNs. Table 1.9 shows the average daily premiums for ETNs across various levels of leverage exposure provided by the ETN. For example, a 2x long ETN provides exposure to twice the return of a long position in the underlying index. The “no leverage” class is equivalent to a 1x long ETN. The table also shows the average daily trading volume for ETNs in a given class of leverage exposure.

Table 1.9
Mean ETN Premiums by Leverage

This table presents the mean ETN premiums by leverage exposure averaged across all ETNs that belong to the given class of leverage. Column 1 shows the standard premium in basis points, as express in equation (3) above. Column 2 shows the arbitrage premium in basis points, also as defined above. Column 3 shows the average daily volume for a given ETN in the class of leverage exposure. The time period of the table is June 2006 through December 2013.

	Mean Premium		
Leverage	Standard	Arbitrage	Avg. Vol
No Leverage	34.32***	33.43***	386,038
2x Long	61.61***	60.24***	473,577
3x Long	0.56***	0.48***	325,286
1x Short	9.61***	9.17***	2,069,827
2x Short	3.57***	3.98***	492,131
3x Short	4.49***	3.61***	241,575
Total	30.89***	30.09***	480,465

***significant at 1% level, **significant at 5% level, *significant at 10% level

As illustrated in the result of table 1.9, at the upper end of premiums, double long ETNs (2x leverage) trade at the highest average daily premium of 62 basis points for the standard premium and 60 basis points for the arbitrage premium. However, counter to the hypotheses that increased leverage should correspond with higher premiums, triple long ETNs (3x leverage) only trade at a 0.6 basis point standard premium and a 0.5 basis point arbitrage premium. In fact, the no-leverage ETNs trade at a much higher standard premium of 34 basis points than all of the classes of leveraged ETNs other than the double longs. None of the ETNs that provide short exposure trade at an average premium higher than 10 basis points. The single short ETNs trade at a 10 basis point standard premium and 9 basis point arbitrage premiums, while the double short and triple short ETNs trade at average daily standard premiums of 3.6 basis points and 4.5 basis points, respectively. Given the lack of pattern in the cross sectional dispersion of average ETN premiums sorted by leverage exposure, it is must be the case that either (i) leverage exposure does not enter the demand function of ETN investors in a meaningful respect, or (ii) other pricing factors are hiding the importance of leverage exposure.

The Persistence of ETN Premiums

While the above results illustrate that ETNs generally trade at positive average daily premiums across issuers, asset class, and leverage exposure, the dynamics of the daily premiums have not been explored. Table 1.10 presents a first step in examining premium dynamics by looking at the persistence of ETN premiums over the short run. The table shows the autocorrelation of premiums with a 1-day, 2-day, 3-day and 4-day lag for both premium percentages and premium levels. The premium percentages are calculated as expressed in equation (2) above, while the premium levels are calculated as expressed in equation (1) above.

Table 1.10
ETN Premium Persistence

This table presents the autocorrelations of ETN premiums with a 1-day, 2-day, 3-day and 4-day lag. Panel A shows autocorrelations for ETN premiums expressed as a percentage of the indicative value. Panel B shows autocorrelation for ETN premiums expressed in levels.

Panel A: Premium %					
N=154,370	Premium	1-day lag	2-day lag	3-day lag	4-day lag
Premium	1.00				
1-day lag	0.94	1.00			
2-day lag	0.91	0.93	1.00		
3-day lag	0.90	0.93	0.95	1.00	
4-day lag	0.89	0.92	0.93	0.94	1.00

Panel B: Premium Level					
N=154,370	Premium	1-day lag	2-day lag	3-day lag	4-day lag
Premium	1.00				
1-day lag	0.67	1.00			
2-day lag	0.62	0.66	1.00		
3-day lag	0.56	0.57	0.62	1.00	
4-day lag	0.49	0.52	0.57	0.63	1.00

The results of the autocorrelations in Table 1.10 show substantial persistence of ETN premiums over the short run. However, persistence is much stronger for premium percentages versus premium levels. The top panel shows that an ETN’s premium percentage will carry over to the following day with a correlation of 0.94 and persist even four days later with a correlation of 0.89. The persistence is weaker for premium levels. The bottom panel of Table 1.10 shows that only an ETN’s premium level will carry over to the following day with a correlation of 0.67, subsequently diminishing to a 0.62 correlation two days later, a 0.56 correlation three days later, and a 0.49 correlation four days later. Clearly, premium percentages are much more likely to persist than a premium level. Since premium percentages can be considered relative premiums and premium levels as absolute premiums, it is not surprising that relative premiums are the more likely of two to exhibit a high degree of persistence.

ETN Premiums and Tracking Error

A primary advantage of ETNs over their ETF counterparts is the absence of tracking error, as discussed in section 1.3 above. By construction, the indicative value of an ETN perfectly tracks the underlying index, net of management fees. The same cannot be said for ETFs, where net asset values commonly deviate from the movement of the underlying index. However, the movement of the indicative value in relation to the underlying index is not the complete story for purposes of tracking error in the ETN market. For an ETN investor, it is movement of the market price that is relevant for determining tracking error, since the investor will enter and exit ETN positions at the market price, not the indicative value. Given the levels and volatility of premiums documented above, the market price may not track the underlying index as closely as does the indicative value. While the indicative value has no tracking error, the market price of an ETN may exhibit substantial tracking error.

The test for tracking error in ETNs will consist of a variance decomposition of an ETN's market price. Specifically, I will break down the daily volatility of an ETN's price into the volatility contribution from the indicative value and the volatility contribution from the premium. An ETN that exhibits minimal tracking error in the market price should have virtually no contribution from the volatility of the premium. Reproducing equation (1) above,

$$\text{Premium}_t = P_t - IV_t \qquad (5),$$

which can be rearranged to

$$P_t = \text{Premium}_t + IV_t \qquad (6).$$

Therefore, the volatility of the market price, P_t, can be decomposed as

$$\text{Var}(P_t) = \text{Var}(\text{Premium}_t + IV_t)$$

$$= \text{Var}(\text{Premium}_t) + \text{Var}(IV_t) + 2\text{Cov}(\text{Premium}_t\,, IV_t) \qquad (7).$$

For an ETN with little tracking error, it should be the case that

$$\text{Var}(P_t) \approx \text{Var}(IV_t) \qquad (8)$$

Or

$$\text{Var}(IV_t)\,/\,\text{Var}(P_t) \approx 1 \quad (9).$$

The ratio of indicative value volatility to market price volatility, expressed in equation (9), was calculated for all ETNs and hereinafter will be termed the "variance statistic." Note that equation (9) should hold even considering management fees, since both the indicative value and market price reflect the management fees. Table 1.11 shows as summary of the results, presenting distribution statistics across issuers.

Table 1.11
ETN Variance Decomposition

This table presents summary statistics on the ratio of indicative value variance to market price variance, as expressed in equation (9) above. The ratio was computed for each individual ETN and aggregated within issuers. The table provides the mean ratio, minimum, maximum, bottom quartile and top quartile across ETN issuers.

Issuer	Mean	Min	Max	Bottom quartile	Top quartile
Barclays	0.974***	0.101	1.212	0.945	1.050
Citigroup	0.911***	0.797	1.025	0.854	0.968
Credit Suisse	0.988***	0.568	1.137	1.000	1.077
Deutsche Bank	0.885***	0.193	1.081	0.846	1.025
Goldman Sachs	0.968***	0.919	1.017	0.944	0.993
HSBC	0.785***	0.785	0.785	0.785	0.785
JPMorgan	0.913***	0.913	0.913	0.913	0.913
Morgan Stanley	0.815***	0.135	1.003	0.870	0.984
Royal Bank of Scotland	1.004	0.873	1.077	0.990	1.035
Swedish Export Credit Corp	0.953***	0.895	1.042	0.926	0.962
UBS	0.911***	0.554	1.527	0.767	1.038
Total	0.946***	0.101	1.527	0.907	1.040

***significant at 1% level, **significant at 5% level, *significant at 10% level

The results of the variance decomposition shown in Table 1.11 provide evidence of considerable tracking error in the ETN market, since all of the variance statistics across issuers are different from 1 at a 1% significance level, except RBS. Absence of tracking error would lead to variance statistics that cannot be distinguished from 1 with any reasonable degree of statistical significance. The results, therefore, show that all ETNs exhibit a degree of tracking error, despite the claimed benefit of ETNs that tracking error is eliminated. Overall, the variance statistic across all ETNs is 0.946, meaning 94.6% of the daily volatility of an ETN's market price is explained by the volatility of the indicative value. HSBC and Morgan Stanley are at the low end among issuer with variance statistics of 0.785 and 0.815, respectively. A number of individual ETNs have significantly lower values. The minimum value among Barclays' ETNs is 10.1%, the minimum value among Morgan Stanley's ETNs is 13.5%, and the minimum among Deutsche Bank's ETNs is 19.3%. The ETNs at the extreme low values are clearly exposing investors to considerable tracking error. Furthermore, the quartile results show that it is not simply extreme outliers that drag down an issuer's mean. The bottom quartile of UBS's ETNs have a variance statistic of 0.767 and the bottom quartile of Citigroup's ETNs have a variance statistic of 0.854.

1.7 Additional Institutional Features of ETNs

Exchange-traded notes have a number of additional institutional features that should be considered in a full summary of the ETN product. Most ETNs issued in the U.S. contain the following features to varying degrees: (i) redemption restrictions, (ii) callability, and (iii) management fees.

Redemption Restrictions

As mentioned above in section 1.3, all ETNs allow the ETN holder to redeem the note with the issuer in exchange for cash payment of the current indicative value, similar to the redemption feature of ETFs. However, while ETF units are created and redeemed through authorized participants, ETNs are redeemed directly with the issuer. The redemption feature of ETNs is important for two main reasons. First, much like the market for ETFs, the redemption of ETNs serves as an arbitrage mechanism to keep the market price of the ETN in line with the indicative value. Second, the redemption of ETNs also serves to reduce an ETN investor's exposure to counterparty risk. Most ETNs have maturities of ten years or greater. However, the counterparty risk inherent in ETNs is limited to the redemption period and not the full term of the ETN, thus reducing the downward pressure on prices due to counterparty risk.

The efficiency of the redemption features of ETNs in aligning market price with indicative value and reducing counterparty risk depends heavily on the redemption restrictions, which come in two forms: minimum redemption sizes and redemption lags.

A minimum redemption size is required for each ETN, which can vary widely across ETNs, from 5,000 units to 1,000,000. Of the 265 ETNs identified, 34 have minimum redemptions sizes of 200,000 or greater and 170 have minimum redemption sizes of 50,000 or greater. A redemption size of 50,000 is the most common with 129 requiring such a minimum amount. Twelve ETNs had a minimum redemption size of only 5,000 units, although all twelve of those ETNs have been terminated.

Table 1.12 provides a summary of the minimum redemption sizes across issuers, showing the median minimum redemption size for the issuer's ETNs and the minimum requirement among any of the issuer's ETNs and the maximum requirement. The average daily trading volume per ETN of an issuer is also shown to provide a reference point for the respective minimum redemption sizes. The larger the minimum redemption size, the more difficult it is for investors to exercise the option to redeem. Comparing the average daily trading volume to the minimum redemption size provides a means to evaluate the restrictiveness of the requirement. To that end, Table 1.12 also shows the ratio of daily trading volume to minimum redemption size and shows the number of trading days it would take to accumulate the minimum redemption size given the average daily volume.

Table 1.12
Minimum Redemption Size for ETNs

This table present statistics on the minimum redemption sizes for ETNs. The minimum redemption size represents the minimum number of ETN units that an investor must redeem with the issuer when exercising the option to redeem. Minimum redemption size data is found in the ETN prospectus and was collected from Bloomberg. Column 4 lists the average daily volume for each ETN of the issuer. Column 5 lists the ratio of average daily volume to median minimum redemption size. Column 6 lists the number of trading necessary to reach the median minimum redemption size based on the average daily trading volume.

	Minimum Redemption Size					
Issuer	Median	Min	Max	Daily Volume	Daily Vol/Min	# Days to Min
Barclays	50,000	25,000	100,000	585,991	11.72	0.09
Citigroup	50,000	50,000	50,000	3,478	0.07	14.38
Credit Suisse	25,000	10,000	250,000	1,263,522	50.54	0.02
Deutsche Bank	200,000	50,000	500,000	387,500	1.94	0.52
Goldman Sachs	75,000	50,000	100,000	16,017	0.21	4.68
HSBC	250,000	250,000	250,000	59,206	0.24	4.22
JPMorgan	50,000	50,000	50,000	912,146	18.24	0.05
Lehman Brothers	50,000	50,000	50,000	1,097	0.02	45.58
Morgan Stanley	50,000	50,000	100,000	21,062	0.42	2.37
Royal Bank of Scotland	20,000	20,000	40,000	17,127	0.86	1.17
Swedish Export Credit Corp	400,000	100,000	1,000,000	298,026	0.75	1.34
UBS	50,000	10,000	50,000	31,621	0.63	1.58

As shown in Table 1.12, the most common minimum redemption size is 50,000 units across all issuers. The Swedish Export Credit Corporation imposes the highest median redemption minimum at 400,000 units and its highest requirement is 1 million units. The second highest median requirement is HSBC at 250,000 units and Deutsche Bank in third at 200,000 units with a high of 500,000 units. At the other end is RBS, which has a median requirement of 20,000 units and a high of only 40,000 units. The final column of Table 1.12 gives a measure of the relative restrictiveness of the issuer's minimum redemption requirement, showing the number of days it would take to acquire the minimum at the daily average volume. With very low average daily trading volumes, Lehman Brothers and Citigroup ETN's are the most restrictive at 45.38 and 14.38 days, respectively. This means that it would take a Citigroup ETN holder 14.38 days to reach the 50,000 unit redemption minimum. Only four of the issuers have a measure below 1 day, while eight of the issuers are greater than 1 day. Given the importance of redemption in the arbitrage process for keeping market prices aligned with indicative values, this redemption restriction is likely a significant limit to arbitrage that should be examined when considering ETN pricing.

The other significant redemption restriction is the lag imposed by issuers. Issuers generally require a minimum 1-day notice for redemption requests before the payout amount is calculated. In most cases, the ETN holder must submit a redemption request by 4pm on day t, committing to exchanging the ETNs in return for payment of the indicative value. However, at the time of the redemption request, the investor does not know the indicative value he will receive. The final indicative value that constitutes the payment will not be calculated until 4pm on day t+1. As a result, investors (and arbitrageurs, in particular) are still subject to market risk between the time of their redemption request and the calculation of the payout amount. This lag feature of ETNs also gives rise to a conflict of interest on the part of issuers who can manipulate the index levels during the lag. Alexander and Korovilas (2013) highlight the ability of issuers to conduct such manipulation in the volatility futures market.

Callability

Most ETNs are callable by the issuer at any time and for any reason. Nearly every ETN issued has a callable feature in which the issuer can call the notes with sufficient notice. Nearly half of the ETNs also include an automatic termination feature, in which case the ETN is automatically terminated if the indicative value falls below a given threshold. In most cases, this threshold is $10, or 20% of the initial face value of the note. Not only does this feature put the investor at risk of losing a portfolio position or a hedge, but it also puts the tax advantage of the ETN at risk. When the note is called, the investor is forced to realize a gain or loss on his position and faces acceleration of tax liability that he no longer has control over.

The callability feature can be at odds with the best interests of the investors. However, since ETN holders are unsecured creditors, the fiduciary standard between issuer and ETN holder is substantially lower than between ETF sponsor and ETF holder. An RBS prospectus summarizes this best:

“[W]e have no obligation to take your interests into account when deciding whether to maintain or redeem the ETNs.”

RBS, TRNM Prospectus, July 15, 2013 (include in all RBS prospectuses)

Management Fees

Similar to ETFs, ETNs also have annual fees that are directly subtracted from the note’s indicative value. However, while ETF fees are charged as management fees of the portfolio, the same is not true of ETNs since there is no portfolio to manage. The justification for the fee is likely compensation for the hedging activities that the issuer must engage in, though, this is not a direct cost of the ETN and does not necessarily need to be passed on to the ETN investor. As a debt instrument, the ETN is simply a source of funding for the issuer, so any hedging necessities would be a cost of the funding (a relatively low cost at that when compared to other sources of unsecured funding). However, given the popularity of ETNs despite their fees, this seems an effective way of reducing funding costs for the issuer, even generating revenue (i.e. a negative interest rate on the source of funding). The attractiveness of ETNs as a source of cheap funding for financial institutions makes them of particular importance when considering systemic risk and financial contagion. The redemption feature of ETNs turns them from long-term debt into very short-term debt absent any rights of the issuer to suspend redemption. As a result, ETNs should be considered short-term debt in regards to any restrictions on short-term funding of financial institutions. As the use of ETNs grows as a source of funding, the potential systemic issue must be considered.

1.8 Policy Considerations and Concluding Remarks

Exchange traded notes are a unique class of exchange traded products that having been growing steadily as a financial product since the inception of the first ETN in June 2006. As outlined above, there are a number of features of ETNs that make them attractive to investors (e.g. tax treatment and access to segmented markets), but there are also a number of institutional features that should raise red flags for investors and securities regulators. As senior unsecured debt instruments, the expectation is that the market price of an ETN would be discounted from its indicative value to reflect the credit risk inherent in the product. However, contrary to that expectation, this chapter shows that ETNs generally trade at substantial premiums to their indicative value. Positive premiums are seen across issuers and across asset classes. The stylized facts documented on ETN premiums pose an ETN pricing puzzle that is deserving of further examination. Aside from the pricing puzzle, it is important that financial market participants and securities regulators consider the implications of the institutional features of ETNs. The most notable feature of ETNs is their status as unsecured debt. While this certainly introduces interesting asset pricing questions, it also raises a number of potential regulatory issues.

Securities regulators should take note of their disparate treatment of ETNs versus *synthetic* ETFs. Most ETFs are *physical* ETFs that directly purchase and hold the underlying securities of the reference index. A new form of ETF has emerged, the *synthetic* ETF, which do not directly hold the underlying securities, but rather use derivatives to replicate the performance of the underlying index. In many cases, the synthetic ETF will enter into total return swaps with a counterparty to generate the desired return. Effectively, an investor in a synthetic ETF holds a portion of a total return swap with a financial institution, which pays off according to the movement of a reference index. A synthetic

ETF and an ETN are both derivatively-priced products linked to the return of an underlying index that are each exposed to the credit risk of the counterparty. The synthetic ETF position, therefore, is economically equivalent to holding an ETN. However, the investor in the synthetic ETF is arguably in a much safer position than the investor in an equivalent ETN. The total return swaps of the synthetic ETF are typically *over*-collateralized, thus substantially reducing the credit risk, while ETNs are entirely unsecured. Also, the ETF structure of a synthetic ETF includes the arbitrage-mechanisms that generally keep the market price at par, while ETNs face the structural problem of issuer control over the creation of new units. Furthermore, ETFs each have a board of directors that oversee management of the ETF with each board member owing a fiduciary duty to the ETF investor. An ETN has no equivalent board structure and the issuer has limited fiduciary duties to the investor, often acting in direct conflict with the best interests of the investor.

A strong argument can be made the synthetic ETFs offer stronger investor protections than an ETN. However, the use of derivatives by synthetic ETFs raised alarms at the SEC and the regulator instituted a moratorium on the creation of new synthetic ETFs, thus halting the growth of the market.[17] ETNs, on the other, have been left unregulated, despite an effectively similar use of derivatives with inferior terms. The primary explanation for this disparate treatment of two similar products may be alarmingly simple—synthetic ETFs are investment funds that fall under the supervision of the SEC's Investment Management Division, while ETNs are debt securities that fall under the supervision of the SEC's Corporation Finance Division. This appears to be a case of form trumping substance as it relates to the regulation of investment products. None of this is to say that ETNs and synthetic ETFs should be grouped as one, but the regulators should take note that the products are largely economically equivalent with one left unchecked while the other is demonized.

The extreme levels of premiums experienced by many ETNs should also be noted by securities regulators, particularly if premiums are the result of the institutional features of ETNs and not simply market forces. If the risks of investing in an ETN are primarily due to the construct of the product, and particularly the control over the product retained by the issuer, then the SEC should heighten its supervisory role over the ETNs. The conflicts of interest between the issuer and the ETN investor should be of particular concern. Chapter 2 and Chapter 3 will explore the explanations for ETN premiums and highlight those institutional features that do raise concerns.

---

[17] U.S. Securities and Exchange Commission, *SEC Staff Evaluating the Use of Derivatives by Funds*, Mar. 25, 2010.

Chapter 2

Exchange Traded Notes: Case Studies of Demand and Limits to Arbitrage

2.1 Introduction

On Monday September 15, 2008, the S&P Listed Private Equity Index fell 0.8%, an otherwise uneventful trading day for investors with exposure to either the index or its underlying components. However, a particular group of investors with exposure to the index through the Opta Exchange Traded Note (ticker: PPE) lost nearly all of their investment. This would have been quite a shock to a PPE investor who had simply been seeking direct exposure to the S&P Listed Private Equity Index, but was unaware that due to the ETN structure, PPE also provided direct unsecured credit exposure to the ETN's issuer: Lehman Brothers. As Lehman went bust that day, so did PPE, becoming as devalued as any other senior Lehman bond. Since PPE traded at a premium of 85 basis points *over* its indicative value on Friday, September 12, it seems that either the entire ETN market was unaware of the default risk embedded in the product or ETN investors were uniquely confident about Lehman's chances of survival. The answer is likely the former.

Chapter 1 described the unique structure of ETNs as a class of exchange traded products that technically are senior unsecured debt liabilities of the issuing financial institution. Given the credit risk inherent in ETN products, the expectation is that ETNs would trade at discounts to their underlying indicative values to reflect this risk. On the contrary, Chapter 1 documents a series of summary statistics about the pricing of ETNs, showing that overall ETNs trade at a daily *premium* of 31 basis points on average. This so-called ETN premium puzzle, therefore, necessitates further exploration. This chapter will take a step in solving the premium puzzle by highlighting a few selected case studies of ETNs that will give insights into important pricing factors.

The first case study will look at the specific case of Lehman Brothers and the trading of the three ETNs it had issued merely seven months prior to failing. The examination of the Lehman Brothers ETNs shows that the market pricing of the ETNs appeared generally unaffected by the increasing default risk of the firm. One possible explanation for this is simply that ETN investors were inattentive to the credit risk of the Lehman ETNs, along the lines of the general concept of investor inattention in the finance literature (Hong and Stein (1999), Huberman and Regev (2001), Hershleifer and Teoh (2003), Peng and Xiong (2006), Gabaix et al. (2006), DellaVigna and Pollet (2007), Barber and Odean (2008)). The Lehman failure also provides an opportunity to examine the entire ETN market's attention to credit risk among all financial institution issuers. The analysis of the "Lehman moment" in the ETN market will show that credit risk was unpriced prior to the failure, but became priced subsequently. However, the ETN market's attention to credit risk was fleeting as the effect of the "Lehman moment" dissipated after only a couple months.

The second case study will examine the effect of suspension on ETN premiums. Unlike share creation in the ETF market, which is conducted by authorized participants, the creation of new units of ETNs can only be performed by the issuer of the ETN. In many instances, the issuer officially suspends suspension of new units of the ETN, thus capping the supply of notes outstanding. The selected case study will show that when an issuer suspends creation of new units of a particular ETN, the premium of the ETN will jump significantly as it essentially trades as a closed-end fund. Premiums of suspended ETNs can persist because there is no available arbitrage mechanism for the market to force re-alignment of the prices (again, unlike the case of ETFs where authorized participants conduct share-creating arbitrage until the premium disappears). The ETN examined will be the VelocityShares 2x VIX Short-Term (ticker: TVIX) issued by Credit Suisse.

Related to the case study of the TVIX suspension will be a case study of the "TVIX effect." Credit Suisse's suspension of TVIX not only resulted in a dramatic increase in premium for TVIX, but also the effects of the suspension reverberated throughout the entire ETN market. ETNs across the market experienced increases in premiums with increases not limited to ETNs in the same asset class as TVIX (volatility) nor even the same issuer. The market-wide jump in premiums spanned the entire 1-month TVIX suspension period. The "TVIX effect" case study will document this market-wide phenomenon.

The final case study will again illustrate the effect of suspension on ETN premiums, but will do so in the context of another potentially important factor in ETN pricing, namely unique exposure to a segmented market. A primary benefit of ETNs is the exposure they provide to various asset classes and, in many cases, to segmented markets that cannot be accessed easily by US investors otherwise. When an issuer suspends an ETN, the supply of units of the ETN becomes capped, thereby allowing investor demand to push up the premium. However, the demand effect on suspended ETNs should be greatest for products that provide unique exposure to the underlying asset class. If alternative products are available, such as competing ETNs or ETFs, then investor demand can be met by those alternative products, thus reducing the upward price pressure on the suspended ETN and dampening the shock to the premium that would have otherwise occurred from the suspension. The ETN examined in this regard is the JPMorgan Alerian MLP (ticker: AMJ) issued by JPMorgan.

2.2 Case 1: The "Lehman Moment" and the Pricing of Credit Risk

As unsecured senior debt obligations, ETNs are embedded with a degree of counterparty credit risk that theoretically should fluctuate with the creditworthiness of the issuing financial institution. If an ETN issuer's credit risk increases, certainty of payment of the ETN's indicative value decreases and should therefore be discounted based on any standard approach to bond pricing. The discounted indicative value should in turn be reflected in market prices that trade slightly below the indicative value, i.e. at a discount. But as will be illustrated in this case study of Lehman Brothers, the ETN market has had an inconsistent approach to the pricing of counterparty risk.

Lehman Brothers entered the ETN business in February 2008 by issuing three ETNs: the Opta Lehman Brothers Commodity Index Pure Beta Agriculture Total Return ETN (ticker: EOH), the Opta S&P Listed Private Equity Index Net Return ETN (ticker: PPE), and the Opta Lehman Brothers Commodity Index Pure Beta Total Return ETN (ticker: RAW). On September 15, 2008, Lehman Brothers declared bankruptcy and exchange trading of its three ETNs ceased. The theoretical credit risk embedded in ETNs had been realized. Over the relatively short life of the Lehman ETNs (seven months), they traded on average at a positive premium. EOH traded at an average premium of 11 basis points, PPE traded at an average premium of 63 basis points, and RAW traded at an average premium of 9 basis points. As a group, the Lehman ETNs averaged a 28 basis point premium. The relatively high average premiums of the Lehman ETNs during a time of extreme uncertainty suggests that the ETN market seemed generally unconcerned with the default risk posed by Lehman Brothers; or market participants were overconfident about its ability to survive. Unfortunately for the holders of Lehman ETNs, whether due to lack of concern or overconfidence, the failure to appropriately discount the ETNs proved costly. Creditor claims on the three ETNs have only paid out 27 cents on the dollar to date, a 73% loss on the ETN investments entirely from the counterparty risk. [18]

Aside from the specific failure of Lehman, the financial crisis in 2008 also provides a natural setting for considering the pricing of credit risk in ETNs, given the heightened uncertainty across all financial institutions. This case study will examine the trading in Lehman Brothers ETNs specifically, but also focus more generally on the pricing of credit risk surrounding the Lehman failure, both prior to and after the bankruptcy filing. The results show that the ETN market ignored credit risk in the ETNs of all issuer prior to the Lehman failure, but did being to price in credit risk after the failure, only to revert to the pre-failure ambivalence after only a couple of months.

---

[18] *See* Notice to Holders of Senior Notes of Lehman Brothers Holding Inc., Re: April 3, 2014 Plan Distribution to Senior Noteholders.

Table 2.1
Summary Statistics for Lehman Brothers' ETNs

This table shows summary statistic for the three Lehman Brothers exchange trade notes: the Opta Lehman Brothers Commodity Index Pure Beta Agriculture Total Return ETN (ticker: EOH), the Opta S&P Listed Private Equity Index Net Return ETN (ticker: PPE), and the Opta Lehman Brothers Commodity Index Pure Beta Total Return ETN (ticker: RAW). The mean premium column provides the average of the daily premiums for each of the ETNs, calculated as (midpoint price - indicative value) / indicative value. The mean CDS price column gives the average daily price of CDS on Lehman's 5-year senior unsecured corporate notes. The mean Lehman note yields column shows the mean daily yield for senior unsecured Lehman corporate notes. The stock return column gives the total period stock return during the specified time period.

	Mean Premium			Mean Lehman Brothers		
Time frame	EOH	PPE	RAW	5-year CDS Price	5-year Note Yield	Stock Return
Full ETN history 2/21/08 - 9/12/08	11 bps	63 bps	9 bps	288	6.91%	-93.26%
1 month prior to bankruptcy 8/12/08-9/12/08	5	65	3	366	9.26%	-77.48%
1 week prior to bankruptcy 9/8/08-9/12/08	7	65	-32	483	12.96%	-74.20%
1 day prior to bankruptcy 9/12/08	18	85	-90	642	17.88%	-13.51%

As can be seen in Table 2.1, despite the belief of the credit markets in Lehman's increasing credit risk, the market for Lehman ETNs appeared not to take notice. The first row of Table 2.1 shows that over the life of the ETNs, Lehman's CDS price averaged 288 basis points and the yield on a 5-year Lehman note averaged 6.91%. The three Lehman ETNs, EOH, PPE, and RAW averaged premiums of 11 basis points, 63 basis points, and 9 basis points, respectively, during this same time period. On September 12, 2008—i.e. the day before Lehman filed bankruptcy—the credit markets took note, as the CDS price reached 642 basis points and the 5-year note yield reached 17.88%. However, on that same day, EOH traded at a *premium* of 18 basis points and PPE at a *premium* of 85 basis points, both higher than the average premiums during prior time periods. Only RAW investors penalized that ETN as it traded at a discount of 90 basis points on the day before bankruptcy. Given the ultimate fate of Lehman Brothers over the following weekend, it is clear that Lehman ETN investors were not at an informational advantage over the rest of the financial markets and were likely ignoring the signs of impending collapse. Alternatively, investors in EOH and PPE may simply have been unaware of the implications of a Lehman failure on seemingly unrelated exchange traded products.

Aside from the isolated effects on the three Lehman ETNs, the Lehman failure also corresponded with market-wide pricing effects across ETNs. Table 2.2 shows the mean premiums of the existing ETN issuers at the time both prior to the Lehman bankruptcy and after the Lehman bankruptcy, considering a two-month window around the failure.

Table 2.2
Mean Premiums for ETNs pre and post Lehman Bankruptcy

The table shows the mean daily premiums across issuers of all exchange traded notes, where premium is calculated as (midpoint price - indicative value) / indicative value. The pre-Lehman bankruptcy column shows the mean daily premium during the 2-month period prior to Lehman's bankruptcy filing on September 15, 2008. The post-Lehman bankruptcy column shows the mean daily premium during the 2-month period after the filing. The last column shows the change in mean daily premium from the pre-Lehman time period to the post-Lehman time period.

Issuer	# of ETNs	Pre-Lehman Bankruptcy 7/12/2008 - 9/12/2008 Mean Premium	Post-Lehman Bankruptcy 9/15/2008 - 11/15/2008 Mean Premium	Change
Barclays	31	13.24 bps	-0.89 bps	-14.13 bps
Credit Suisse	2	15.71	-32.95	-48.66
Deutsche Bank	25	-3.71	-15.53	-11.82
Goldman Sachs	2	-5.95	-24.39	-18.44
HSBC	1	9.63	40.47	30.84
JPMorgan	2	-3.60	-25.77	-22.17
Lehman Brothers	3	30.04	N/A	N/A
Morgan Stanley	4	12.19	-76.58	-88.77
SECC	7	-13.72	-49.76	-36.04
UBS	10	-0.14	-166.94	-166.80
Total	87	4.12 bps	-22.96 bps	-27.08 bps

The overall ETN market averaged a 4 basis point premium prior to the Lehman failure, but dropped to a 23 basis point discount after the failure, a 27 basis point decline. Certain individual issuers were impacted more than others. The UBS ETNs fell from trading roughly at par prior to the Lehman failure to a mean discount of 167 basis points after the failure. The Morgan Stanley ETNs fell from a premium of 12 basis points to a discount of 77 basis points. Of the nine total ETN issuers (aside from Lehman), five experienced premiums declines of greater than 30 basis points, while only one had an increase—HSBC increased from 10 basis points to 40 basis points, but this only represents a single ETN. While the results do not necessarily indicate that the Lehman failure caused the drop in premiums, it is certainly the case that there was a correlated effect in the market.

While table 2.2 illustrates an interesting cross-sectional view of ETN issuers surrounding the Lehman Brothers failure, the question remains as to whether the Lehman failure served as an inflection point for the ETN market's pricing of credit risk. Did the failure of Lehman Brothers and the consequent losses to it ETNs have any effect on credit risk as a priced factor in ETNs? To answer this question, I test the pricing of credit risk through a series of panel regressions on ETN premiums over a six-month period, from June 15, 2008 through December 15, 2008. This six-month period constitutes the three-month period prior to the Lehman failure on September 15, 2008 and the three-month period after the Lehman failure. The panel regressions test whether changes in an issuer's credit risk have a statistically significant effect on premiums.

Various candidates exist as a proxy for measuring an issuer's credit risk. A common measure is the price of a credit default swap (CDS) on the issuer's corporate notes, which reflects the credit risk of the reference entity (Cserna et al. (2013), Longstaff et al. (2005), Pan and Singleton (2008), Hull and White (2001)). Since issuers often have multiple series of CDS trading on various tranches of debt, a choice must be made for a reference CDS price. The most liquid CDS have reference obligations as 5-years senior unsecured notes, so the CDS price on the issuers' 5-year senior unsecured notes is the natural candidate. And since the aim of the analysis is to measure the effect of changes in issuer credit risk on ETN premiums, the independent variable of interest is the daily return on the CDS price of the ETN issuer's 5-years senior unsecured corporate notes. In addition, the bid-ask spread is also included as an independent variable to capture any premium variation that is attributed to volatile spreads that may have occurred during the particularly volatile times in the financial markets generally.

The panel regressions on ETN premiums take the following forms:

$$Prem_{i,t} = constant + b_1 BIDASK_{i,t} + credit\_risk_{i,t} + e_{i,t}\,, \qquad (1)$$

where $Prem_{i,t}$ is the premium for ETN *i* on day *t*, expressed in basis points, and $credit\_risk_{i,t}$ takes three different forms:

i. $credit\_risk_{i,t} = c_1 CDS\_RET(full)_{i,t}$

ii. $credit\_risk_{i,t} = c_1 CDS\_RET(prior)_{i,t} + c_2 CDS\_RET(after)_{i,t}$

iii. $credit\_risk_{i,t} = c_1 CDS\_RET(3\ mo\ prior)_{i,t} + c_2 CDS\_RET(2\ mo\ prior)_{i,t}$
$+ c_3 CDS\_RET(1\ mo\ prior)_{i,t} + c_4 CDS\_RET(1\ mo\ after)_{i,t}$
$+ c_5 CDS\_RET(2\ mo\ after)_{i,t} + c_6 CDS\_RET(3\ mo\ afterr)_{i,t}$

The three forms of the *credit_risk* vector correspond to different subdivisions of the 6-month window to account for the varying significance of credit risk during the respective subdivided period. Form (i) considers the significance of credit risk over the entire 6 months. Form (ii) considers the significance of credit risk during the 3 months prior to the Lehman failure and separately during the 3 months after the Lehman failure. Form (iii) further subdivides form (ii) by considering the significance of credit risk month by month.

Table 2.3
Panel Regression Results Around Lehman Bankruptcy

The table reports the results of a panel regression for 41 exchange traded notes traded in the U.S. The time period studied is June 15, 2008 through December 15, 2008, which consists of 3 months prior to and 3 months after the Lehman Brothers' bankruptcy filing on September 15, 2008. Only ETNs with a minimum of three months of trading data are considered. Column (1) reports a regression of the premium on the bid-ask spread and CDS returns over the entire sample time period. Column (2) reports a regression of the premium on the bid-ask spread and two CDS return variables with one representing CDS returns prior to the Lehman bankruptcy and one representing CDS returns after the Lehman bankruptcy. Column (3) is a regression of the premium on the bid-ask spread and six CDS return variables: one for each of the three months prior to the Lehman bankruptcy filing and one for each of the three months after the filing.

Independent Variables	(1)	(2)	(3)
Bid-Ask Spread (bps)	-0.078 ***	-0.076 ***	-0.074 ***
	(3.23)	(3.14)	(3.06)
CDS Return (full time period)	-65.35 ***		
	(3.25)		
CDS Return (prior)		27.85	
		(0..49)	
CDS Return (after)		-78.01 ***	
		(3.65)	
CDS Return (3 months prior)			25.40
			(0.31)
CDS Return (2 months prior)			40.24
			(0.35)
CDS Return (1 month prior)			19.33
			(0.17)
CDS Return (1 month after)			-74.97 ***
			(3.21)
CDS Return (2 months after)			-93.56 *
			(1.60)
CDS Return (3 months after)			-94.80
			(0.82)
Constant	11.14 **	10.66 *	10.79 *
	(1.71)	(1.63)	(1.59)
F.E.	yes	yes	yes
N	4,628	4,628	4,628
R-sq.	0.100	0.102	0.105

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level

Table 2.3 shows the results of the panel regressions. Column 1 shows the results of the regression using form (i) of the *credit_risk* vector. Column 2 shows the results of the regression using form (ii) and Column 3 shows the results of the regression using form (iii).

The results in column (1) show that CDS returns are a statistically and economically significant factor over the entire six month period. The CDS return independent variable in this case covers the whole sample period, June 15, 2008 through December 15, 2008, which is 3 months prior to the September 15 Lehman failure and 3 months after the failure. As expected, as CDS returns increase (meaning an increase in the market's perception of the credit risk of the issuer), ETN premiums decrease to account for this risk. A one standard deviation increase in the CDS return (i.e. a 10% change in CDS price) corresponds with a 6.53 basis point decrease in the ETN premium. The bid-ask spread is also a statistically significant factor and has the expected sign, showing that higher bid-ask spreads result in lower premiums. Based on these results, it appears that the ETN market was attentive to credit risk over the entire 6-month time frame. However, while the results in column (1) provide evidence of the pricing of credit risk, the results only tell part of the story.

The regression in column (2) subdivides the CDS return factor into two sub-factors based on the 3 months prior to the Lehman bankruptcy and the 3 months after the bankruptcy. The CDS Return variable, "CDS Return (prior)," measures the significance of credit risk prior to the Lehman failure and the CDS Return variable, "CDS Return (after)," measures the significance of credit risk after the Lehman failure. The results show that issuer credit risk was not reflected in ETN premiums prior to the Lehman failure, but that issuer credit risk was reflected in premiums after the failure. As seen in column (2), during the three months prior to Lehman's bankruptcy filing, CDS returns were not a priced risk factor for ETN premiums, as evidenced by the lack of statistical significance of the "CDS Return (prior)" variable. However, after the Lehman bankruptcy, CDS returns were a priced risk factor for ETN premiums, as evidences by the statistical significance of the "CDS Return (after)" variable, at a 1% level. The "CDS Return (after)" variable illustrates that during the three months after the Lehman bankruptcy filing, a one standard deviation increase in an issuer's CDS return corresponded with a 7.80 basis point decrease in the ETN premium.

The results in column (2) show that the Lehman bankruptcy served as an inflection point for the pricing of credit risk in ETNs. But the question still remains as to how long the attention to an issuer's credit risk persisted. The regression in column (3) provides an even further refinement of the ETN market's attention to credit risk. In this regression, the CDS return variables are further subdivided into one-month intervals corresponding to a one-month time frame beginning 3 months, 2 months, and 1 month prior to the Lehman bankruptcy filing and 1 month, 2 months, and 3 months after the filing. For example, the variable "CDS Return (3 months prior)" measures the significance of credit risk from June

15-July 15, 2008, while the variable “CDS Return (2 months prior)” measures the significance of credit risk from July 16-August 15, 2008, and so on.

As seen in the results, in no single month prior to the Lehman bankruptcy filing was CDS return a priced factor, noting the lack of significance of the factors labeled “ CDS Return (3 months prior),” “ CDS Return (2 months prior),” and “CDS Return (1 month prior).” Consistent with regression (2), CDS returns were not a significant factor until after the Lehman bankruptcy filing. But the results in this regression show that the significance faded after 2 months. The statistical significance of the CDS return factor was strongest in the first month after the Lehman bankruptcy, but dissipated by the third month. The “CDS Return (1 month after)” variable is statistically significant at a 1% level and the “CDS Return (2 months after)” variable is statistically significant at a 10% level, but the “CDS Return (3 months after)” variable lacks any meaningful level of statistical significance.

These results suggest that the ETN market reacted strongly to the Lehman Brothers failure, but only temporarily. The Lehman failure served as an inflection point for the ETN market’s pricing of issuer credit risk, but within three months of that inflection point, the effect dissipated. The reasonable takeaway from these regression results is that the ETN market was relatively indifferent to changes in an issuer’s credit risk until one ETN issuer actually failed. At that point, the market did begin to price credit risk changes, but only in the immediate aftermath of the Lehman failure. Two months later, credit risk changes were again ignored. The market, it would seem, had a short memory.

The above regressions focused on the date of the Lehman Brothers failure as the reference date for a test of a “regime change” in the pricing of credit risk in ETN premiums, ultimately showing that the date of the failure did serve as an inflection point. As a robustness check for this conclusion, I randomly selected a number of other dates outside the Lehman failure window to serve as the reference date and tested whether the same panel regressions led to the same “regime change” conclusions about the random reference dates. None of these random placebo regressions produced similar results to Lehman regression, suggesting that the effect of the Lehman failure on the pricing of credit risk was not merely a coincidental occurrence.

2.3 Case 2: Issuer Suspension of Additional Notes Creation

The creation of additional notes of an ETN is entirely subject to the discretion and interests of the issuer. Unlike ETFs, where authorized participants can create additional ETF shares, ETNs do not have a similar creation process for market participants. Only the issuer of an ETN can create new units. Most of the time issuers respond to demand for an ETN by consistently creating new units to meet demand. However, in many instances, the issuer suspends creation of new notes, thus capping the outstanding supply. An ETN that has been suspended by its issuer essentially becomes a quasi- closed-end fund. There is a cap on the supply of notes, similar to a closed end fund, but investors still have the option to redeem notes with the issuer, thus reducing the supply, which is unlike closed end funds. Suspension of an ETN imposes a structural limit to arbitrage because the market has no arbitrage mechanism to respond to ETNs trading at a premium, since the issuer has ceased performance of the creation process. However, the redemption process is unaffected by suspension, so the arbitrage mechanism for ETN discounts still exists. As a result, a suspended ETN is subject to an asymmetric system of arbitrage. Discounts can still be arbitraged away by arbitrageurs, but premiums cannot be. The net effect of this asymmetry is an increase in the average premiums of suspended ETNs.

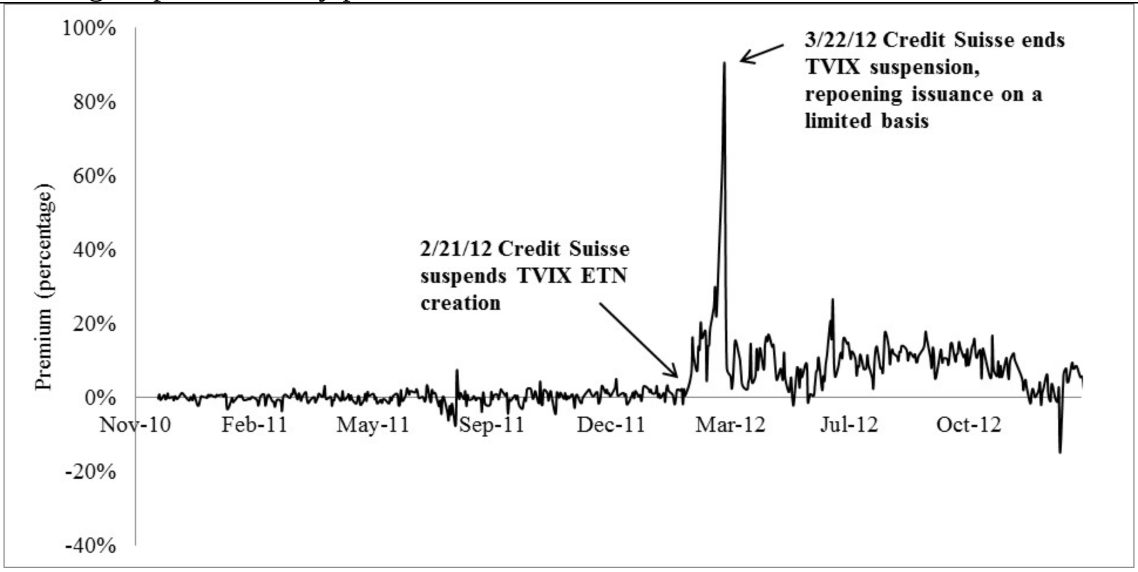
The most prominent case of heightened premiums that resulted from issuer suspension occurred with the Credit Suisse Velocity Shares 2x VIX Short-Term ETN (ticker: TVIX). At the end of the trading session on February 21, 2012, Credit Suisse issued a brief press release in which it announced that it had "temporarily suspended further issuance of the Velocity Shares 2x VIX Short-Term ETNs (TVIX) due to internal limits on the size of the ETNs."[19] At that point, Credit Suisse ceased creation of new units, thus capping the supply of notes outstanding for TVIX and allowing trader demand to put upward pressure on premiums with no mechanism for stabilizing the price. As a result, the demand pushed premiums to significant levels immediately, reaching 625 basis points on the subsequent trading day, February 22, 2012. Figure 2.1 illustrates the dramatic increase in premium of TVIX ETNs as a result of the Credit Suisse suspension. The peak of the TVIX premium hit 8,917 basis points or 89.17% on March 21, 2012; the closing bid was $14.41 while the indicative value was only $7.62. At the end of the trading session on March 22, 2012, Credit Suisse reversed course and re-opened new issuance of TVIX units, announcing via a press release that it intended to reopen issuance of TVIX on a *limited basis*.[20] The following day, the TVIX premium dropped to 761 basis points from the peak of 8,917 two days prior, corresponding with Credit Suisse's issuance of 600,000 new notes. However, given that Credit Suisse only committed to creating new units on a limited basis, TVIX remained partially suspended, in effect, and consequently still traded at a significant premium even after Credit Suisse reopened issuance.

---

[19] Credit Suisse Press Release, Feb. 21, 2012.
[20] Credit Suisse press release, Mar. 22, 2012.

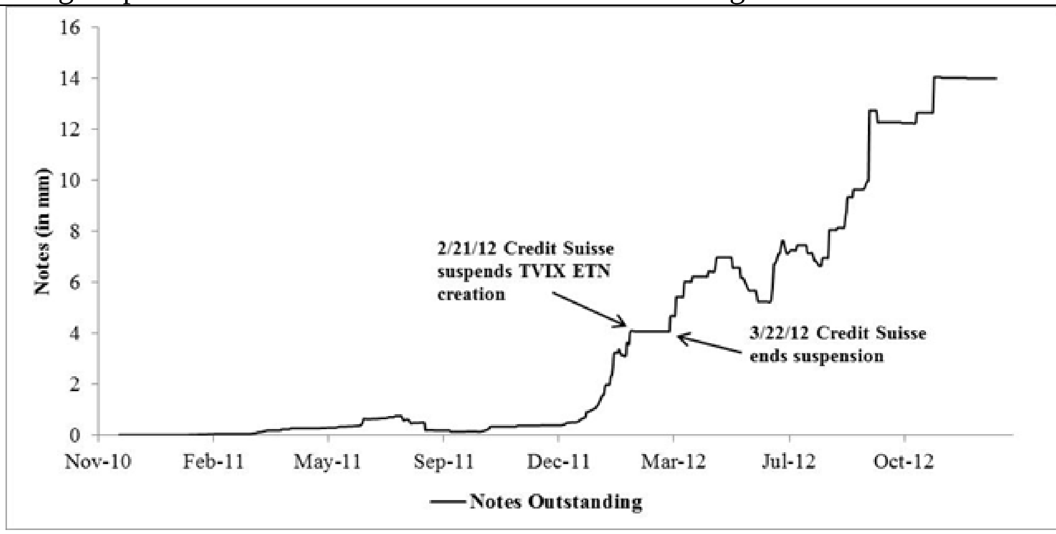
Figure 2.1
The Daily Premium of TVIX

This figure plots the daily premium of the Credit Suisse TVIX ETN.



While the reason for Credit Suisse's suspension of TVIX can only be speculative given the lack of detailed explanation and lack of requirement to disclose an explanation, it is clear that a steep build up in outstanding notes occurred prior to the suspension decision. Figure 2.2 illustrates a times series of the total TVIX notes outstanding. In the couple of months prior to suspension, issuance of new TVIX notes accelerated quickly, as seen in the figure. It is also clear that despite the intention to issue new units on a limited basis, demand for TVIX notes has pushed new issuances to substantial levels.

Figure 2.2
TVIX Notes Outstanding
This figure plots a times series of the total notes outstanding of the TVIX ETN.



2.4 Case 3: Suspension and the "TVIX Effect"

The suspension of TVIX by Credit Suisse and absence of an arbitrage mechanism not only caused a substantial premium for TVIX, but it also disrupted the premiums of most other ETNs in the market. Premiums across the board increased significantly as a result of the TVIX suspension (the "TVIX effect"). As shown in Table 2.4, the "TVIX effect" manifested itself across multiple issuers and asset classes. The effects were confined neither to other ETNs issued by Credit Suisse nor to other ETNs linked to volatility indices.

Table 2.4
A Snapshot of the "TVIX Effect" on the ETN Market

The table shows the mean daily premium for a sample of ETNs during various time periods, where the premium is calculated as (midpoint price – indicative value) / indicative express in basis points. The first column shows the mean daily premiums from the inception of that ETN up until Credit Suisse's suspension of TVIX on 2/22/2012. The second column shows the mean daily premiums during the TVIX suspension from 2/22/2012 through 3/22/2012 and the third column includes the difference in mean premium between columns 1 and 2. The fourth column shows the mean daily premiums after Credit Suisse reopened new issuance of ETN units on 3/23/2012 through the end of 2012. The fifth column shows the difference in mean premium between columns 4 and 2.

			Inception - 2/21/2012	TVIX Suspension 2/22 - 3/22/2012		Post-TVIX 3/23 - 12/31/2012	
Ticker	Issuer	Asset Class	Mean	Mean	Change	Mean	Change
TVIX	Credit Suisse	Volatility	-3 bps	2,586 bps	2,589	863 bps	-1,723
GAZ	Barclays	Commodity	254	9,263	9,009	3,572	-5,691
GSP	Barclays	Equity	6	38	32	0	-38
VXX	Barclays	Volatility	-2	42	44	0	-42
DGAZ	Credit Suisse	Commodity	12	40	28	-4	-44
DGLD	Credit Suisse	Commodity	4	41	37	0	-41
VIIX	Credit Suisse	Volatility	-7	39	46	-4	-43
DAG	Deutsche Bank	Commodity	58	300	242	31	-269
WMW	Deutsche Bank	Equity	4	50	46	6	-44
GASZ	UBS	Commodity	-33	8	41	-16	-24
PTM	UBS	Commodity	101	648	547	245	-403

Prior to the suspension TVIX traded at a mean premium of -3 basis points (i.e., a discount) from its inception through the suspension on February 21, 2012. During the suspension period from February 22, 2012 through March 22, 2012, TVIX traded at a mean premium of 2,589 basis points. After Credit Suisse reopened issuance in a limited manner, TVIX still traded at a mean premium of 863 basis points through the end of 2012, which reflects the continued limit to arbitrage on the upside as a partially suspended ETN, though to a much lesser degree than during the fully suspended period.

The "TVIX Effect" also reverberated throughout the entire ETN market, regardless of asset class and regardless of issuer. The Barclays ETN GAZ traded at a mean premium of 254 basis points prior to the TVIX suspension, spiked to a mean premium of 9,263 basis points or 92.6% during the TVIX suspension period and reverted to a mean premium of 3,572 basis points or 35.7% after Credit Suisse reopened TVIX creations on a limited basis. Even the most liquid ETNs that traded roughly at par during the entirety of their existence saw a spike during the TVIX suspension. The Barclays ETN VXX traded at a mean premium of -2 basis points prior to the TVIX suspension, then rising to a mean premium of 42 basis points (a 44 basis point increase) during the TVIX suspension period, and falling back to a mean premium of 0 basis points after TVIX was reopened. Each of the tickers listed in Table 2.4 saw significant increases in premiums, an effect that was not limited to those select ETNs. The increase in premiums arose across asset classes and across issuers. As a result, the TVIX suspension period will be an important pricing factor to consider in further examination of the ETN premium puzzle (the "TVIX effect").

2.5 Case 4: Suspension and Segmented Markets

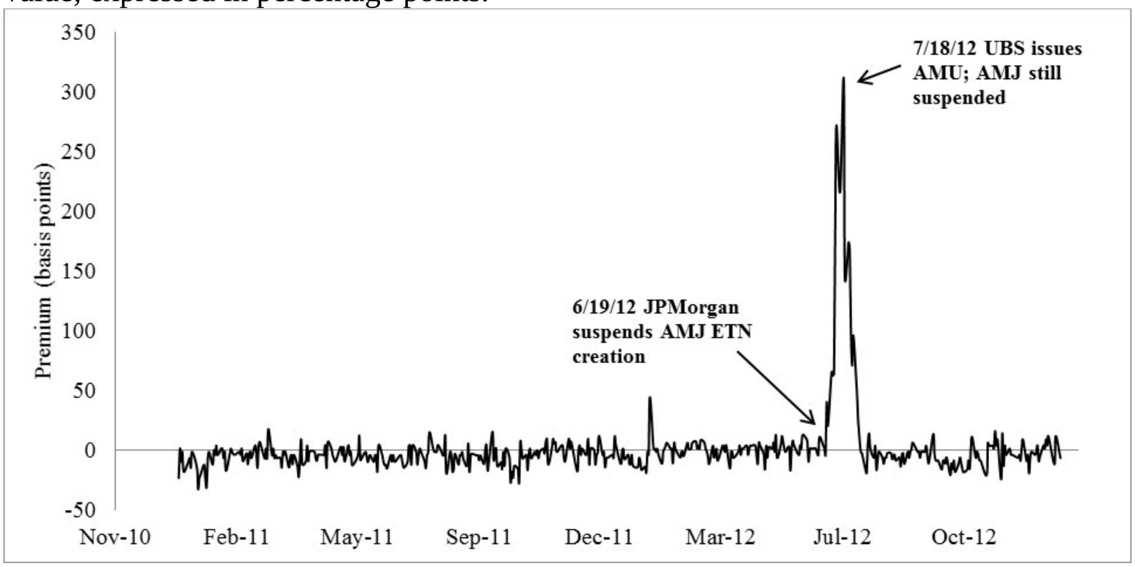
Suspension of the issuance of new units puts a cap on the supply of the notes outstanding, thereby allowing demand pressure by ETN investors to push up the premium with no response by the issuer to create new units to meet demand. Since the issuer refrains from responding to demand by issuing new units, higher demand will lead to higher premiums. Therefore, suspended ETNs that are in the highest demand will have the highest premiums. In the same respect, ETNs with lower investor demand will be less affected by suspension and will not see the same degree of premium increase as those ETNs in higher demand. In essence, suspension should have the largest premium impact on those ETNs that are in the highest demand. Since suspension will not affect all ETNs equally, the question becomes which factor is most determinative of high demand versus lower demand. This case study will show the results of one candidate factor which is based on segmented markets.

A primary benefit to investors of ETNs is economic exposure to difficult to access asset classes and segmented markets that cannot be accessed easily by US investors. ETNs that provide such exposure will be in high demand. More so, ETNs that provide *unique* exposure to the segmented market will be in particularly high demand. Unique exposure is provided when there is no competing alternative product (e.g. an ETF or other ETN) for investors to gain exposure to the same market. These unique ETNs will be termed "segmented" ETNs, i.e. providing unique exposure to a segmented market. Since segmentation is an important factor determining investor demand for an ETN, segmented ETNs should be more greatly affected by issuer suspension than non-segmented ETNs. The intuition is that if an issuer suspends a non-segmented ETN, then investors can turn to alternative products to gain exposure to the desired market and are not forced to bid up the price of the suspended ETN. Since investor demand for exposure to that market is not confined to the non-segmented ETN, the supply cap imposed by the suspension does not lead to as large a premium as for segmented ETNs. When an issuer suspends a segmented ETN, there is no alternative product, so any demand from investors that is unmet by the issuer will result in substantially increased premiums. Therefore, the expectation is that segmented ETNs will be more affected by suspension than non-segmented ETNs.

Conveniently, the case of the JPMorgan Alerian MLP Index ETN (ticker: AMJ) provides clear support for the above hypothesis, illustrating the significance of the interaction between suspension and unique exposure to segmented markets. AMJ is an ETN that provided both unique exposure to a segmented market and experienced an issuer suspension. Furthermore, subsequent to suspension, a competing product entered the market and AMJ lost its unique segmented status. Figure 2.3 show a times series of the AMJ premium over a two-year period, which includes its suspension and the introduction of a competing product.

Figure 2.3
The Daily Premium of AMJ

This figure plots the daily premium of the JPMorgan Alerian MLP Index ETN (ticker: AMJ). The premium is calculated as (midpoint price – indicative value) / indicative value, expressed in percentage points.



Two distinct events are highlighted in the figure. The first is the effect of the issuer suspension on June 19, 2012 when JPMorgan announced it would no longer create new unites of AMJ. At that time, AMJ was a segmented ETN, providing unique exposure to a segmented market (the Alerian MLP Index) with no competing ETPs on the market that offered similar exposure. As seen in the figure, the premium on AMJ rose to over 300 basis points immediately upon the suspension by JPMorgan. As expected, the suspension of new units allowed the demand for the segmented AMJ to push up premiums in the face of no arbitrage mechanism to dampen the increase.

However, on July 18, 2012, AMJ's status as a segmented ETN ceased when UBS issued a competing ETN that tracked the same underlying index as AMJ, the ETRACS Alerian MLP Index ETN (ticker: AMU). At this point, despite the fact that AMJ still faced a significant limit to arbitrage as a suspended ETN, AMJ became non-segmented and the introduction of a competing product in AMU produced a negative demand shock for AMJ that pushed premiums back down. As seen in the chart, AMJ even traded at slight negative premiums for much of the following months, though never below -50 basis points. The premium was unlikely to fall below -50 basis points because the redemption process was still intact despite the suspension, providing an arbitrage mechanism that prevents deep discounts. The case of AMJ illustrates the importance of the interaction between the suspension factor and the segmented markets demand factor for ETN pricing. The interaction of these factors will be examined in detail in Chapter 3.

2.6 Concluding Remarks

The above case studies provide a first step in examining the ETN premium puzzle. The Lehman Brothers example illustrates a specific issue regarding the mispricing of the three Lehman ETNs, two of which traded at premiums on the day before the Lehman bankruptcy filing, despite strong market signals of Lehman's increasing counterparty risk. The Lehman example also highlights a more general issue about investor inattention. Prior to Lehman's failure, the credit risk of ETN issuers was not a priced factor. Subsequent to the failure, credit risk did become price factor, but only in the short-term. Two months later, the significance of credit risk disappeared again. If this is indeed an example of investor inattention, the implications could be even further reaching than simply for purposes of pricing credit risk. As was shown in the subsequent cases, an issuer's suspension of new units for an ETN has a substantial effect on premiums. If an investor is as equally inattentive regarding the risk posed by suspension as it is about credit risk, then market efficiency in ETNs certainly fails. This may provide support for enhanced regulatory involvement in the regulation of ETNs.

Suspension is a significant risk for ETN investors. The fact that premiums generally increase does not indicate that suspension is a *de facto* benefit for ETN investors. The optimal use of ETNs for investors is to gain economic exposure to an underlying index, not to speculate on the fluctuations of the ETN's premium. When substantial premiums exist, the market price is uncoupled from the underlying index, by definition. The uncoupling is even more pronounced given the volatility of premiums that occurs under suspension. Therefore, suspension makes it increasingly difficult for an investor to utilize the ETN to gain the level of exposure to the underlying index that the investor desires. For example, if an investor sought to use the TVIX to hedge his portfolio, the TVIX suspension period severely diminished that investor's ability maintain an optimal TVIX position. Furthermore, as also seen in the TVIX example, the premium can be transitory if the issuer re-opens the ETN. TVIX investors who purchased the ETN at its peak premium of 89% suffered extraordinary losses, most of which were entirely independent of the movement of the VIX index.

Aside from the implications of suspension illustrated by the TVIX example, the main takeaway for purposes of explaining the ETN premium puzzle comes from the final case study on the AMJ ETN. As shown by the TVIX case, when an issuer suspends creation of new units, the premium of the ETN can jump dramatically as demand for the product exceeds the capped supply. This occurred with AMJ as well. However, the AMJ case also illustrates the significance of the specific demand for an ETN as it relates to the effect of issuer suspension. At the time of suspension, AMJ offered unique exposure to an underlying index, so the capped supply led to substantial premiums. However, when a competing product entered the market, such that AMJ no longer offered unique exposure, the issuer suspension became much less significant. With alternative products to satisfy investor demand, the premium on AMJ dropped dramatically, despite it still being suspended. Therefore, in further analyses of the ETN premium puzzle, not only is suspension and important factor, but also more important is the interaction between suspension and unique exposure to segmented markets.

Chapter 3

The ETN Premium Puzzle: Noise Traders, Limits to Arbitrage and Segmented Markets

3.1 Introduction

Chapter 1 documented extensively that exchange traded notes ("ETNs") trade at a premium over their indicative value on average. Since the inception of the first ETN product in June 2006 through the end of 2013, this premium averaged 31 basis points across the ETN market. In an extreme case, the premium on a widely traded ETN reached nearly 90%.[21] Overall, average premiums of ETNs are significantly higher than the average premiums of their exchange traded product counterparts, exchange traded funds ("ETFs"), and higher than the premiums of closed-end funds ("CEFs"). Engle and Sarkar (2006) document average ETF premiums of roughly 1 basis point for a sample of the largest domestically traded ETFs in the U.S. A substantial amount of literature documents that CEFs trade at a significant discount, with some studies finding an average discount of 10 percent (e.g. Weiss (1989); also Boudreaux (1973) and Malkiel (1978) for earlier work documenting the CEF discount). The fact that of those three products, ETNs are the product to trade at substantial premiums is particularly puzzling. ETNs are unsecured senior debt obligations of the issuing financial institution. As result, ETN holders are not only exposed to the default risk of the issuer, but also there is no recourse to pledged collateral upon default. This is a critical distinction from ETFs, which pose no credit risk to ETF shareholders and are nonetheless direct ownership interests in the underlying assets. So the open question remains as to why ETNs typically trade at average premiums, unlike ETFs. This chapter will take a first step in explaining that puzzle.

As will be evident in the analysis that follows, the ETN premium puzzle finds its resolution largely in the noise trader / arbitrageur model of Delong, et al. (1990) and

[21] The Credit Suisse Velocity Shares 2x Short-Term VIX ETN (ticker: TVIX) reached a premium of 89.5% on March 22, 2012.

Shleifer and Summers (1990), alternatively known as an investor sentiment / limits to arbitrage approach to finance. However, while the aforementioned models group traders as either *noise traders* or *arbitrageurs*, it is more appropriate for the ETN premium puzzle to consider *demand traders* instead of *noise traders*, in which *demand traders* consist of *noise traders* as well as rational speculators and hedgers. The results that follow will show that both demand traders and arbitrageurs play a critical role in the pricing of ETNs. Demand traders put both positive and negative price pressure on ETNs, causing market prices to deviate from indicative values, while arbitrageurs act to counter the demand pressures by engaging in arbitrage until prices realign. However, significant limits to arbitrage impose frictions on the ability of arbitrageurs to dampen the price deviations caused by demand traders, thus allowing demand-driven premiums or discounts to persist. The net result empirically is an ETN market that overall trades at average premiums with many individual ETNs trading at substantial premiums.

This chapter will show that positive premiums in the ETN market arise due to the asymmetry in the limits to arbitrage; that is, more restrictive arbitrage limitations exist for ETNs trading at a premium than for ETNs trading at a discount. Arbitrageurs have significantly lower frictions when correcting negative price deviations (i.e. negative premiums, or discounts) than they face when correcting positive price deviations (i.e. premiums). Given this asymmetry, positive premiums are both more likely to persist and more likely to be unbounded – a complete reversal of the explanation for the CEF puzzle espoused by Gemmil, et al. (2002). When strong limits to arbitrage are combined with demand factors that increase demand for a given ETN, the result is the emergence of substantial premiums, as seen in the data. For ETNs that have demand factors that put upward pressure on prices (e.g. ETNs in high demand that offer unique exposure to a segmented market), the asymmetry in limits to arbitrage is most pronounced, leading to the highest premiums.

In this chapter, I conduct two empirical tests of the demand trader / arbitrageur theory for the ETN premium puzzle. The first test focuses on the factors that limit the arbitrage mechanisms that keep ETN market prices aligned with indicative values. The model for this test considers demand shocks as exogenous and measures how quickly arbitrageurs are able to arbitrage away the shock and re-align prices. After determining the individual arbitrage speed for each ETN, I run a cross-sectional regression of those speeds on various ETN characteristics that serve as limits to arbitrage. The main finding from this test is that the most significant limit to arbitrage arises when an issuer suspends creation of new ETN units. The effect of a suspension is a complete breakdown of the arbitrage mechanism, such that positive demand shocks persist indefinitely for suspended ETNs. If positive demand forces for a suspended ETN exceed negative demand forces, then the suspended ETN will trade at substantial premiums.

The second test incorporates various factors that serve as measures of the positive demand forces and the negative demand forces, combining those demand factors with the factors that limit arbitrage. The result is a complete model of ETN pricing based on demand traders and arbitrageurs that explains roughly 63% of the variation in ETN premiums under the model. The main finding from this test is that the most economically significant factor that causes ETNs to trade at average premiums is the combination of a demand factor and a limit to arbitrage. The demand factor involves exposure to an otherwise segmented market. Specifically, an ETN will be in high demand if it offers unique exposure to a difficult to access asset class or market with no competing products in the market offering similar exposure. When such an ETN is also subjected to issuer suspension, whereby the arbitrage mechanism breaks down entirely, the combination of the demand and limit to arbitrage increase the ETN's premium by 274 basis points. In addition to that main factor, the second test documents the significance of a number of other demand factors and limits to arbitrage that collectively explain much of the ETN premium puzzle.

Prior to the empirical tests, this chapter will discuss the noise trader/arbitrageur framework as it relates to the ETN market to provide context for the subsequent empirical discussion. The chapter will also supplement the motivation for the empirical tests that was provided in the Chapter 1 description of the ETN premium puzzle by examining the asymmetric distribution of premiums. The distribution results will provide further evidence of the ETN market's strong tendency to trade at positive premiums.

The rest of the chapter will proceed as follows: section 3.2 briefly discusses the related literature, section 3.3 outlines the noise trader / arbitrageur model as it relates to the ETN market, section 3.4 discusses the dataset, section 3.5 documents the asymmetric nature of ETN premiums, section 3.6 provides the results of an error correction model, section 3.7 conducts a panel regression on ETN premiums, and section 3.8 concludes.

3.2 Related Literature

The only prior literature attempting to explain the ETN premium puzzle is Diavatopolous, et al (2011), which only considers two factors in an attempt to explain ETN pricing. The two factors considered are daily trading volume and prior index returns; the authors find no significance in either factor. This paper is distinguished from Diavatopolous (2011) by utilizing an arguably more robust data set (as explained in Chapter 1) and examining a much more extensive model for ETN pricing by considering numerous pricing factors. Furthermore, while Diavatopolous (2011) find no significance in the pricing factors tested, this paper finds a number of significant results that explain the ETN premium puzzle. Cserna, et al (2103) examine the pricing of credit risk in ETN market prices by comparing a theoretical ETN price that accounts for credit risk against actual ETN prices, finding underpricing of credit risk. This paper finds similar results with respect to credit risk.

This paper is also related to the literature that examines the pricing of closed-end funds. The literature on closed-end funds has identified and investigated a number of empirical irregularities. Many prior papers have analyzed the closed end fund puzzle, including

Boudreaux (1973), which documents the puzzle and Thompson (1978), which examines the relationship between premiums and returns for closed-end funds, finding that a positive premium predicts negative abnormal returns for those funds, while a negative premium predicts the opposite. Berk and Stanton (2007) build off the models of Gemmill and Thomas (2002) and Ross (2002) to theorize that discounts in closed-end funds are primarily a function of fund manager ability and fees.

Given the relatively sparse literature examining the ETN premium puzzle, this paper should make a significant contribution to the field. The results of the empirical tests also provide additional empirical support for Shleifer and Summers' (1990) theoretical noise trader / arbitrageur approach to explaining a number of financial market anomalies.

3.3 The Noise Trader / Arbitrageur Framework for ETNs

The ETN premium puzzle is best analyzed under the noise trader / arbitrageur framework developed by De Long, et al. (1990) and Shleifer and Summers (1990). De Long, et al. (1990) develop a model consisting of irrational noise traders and rational arbitrageurs in which noise trader risk explains a number of asset pricing anomalies, including the closed-end fund puzzle. The dynamic between noise traders and arbitrageurs provides an equally convenient framework for explaining the ETN premium puzzle and the significance of the relevant pricing factors. However, rather than considering irrational noise traders and rational arbitrageurs, it is conceptually more intuitive in the ETN market to consider demand traders (both irrational and rational) and arbitrageurs. This section provides a qualitative discussion of that framework as it relates to the ETN market.

Market Participants under the Noise Trader/Arbitrageur Framework

Consistent with the noise trader / arbitrageur approach to finance, the ETN market can be considered to consist of the similar types of investors: (i) *demand traders*, whose participation in the ETN market tends to cause deviations of market prices from fundamental value (i.e. the indicative value in the case of ETNs), and (ii) *arbitrageurs*, whose active participation in the ETN market counteracts the effects of the demand traders, thus dampening the deviations and keeping market prices generally aligned with indicative values.

The substitution of *demand traders* for *noise traders* is not merely for semantic convenience. In the De Long, et al. (1990) model, *noise traders* are irrational by definition, trading from an uninformed position on false beliefs about the fundamental value of the assets. Asset prices deviate from fundamental value as a result of *noise traders* under their model. Sophisticated traders, or *arbitrageurs*, are rational by definition and exploit the misperceptions of the *noise traders* through profitable contrarian trades. The collective investment strategy of *arbitrageurs* serves to push asset prices back towards their fundamental value. As applied to the ETN market, the market actors can similarly be grouped into those actors whose trading causes deviations from fundamental value (i.e. *noise traders*) and those whose trading re-aligns prices (i.e. *arbitrageurs*). However, for ETNs, price deviations from fundamental value are not all irrational *per se*, so to treat all such trading as irrational *noise* is not appropriate. There are many inputs that factor into the demand function of a generalized *noise trader* with some factors being rational and others being irrational. For example, a rational factor includes unique exposure to an otherwise segmented market; foreign restrictions on equity ownership is a common form of a segmented market in asset pricing models (Bonser-Neal at al. (1990), Domowitz, et al. (1997), Stulz (1981), Eun and Janakiramanan (1986), Bailey and Jagtiani (1994)). One such segmented market is the Indian stock market. Significant barriers have existed historically preventing U.S. investors from gaining exposure to equity securities in India. As a result, any products offered in the U.S. that provide such exposure relatively efficiently will be in high demand. This demand will be particularly high for a given product when there are few, if any, alternatives. For such a product, it may be perfectly rational for demand traders to drive up the premium of the ETN linked to the Indian stock market. Indeed, such a product exists: the iPath MSCI India Index ETN (ticker: INP) issued by Barclays. Demand for exposure to this segmented market is perfectly rational and could lead to positive deviations from the indicative value, reflecting such a demand. In this case, rational trading occurs by non-arbitrageur traders. In general, this paper will remain agnostic in terms of any normative exposition of the particular demand function of such traders, but instead will collectively deem those traders as *demand traders*. The inputs to the demand function of a demand trader may be a mix of irrational and rational factors, so a *demand trader* is simply a market participant whose demand for an ETN product results in deviations from the indicative value. This includes both irrational noise traders and rational sophisticated traders, such as speculators and hedgers.

Along with demand traders, the ETN market also contains *arbitrageurs*, who standby ready to extract profits from the deviations caused by demand traders. Absent frictions, arbitrageurs will exploit the price discrepancy until ETN premiums (or discount) have reverted back towards zero and prices re-align. The arbitrage mechanism in the ETN market is both similar to the arbitrage mechanism for ETFs, but also crucially different. There are two primary arbitrage methods in ETNs, which mirror those of ETFs:

Arbitrage I: *(pure arbitrage)*	For discounts, i.e. when market price < indicative value, arbitrageur purchases notes at the deflated market price and redeems the notes for the higher indicative value.
	For premiums, i.e. when market price > indicative value, arbitrageur creates new notes for the lower indicative value and sells at the inflated market price.

Arbitrage II: (risky arbitrage)	Arbitrageur buys (sells short) at the lower (higher) market price when ETN trades at a discount (premium) and holds the notes until prices re-align and the discount (premium) disappears, thus exiting the position and collecting the arbitrage profits.

Arbitrage I is a purer form of arbitrage in which riskless arbitrage profits can be gained, while *Arbitrage II* is not a pure arbitrage and poses risks for the arbitrageur. The pure *Arbitrage I* method is the more effective arbitrage mechanism for keeping market prices aligned with indicative values and is functionally equivalent to the creation and redemption process in the ETF market. However, the institutional features of ETNs differ significantly from those of ETFs, causing a fundamental difference between the ETF arbitrage and the ETN arbitrage. In ETF arbitrage, authorized participants serve the role in creating and redeeming ETF shares, conducting pure *arbitrage I* in response to both discounts and premiums. When an ETF trades at a discount, the authorized participant can purchase the ETF shares at the lower market price and redeem those shares with the fund in exchange for the higher-valued basket of underlying securities. When an ETF trades at a premium, the authorized participant can purchase the cheaper underlying basket of securities and create a new ETF share at the higher market price. This process generally prevents ETFs from trading at substantial premiums or discounts. A similar process occurs in the ETN market, but takes fundamentally different forms and involves different players depending on whether the ETN is trading at a discount or at a premium.

The unique feature of the arbitrageurs in the ETN market is that the specific entity acting in the role of arbitrageur differs depending on the direction of the price deviation, unlike in the ETF market where the same authorized participants engage as arbitrageurs for both discounts and premiums. In the ETN market, on the downside, when the market price of an ETN deviates from the indicative value in the negative direction (i.e. a negative premium, or discount, exists), the arbitrageur is the same sophisticated trader monitoring the market for arbitrage opportunities as in any model with arbitrageurs (most likely high frequency trading firms, as in the ETF market). Under *arbitrage I*, the arbitrageur purchases the notes at the deflated market price and exercises the options to redeem the notes with the issuer for the higher indicative value. These "classic" arbitrageurs can be considered *market arbitrageurs*.

On the upside, when the market price deviates in the positive direction (i.e. a positive premium exists), there is no method for *market arbitrageurs* to conduct Arbitrage I. This is because the issuing financial institution of an ETN, i.e. the counterparty responsible for payment of the indicative value at maturity or upon redemption, is the only entity that can create new ETN units and has complete discretion over that creation. Therefore, for ETNs trading at a premium, a new potential arbitrageur enters the market: the issuer of the ETN. The issuer can issue new notes for the higher market price, but will only ultimately owe the lower indicative value upon redemption or maturity. The issuer acting as arbitrageur can be considered *issuer arbitrageurs*. Note, that while the issuer arbitrageur may also potentially play a role on the downside, its ability to conduct this arbitrage is limited since the issuer can only call the notes (i.e. automatically redeem) under specific market conditions in most cases. The primary implication of the existence of issuer arbitrageurs in addition to market arbitrageurs is that the asymmetry in the roles of arbitrageur results in asymmetric directions for the premiums.

Market arbitrageurs do have the ability to engage in Arbitrage II when an ETN is trading at a premium by short selling the ETN at the inflated market price and covering the short position at a later time when the market price realigns with the indicative value. However, this arbitrage strategy is risky and not a guarantee of pure arbitrage profits, thereby severely limiting the effectiveness of this arbitrage strategy to keep market prices aligned with indicative values. There is no mechanism for the market arbitrageur to conduct the pure Arbitrage I method when an ETN trades at a premium.

Limits to Arbitrage in the ETN Market

The institutional features of ETNs present significant limits to arbitrage in the ETN market – limits that will be shown empirically to have a significant economic impact on ETN premiums. The asymmetry in the ability of market arbitrageurs to conduct arbitrage along with the existence of issuer arbitrageurs is a primary driver of the limits, as well as certain frictions in the redemption process for market arbitrageurs conducting pure Arbitrage I on the downside. Shleifer and Summers (1990) identify two types of risks that limit arbitrage: (i) *fundamental risk*, in which the arbitrageur may suffer losses as result of an error in expectations of fundamental values (e.g. such as the realization of dividends exceeding prior expectations held by the arbitrageur), and (ii) *resale price risk*, in which the arbitrageur may suffer losses as a result of further price deviations that persist longer than the trade horizon of the arbitrageur. In each case, the existence of these risks limit the size of the positions taken by the arbitrageur, thus limiting the effectiveness of arbitrage in correcting pricing errors.

In the ETN market, arbitrageurs can be considered to face similar types of risk. Fundamental price risk occurs when the indicative value deviates from the expected indicative value. When this occurs during a pure Arbitrage I trade, the "riskless" arbitrage profit can become volatile during the execution of the trade. Resale price risk is the primary risk faced by arbitrageurs conducting risky Arbitrage II trades. For an arbitrageur conducting risky Arbitrage II, there is no guarantee that price deviations will not persist, or increase, longer than the trade horizon of the arbitrageur. As mentioned above, due to the resale price risk in Arbitrage II, this is generally an ineffective mechanism for price alignment.

For ETN discounts, there are a number of factors that serve as limits to arbitrage. In general, these factors add to the fundamental price risk faced by market arbitrageurs conducting pure Arbitrage I. Absent any arbitrage frictions, the market arbitrageur faces no fundamental price risk as there are no errors in the expectation about the indicative value that the arbitrageur will receive upon redemption. However, these arbitrage-limiting factors do impose arbitrage frictions, adding costs and uncertainty to the arbitrage opportunity. These limit to arbitrage factors include a minimum redemption size, a redemption lag, bid-ask spread, volatility of the underlying index, and the level of the VIX. Each of these factors will be discussed in more detail below.

For ETN premiums, only issuer arbitrageurs engage in arbitrage, bearing no fundamental price risk nor resale price risk, since they can simply hold the ETN as a liability on their balance sheet until maturity, at which point the prices re-align by construction. However, the absence of market arbitrageurs and the existence of issuer arbitrageurs as the sole arbitrageurs in the face of premiums introduces a substantial limit to arbitrage, most noticeably when the issuer publicly declares a refusal to play this role. This occurs when an issuer suspends creation of new ETN units – effectively declaring that it will not conduct arbitrage despite the emergence of a premium. Upon suspension of an ETN by the issuer, the only remaining arbitrageur to engage in arbitrage when the ETN trades at a premium is the market arbitrageur, who can only engage in the more risky form of Arbitrage II. However, since Arbitrage II imposes substantial resale price risk on the market arbitrageur, the market arbitrageur is severely limited in engaging in the arbitrage. As a result, when an issuer suspends issuance of an ETN, any positive demand shocks from demand traders that lead to premiums are left to persist in the absence of effective arbitrageurs in the market.

Demand Factors in the Demand Trader / Arbitrageur Framework

While the limits to arbitrage allow demand shocks to persist in the ETN market, it is the specific demand factors that will determine the levels of premiums and discounts. General trader "noise" may contribute to demand shocks, but the demand trader / arbitrageur framework will consider the rational demand factors that play a role in ETN pricing beyond simple noise. The demand factors that will be considered include exposure to segmented markets, credit risk of the issuer, annual management fees, tax considerations of specific classes of ETNs, and two specific ETN-related market events: the "TVIX effect" and FINRA's public advisory warning investors about the risks posed by ETNs. Each of these demand factors will be discussed in more detail below and the significance of each factor will be tested empirically in section 8.

Before examining the limits to arbitrage factors and demand factors in more detail, it will be useful to take a closer look at the premium/discount distribution in the ETN market, beginning with a discussion of the data.

3.4 Premium Data

The ETN data set that is used for all empirical analyses in this chapter was collected for 262 ETNs for the period beginning on the inception date of the first ETNs in June 2006 through the end of December 2013. Daily quotation data was collected from the Trade and Quote (TAQ) database. To obtain the closing national best bid and best offer (NBBO), I used a modified version of an NBBO algorithm provided by WRDS to extract the closing NBBO for each ETN. Using my modified algorithm, I collected the best bid and best ask quotes as of 4:00pm (Eastern Time) for all ETNs over the specified time period. I also collected data from Bloomberg, including (i) the daily indicative value as of 4:00pm, (ii) the daily volume of notes traded, (iii) daily total notes outstanding, (iv) fees, (v) leverage amounts for the ETN, and (vi) minimum notes required to redeem each ETN with the issuer. Daily credit default swap prices for the ETN issuers were also collected from Bloomberg. These included CDS prices on the 5-year senior unsecured corporate bonds for Barclays, Citi, Credit Suisse, Deutsche Bank, Goldman Sachs, HSBC, JPMorgan, Lehman Brothers, Morgan Stanley, RBS, and UBS. CDS prices on the 5-year senior unsecured debt of the Swedish government was also collected since the Swedish Export Credit Corporation (SECC) is an ETN issuer backed by the Swedish government.

As mentioned above, the market price for an ETN may deviate from this indicative value, such that the ETN trades at a premium or discount. For ease of notation, the premium/discount will simply be referenced as a premium, where a negative premium represents a discount. Unlike the methodology used in Diavatopoulos et al. (2011) which calculated ETN premiums based on the price of the last trade of the ETN, I used the midpoint of the closing bid and ask quotes to calculate the ETN premium. The distinction between the Diavtopoulos method and the method in this chapter is discussed in more detail in Chapter 1. Using this methodology, I constructed daily premiums for each ETN.

In levels, the definition of the ETN premium is the following:

$$\text{Premium}_t = P_t - IV_t \qquad (1)$$

where P_t is the market price of the ETN, determined by calculating the midpoint of the bid and ask quotes for the ETN at time t and IV_t is the indicative value per note at time t.

As a percentage of the ETN's indicative value, the premium becomes:

$$\text{Premium }\%_t = \text{Premium}_t / IV_t = (P_t - IV_t) / IV_t \qquad (2)$$

It will often be most convenient to quote the ETN premium percentage in basis points, given the range of premiums. In that case the ETN premium becomes:

$$\text{Premium }\%_t \text{ (bps)} = (P_t - IV_t) / IV_t \times 10{,}000 \qquad (3)$$

3.5 Evidence of Asymmetric ETN Premiums

The demand trader / arbitrageur framework hypothesizes that various demand factors impose both positive and negative pressures on ETN prices, which then persist at varying levels depending on the imposition of limits to arbitrage. The net result empirically is an ETN market that trades overall at average premiums with many individual ETNs having positive long-run equilibrium premium levels. The demand trader / arbitrageur framework also suggests that it is the asymmetry in the limits to arbitrage that leads to average ETN premiums.

The results in Chapter 1 illustrated the existence of average premiums in the ETN market and motivates the search for a solution to the premium pricing puzzle. However, before considering the various factors that determine the long-run equilibrium premium levels across ETNs, it will be informative to examine in detail whether the trading patterns of ETNs do indeed illustrate an asymmetric pattern, which could help explain the existence of average premiums. The summary statistics in Table 3.1 show preliminary evidence of such an asymmetric pattern. Across a sample of the top fifty ETNs ranked by market capitalization, the mean premium is 33 basis points, consistent with the findings in Chapter 1. But while the first moment of an ETN's premium (i.e. the mean) provides a glimpse into ETN pricing, it does not *per se* indicate any asymmetry in daily ETN premiums. Table 3.1 sheds more light on the asymmetric patterns of ETN premiums in multiple respects.

First, the table shows that the mean premium of ETNs on days when the ETN trades at a premium is substantially higher than the mean discount of ETNs on days when the ETN trades at a discount (i.e. negative premium). Column 5 of the table shows the mean premium on positive days and column 6 shows the mean premium on negative days. In aggregate, the mean premium on positive trading days is 94 basis points, while the mean discount on negative trading days is 31 basis points, which are statistically different from each other at a 1% level. The absolute values of the premiums are substantially higher than the absolute values of the discounts. Second, the table also shows that the empirical upper bound and lower bound for ETN premiums is far from symmetrical. Column 3 shows the minimum daily premium reached at any point and column 4 shows the maximum daily premium reached. The minimum and maximum, therefore, are indications of empirical bounds on the premium at both ends. As shown in the results, the maximum premium that has occurred is 136.38%, while the minimum premium (or maximum discount) was only -15.02%. The upper bound for premiums greatly exceeds the lower bound by a factor of nine.

Looking at the breakdown by issuer, for only 1 of the issuers (Morgan Stanley) is the mean premium on positive days not higher than the mean discount on negative days, while most of the other issuers have substantial differences. Barclays' ETNs trade at a mean premium of 125 basis points on positive trading days and a mean discount of 31 basis point on negative trading days. Credit Suisse ETNs trade at a mean premium of 178 basis versus a mean discount of 52 basis points. All differences are significant at a 1% level. The same is true across assets classes, except for currency. Commodity ETNs trade at a mean premium of 104 basis points on positive trading days and a mean discount of 31 basis points on negative trading days. Volatility ETNs are even more extreme, trading at a mean premium of 162 basis points on positive days and 52 basis points on negative trading days.

The factors involved in produced the asymmetric trading of ETNs will be considered in both a cross sectional regression of error correction terms and a panel regression of daily premiums.

Table 3.1
Premium Statistics by Issuer and Asset Class

This table shows premium statistics for a sample of exchange traded notes during the period beginning in June 2006 and ending in December 2013. The top panel shows statistics for each issuer and the bottom panel shows statistics for each asset class. The first column gives mean daily premiums listed in basis points, where premium is measured as (midpoint price - indicative value) / indicative value. The second column shows the standard deviation of the premium. The third column shows the minimum premium and the fourth column shows the maximum premium. The fifth column shows the mean premium for only positive premium days and the sixth column shows the mean premium for only negative premium days.

	Premium				Positive	Negative
Panel A: By Issuer	Mean	Std. Dev.	Min	Max	Mean	Mean
Barclays	55.11	507	-8.77%	136.38%	124.70	-31.15
Credit Suisse	65.39	324	-15.02%	89.17%	178.09	-51.97
Deutsche Bank	2.75	94	-11.08%	14.06%	51.10	-46.40
Goldman Sachs	4.39	33	-1.95%	3.23%	22.57	-20.73
HSBC	0.17	58	-3.21%	8.16%	40.88	-32.92
JPMorgan	21.11	85	-0.83%	4.94%	73.65	-10.64
Morgan Stanley	-6.24	38	-4.34%	5.38%	19.00	-23.66
Royal Bank of Scotland	1.82	11	-0.65%	0.63%	8.34	-7.36
Swedish Export Credit Corporation	8.54	43	-2.85%	5.77%	31.36	-20.99
UBS	20.98	135	-8.45%	22.52%	75.09	-16.49
Panel B: By Asset Class						
Commodity	43.42	432	-13.64%	136.38%	104.06	-30.55
Currency	-5.99	42	-4.34%	5.38%	20.54	-26.11
Equity	8.52	109	-6.92%	24.37%	52.88	-24.09
Fixed Income	2.55	48	-4.28%	5.79%	32.93	-30.31
Volatility	58.57	311	-15.02%	89.17%	161.69	-51.92
Total	33.20	353	-15.02%	136.38%	94.10	-30.64

In another test of the asymmetric trading of ETN premiums versus discounts, I look at the premium distributions across the top 100 ETNs by market capitalization. The presence of asymmetry in the positive direction should result in a distribution of premium levels that is skewed to the right and has increased kurtosis. Table 3.2 shows the results of this test.

Table 3.2
Distribution Characteristics for ETN Premiums

This table presents summary statistics for the distribution of the 3rd and 4th moments (skewness and kurtosis) for a sample of ETNs constituting the top 100 as ranked by market capitalization as of the end of 2013. Columns 1 and 2 show distribution statistics for premium percentages, measured as (midpoint price - indicative value) / indicative value. Columns 3 and 4 show distribution statistics for premium levels, measured as midpoint price - indicative value. The first row shows the percentage of ETNs in the sample that have positive skewness and excess kurtosis. The second and third rows show the percentage that have skewness and excess kurtosis greater than 1 or greater than 2. The mean, minimum, and maximum skewness and kurtosis of the sample are also shown. The sample period is June 2006 through December 2013.

	Percentage of ETNs with Characteristic			
Thresshold	Premium % Skewness	Premium % Excess Kurtosis	Premium Level Skewness	Premium Level Excess Kurtosis
Positive	70.0%	100.0%	68.0%	100.0%
>1	38.0%	98.0%	36.0%	98.0%
>2	26.0%	94.0%	20.0%	96.0%
Mean	1.10	19.60	0.92	21.79
Min	-2.81	0.71	-3.82	0.81
Max	8.56	81.63	8.44	107.90

Table 3.2 further illustrates the asymmetry in the direction of price deviations in the ETN market. For each of the top 100 ETNs, distribution statistics of the daily premium/discount were collected for each ETN individually, specifically the third and fourth moments, i.e. skewness and kurtosis, respectively. Distributions were constructed for both premium percentages (premium / indicative value) and premium levels. Table 3.2 presents the skewness and kurtosis results across the entire sample of ETNs. For premium percentages, 70% of the ETNs in the sample exhibit positive skewness, indicating a higher concentration of positive premiums than negative premiums (or discounts). The results are similar for premium levels with 68% of ETNs exhibiting positive skewness. More extreme levels of skewness are found in both premium percentages and levels with 38% and 36% having skewness higher than 1 for percentages and levels, respectively. Furthermore, 26% and 20% of ETNs have skewness higher than 2 for premium percentages and levels, respectively.

Table 3.2 also shows evidence that extreme premiums and discounts are more common than would be expected with a normal distribution as illustrated by the excess kurtosis statistics.[22] For premium percentages and levels, 100% of the ETNs exhibit positive excess kurtosis. In addition, 98% exhibit excess kurtosis greater than 1 for percentages and levels, and 94% and 96% exhibit excess kurtosis greater than 2 for percentages and levels, respectively. The levels of excess kurtosis are strong evidence that limits to arbitrage allow premiums and discounts to reach extreme levels. Absent limits to arbitrage, extreme values should be quickly arbitraged away, resulting in a normal distribution with no excess kurtosis.

Given the evidence of asymmetry in the ETN premiums with skewness in the positive direction and the prevalence of extreme levels of premiums and discounts shown by the excess kurtosis statistics, this study now turns to an exploration of the factors involved in the ETN premiums under the demand trader / arbitrageur framework.

3.6 Demand Factors and Limits to Arbitrage

Under the demand factor / arbitrageur framework, demand traders impose both positive and negative price pressure on ETNs based on the particular inputs to their demand functions. Arbitrageurs under the framework are not motivated by the demand factors, since they do not take directional positions in the ETNs, by definition of arbitrage. Rather arbitrageurs are motivated by demand-neutral arbitrage opportunities. However, the ability of arbitrageurs to conduct the demand-neutral arbitrage depends on any limits to arbitrage for a particular ETN. The demand factors and limit to arbitrage factor under this framework will be tested empirically in sections 3.7 and 3.8.

The relevant demand factors and limit to arbitrage factors were introduced briefly in section 3.3. This section describes the various demand factors and limits to arbitrage in more detail, beginning with the demand factors, then following with the limit to arbitrage factors, and concluding with the hybrid factors that combine demand and limits to arbitrage. Each of these will be the independent variables used in the cross-sectional regressions in section 3.7 and the panel regressions in section 3.8. The discussion of the factors will also include hypotheses on the sign of the coefficients.

---

[22] Excess kurtosis is the amount of kurtosis above 3, which is the kurtosis of the normal distribution. Positive excess kurtosis is indicative of kurtosis greater than 3.

Demand Factors

i. Annual Fees

Every ETN is assessed an annual fee that is similar to the management fee charged for ETFs, but often goes by different names (e.g. Barclays terms them "investor fees"). Fees range from 40 basis points to 200 basis points per year with a mean of 85 basis points across all ETNs. Management fees are consistently used as explanatory variables in asset pricing models involving investment management products (Ramadorai (2012), Cherkes et al. (2009), Berk and Stanton (2007)). Higher fees increase the cost to a demand trader to gain the desired exposure to an ETN's underlying index. Increased costs will decrease demand, thus putting downward pressure on ETN premiums. Furthermore, fees may contribute to tracking error. Tracking error is introduced when the indicative value deviates from the underlying index. The daily change in an ETN's indicative value is based on the daily movement of the underlying index minus the fee (fees are subtracted daily from the indicative value). Therefore, the fee imposes a downward drift on indicative values, which is not present in the underlying index. As a result of this asymmetric drift, annual fees introduce a level of tracking error to the ETN. Higher fees will lead to great drift and, therefore, greater tracking errors for the ETN which may lead to downward pressure on the premium. However, since the annual fee is a known cost to the demand trader that is already factored into the indicative value, it is not clear that this should intuitively lead to lower premiums. This demand factor will be tested in the panel regression.

ii. Counterparty risk and CDS Prices

Since ETNs are senior unsecured debt liabilities, the credit worthiness of the ETN issuer is theoretically an important demand factor for ETN pricing. ETN investors are exposed to the credit risk of the issuer and would suffer the same losses as other corporate noteholders of the same issuer. A vast amount of literature exists examining asset pricing models for corporate notes (see, e.g. Longstaff et al. (2005), Merton (1974), Geske (1977), Longstaff and Schwartz (1995), Leland and Toft (1996), Collin-Dufresne and Goldstein (2001)). Lower credit worthiness of the issuer should be a negative demand factor, putting downward pressure on ETN premiums.

The risk of loss is not merely theoretical. As documented in Chapter 2, losses due to default were borne out in the case of three ETNs issued by Lehman Brothers in 2008 and became precipitously close in the case of an ETN issued by Bear Stearns. The Bear Stearns ETN only staved off default as a result of JPMorgan's last minute purchase of Bear Stearns and the corresponding assumption of its assets and liabilities. At that point, the Bear Stearns ETN was transferred to the balance sheet of JPMorgan and ETN holders assumed the counterparty risk of JPMorgan. However, also shown in Chapter 2 was that ETN investors generally disregarded credit risk as pricing factor for ETNs prior to the Lehman Brothers failure. Credit risk did become a significantly priced factor for the two months following the failure, but became insignificant again by the third month. Given that an important institutional feature of ETNs is their status as debt liabilities, credit risk as a demand factor will be tested in the panel regression.

Various candidates exist as a proxy for measuring an issuer's credit risk. A common measure is the price of a credit default swap (CDS) on the issuer's corporate notes, which reflects the credit risk of the reference entity (Cserna et al. (2013), Longstaff et al. (2005), Pan and Singleton (2008), Hull and White (2001)). Since issuers often have multiple series of CDS trading on various tranches of debt, a choice must be made for a reference CDS price. The most liquid CDS have reference obligations as 5-years senior unsecured notes, so the demand factor for the panel regressions will be the CDS price on the issuer's 5-year senior unsecured notes.

iii. Segmented Market Exposure

When significant barriers to entry exist for a market, such as a foreign stock market, that market is termed a "segmented market." The effect of segmented markets on asset pricing has been explored in a variety of contexts in the literature (Bonser-Neal at al. (1990), Domowitz, et al. (1997), Stulz (1981), Eun and Janakiramanan (1986), Bailey and Jagtiani (1994)), but never in the context of the ETN market. Since one of the primary benefits of ETNs is efficient exposure to otherwise difficult or expensive to access asset classes, indices, and markets, the concept of segmented markets is equally relevant for trader demand.

One of the more prominent examples of a segmented market is the Indian stock market, which historically has had significant barriers to entry for U.S. investors due to foreign investment restrictions imposed by the Indian regulators. The U.S. ETN market opened up access to the Indian stock market when Barclays issued the iPath MSCI India Index ETN (ticker: INP), which provided exposure to an underlying index that tracks the top 71 companies by market capitalization on the National Stock Exchange of India. At its inception, INP was the only exchange traded product offering exposure to Indian equities and consequently traded at a premium of 87 basis points.

While INP is one example, many of the ETNs in the market offer unique exposure to an otherwise segmented market. In general, trader demand should be higher for ETNs that offer exposure to a market or asset class for which there are no competing exchange traded products (neither ETFs nor ETNs) as an alternative. The ETNs that offer unique exposure to a segmented market will be termed *segmented ETNs*. In theory, segmented ETNs should trade at higher premiums than non-segmented ETNs, since demand for exposure to the underlying indices of the non-segmented ETNs will be dampened by the availability of competing products. Demand for exposure to segmented ETNs will be relatively higher. As a result, an important demand factor will be an indicator variable of whether an ETN is segmented or not.

The determination of whether or not an ETN is segmented requires an identification process. In some case, the identification is straight forward. For example, the JPMorgan

Alerian MLP Index (ticker: AMJ) provided unique exposure to the Alerian MLP index at its inception, but subsequently UBS issued a competing product tracking the same index, the ETRACS Alerian MLP Index (ticker: AMU). In that case, AMJ began as a segmented ETN until the issuance of AMU, at which point neither AMJ nor AMU were segmented ETNs. Other cases of identification are also straight forward, such as ETNs that track single currencies or single commodities. In those cases, it is clear whether there are competing ETFs or ETNs tracking the same currency or commodity. However, in other cases, the identification is not as straight forward. Therefore, it is important to be more systematic in determining whether an ETN is segmented.

The method I employed to identify whether an ETN should be indicated as segmented or not was based on the correlation of returns of all ETNs' and ETFs' underlying indices. Specifically, if a given ETN tracked an underlying index that was highly correlated (e.g. 99% or higher) with the underlying index of an ETF or another ETN, then the test ETN would not be considered segmented. To employ this method, I first grouped all ETNs into their respective asset classes, as defined by Bloomberg. Next for each ETN, I calculated cross correlations of daily underlying index returns with all other ETPs in the same corresponding asset class. Using the resulting correlation matrix, I then classified each ETN as segmented if it was not correlated with any other ETP at a threshold of 99% or higher. For robustness, I also conducted the same identification process using a 98% correlation threshold, but the results did not change materially. Under this identification process, the demand factor for the regressions is an indicator variable for *segmented* ETNs.

iv. IRS Adverse Tax Ruling

The tax treatment of ETNs can generally be considered a positive characteristic of ETNs as compared to other alternatives, including ownership of the underlying assets directly or through a mutual fund or ETF (in some cases). The tax benefits of the ETF structure over the mutual fund structure has been examined in Poterba and Shoven (2002) and a fuller analysis of the tax treatment of ETNs versus ETFs is considered in Pahl (2012). Prior to a December 2007 IRS ruling, all ETNs had been characterized as prepaid forward contracts, whereby gains and losses were treated as capital gains, taxable upon the sale, redemption, or maturity of the ETN. This favorable tax treatment allowed investors to defer taxation on ETN holdings and pay taxes at a lower capital gains rate, rather than the ordinary income rate. Furthermore, since most ETNs do not pay interest, an ETN investor would never face ordinary income tax rates and had complete control over realization of gains and losses for tax purposes. This tax treatment is materially different than the tax treatment for ETFs. For example, while a volatility-linked ETN is only subject to capital gains upon the sale of the ETN, a volatility-linked ETF that owns futures must issue a schedule K-1 to each ETF investor annually, thus requiring the ETF investor to pay ordinary income tax on any gains to the ETF each year.

In December of 2007, the IRS materially changed the tax treatment for ETNs linked to currency indices through Revenue Ruling 2008-1.[23] As a result of this ruling, currency ETNs no longer received favorable tax treatment. Going forward, currency ETNs were re-characterized as debt instruments, whereby annual gains would be treated as interest and taxable as ordinary income each year, regardless of whether the investor actually recognized the gain through a sale. After the adverse tax ruling by the IRS, demand for currency ETNs should experience a noticeable drop. Therefore, the significant shift in tax treatment should have put downward pressure on the premiums for currency ETNs, while having no effect on non-currency ETNs. The demand factor used for the regressions is an indicator variable for currency ETNs on trade dates after the adverse IRS ruling, thus capturing the demand effect of this change in tax treatment.

v. The "TVIX Effect"

At the end of the trading session on February 21, 2012, Credit Suisse issued a brief press release in which it announced that it had "temporarily suspended further issuance of the Velocity Shares 2x VIX Short-Term ETNs (TVIX) due to internal limits on the size of the ETNs."[24] One month later on March 23, 2012, Credit Suisse reopened issuance of TVIX on a limited basis. As documented in Chapter 2, not only did the TVIX premium jump significantly as a result of Credit Suisse's suspension, but the effects reverberated throughout the entire ETN industry, regardless of asset class or issuer. For example, prior to the TVIX suspension, the PowerShares DB Agriculture Double Long (ticker: DAG) issued by Deutsche Bank traded at an average premium of 58 basis points. During the one month TVIX suspension period, DAG traded at an average premium of 300 basis points. After the suspension period ended, the DAG premium regressed back to 31 basis points. Even ETNs that historically traded at par (i.e. neither a premium nor discount) were affected. The VelocityShares 3x Inverse Gold (ticker: DGLD) traded at a premium of 4 basis points prior to the TVIX suspension, jumped to a premium of 41 basis points during the suspension, and then fell back to 0 basis points afterwards. Given the effect that the TVIX suspension had on the entire ETN market, the "TVIX effect" will be a demand factor including in the regressions as an indicator variable for premium dates falling between February 21, 2012 and March 22, 2012.

vi. FINRA's Warning to Investors

As a result of the market turmoil following Credit Suisse's suspension and subsequent limited reopening of TVIX issuances, the Financial Industry Regulatory Authority

---

[23] IRS Revenue Ruling 2008-1 (announced on December 7, 2007; published on January 14, 2008), available at https://www.irs.gov/irb/2008-02_IRB/ar08.html.

[24] TVIX Press Release

(FINRA) issued an Investor Alert on ETNs in July 2012.[25] The statement enumerated various risks associated with ETNs including credit risk, market risk, liquidity risk, price-tracking risk, holding-period risk, early redemption risk, and issuer conflicts of interest. While many of these risks were already outlined in each ETN prospectus, this was the first regulatory body to highlight these risks for the market as a whole and portrayed ETNs generally in a negative light. Therefore, it is likely that the FINRA announcement served to heighten the attention of demand traders to the various risks of ETNs. The expectation is that the negative statement by FINRA put downward pressure on demand for ETNs over a brief time period subsequent to the announcement. Given the attention to the Lehman failure lasted roughly one month, an indicator variable for the post-FINRA warning is included for the month following the FINRA announcement, thus capturing the demand effect of the warning.

Limits to Arbitrage Factors

i. Redemption Restrictions

All ETNs provide the investor the option to redeem the note directly with the issuer in exchange of the indicative value. As discussed in section 3.3, this option allows *market arbitrageurs* to exploit arbitrage opportunities that arise when an ETN trades at a discount. In that case, the *market arbitrageur* can purchase the ETNs at the discounted market price and then redeem the ETNs with the issuer for the higher indicative value. The *market arbitrageur* will continue to conduct the arbitrage trade until the discount disappears. In this manner, the arbitrage mechanism serves to ensure that ETNs do not trade at substantial discounts.

Any frictions that limit the ability of the *market arbitrageur* to conduct the redemption arbitrage will limit the effectiveness of the arbitrage mechanism in re-aligning prices when ETNs trade at a discount. Note that the redemption process does not serve an arbitrage purpose when ETNs trade at a premium. There are two primary restrictions to redemption that serve as limits to arbitrage: a minimum redemption size and a redemption lag. For each of these limits to arbitrage, the more severe the friction, the less effective the arbitrage mechanism, resulting in downward pressure on premiums since it becomes more difficult to arbitrage away discounts.

The first redemption restriction is the minimum redemption size. ETN issuers all impose minimum size thresholds for the number of notes investors must redeem to exercise the redemption option. These minimum thresholds vary from 5,000 to 1,000,000 notes with 50,000 being the most common. Higher minimum thresholds increase the limits to

---

[25] FINRA Investor Alert, *Exchange-Traded Notes—Avoid Unpleasant Surprises*, July 10, 2012, available at https://www.finra.org/investors/alerts/exchange-traded-notes%E2%80%94avoid-unpleasant-surprises.

arbitrage since *market arbitrageurs* face greater frictions in conducting the arbitrage. The higher the minimum threshold, the more capital that must be employed by the arbitrageur to conduct the arbitrage. Even more limiting is that the size of the arbitrage opportunity may be far less than the minimum redemption threshold. For example, if an ETN trades at a discount, but only 10,000 units are available, a minimum redemption threshold of 50,000 units will make the arbitrage opportunity much more risky. The *market arbitrageur* can purchase the 10,000 discounted units, but then must purchase an additional 40,000 units before locking in the arbitrage profit. Since there is no guarantee of the market price on the additional 40,000 units, the *market arbitrageur* faces substantial fundamental risk, thus imposing a limit to arbitrage. The minimum redemption size will therefore be a limit to arbitrage factor, but will be scaled by the total number of notes outstanding for the ETN. In this way, the limit to arbitrage factor is a measure of the *relative* minimum redemption size. For example, a 100,000 minimum threshold will impose greater arbitrage limitations on an ETN that has a total of only 150,000 notes outstanding than it will on an ETN with a total of 10 million notes outstanding. As the ratio of minimum threshold to total notes outstanding increases, limits to arbitrage increase, which will decrease the efficiency of the arbitrage mechanism for discounts, thus putting downward pressure on premiums.

The second redemption restriction is the redemption lag. The redemption process is typically embedded with a lag between an investor's commitment to redeem and the calculation of the indicative value that will be exchanged. As a result, an investor cannot be certain of the indicative value he will receive upon redemption. This uncertainty increases the risks to the *market arbitrageur*, thus limiting arbitrage. The main driver of the risk is the volatility of the underlying index. For ease of explanation, this limit to arbitrage based on the redemption lag will be discussed separately below as "Volatility of Underlying Index."

ii. Volatility of Underlying Index

As mentioned above, the lag between the ETN investor's commitment to redeem the notes and the determination of the final indicative value imposes a limit to arbitrage. The specific mechanics of the redemption process are illustrative in this respect. The typical redemption process requires the ETN holder to submit a binding redemption notice to the issuer by 4:00pm on day *t*. However, the indicative value that the ETN holder will receive in exchange for his redeemed notes is not determined until the close of trading on day *t+1*.

When an ETN trades at a discount, the *market arbitrageur* can capture an arbitrage profit by purchasing the notes at the discounted market price and redeeming the notes with the issuer at the higher indicative value. On day *t*, the *market arbitrageur* will decide whether to engage in the arbitrage based on the discount at the time,

$$DIS_t = IV_t - P_t \qquad (5)$$

where DIS_t is the level of the discount on day t, IV_t is the indicative value on day t and P_t is the market price on day t. Since the assumption is that the ETN trades at a discount, then $IV_t > P_t$, by construction, and $DIS_t > 0$.

However, while the arbitrageur purchases the ETN at the lower price, P_t, he will not necessarily receive IV_t upon redemption due to the lag. Instead, he will receive IV_{t+1} on day $t+1$. Therefore, the ultimate arbitrage profit received from the arbitrage trade conducted on day t is not DIS_t, but rather is,

$$ARB_t = IV_{t+1} - P_t \quad (6)$$

$$= (IV_t - \mathrm{P}_t) + (IV_{t+1} - IV_t)$$

$$= DIS_t + \Delta IV_{t+1} \quad (7)$$

where ARB_t is the arbitrage profit received and ΔIV_{t+1} is the change in indicative value from day t to day $t+1$. On day t, when the arbitrageur must commit to the trade, the first term of (7), DIS_t is known, but the second term of (7), ΔIV_{t+1} is unknown, introducing fundamental risk to the arbitrageur. The arbitrage opportunity has the following conditional mean and variance,

$$\mathrm{E}_t[ARB_t] = \mathrm{E}_t[DIS_t + \Delta IV_{t+1}]$$

$$= DIS_t + \mathrm{E}_t[\Delta IV_{t+1}] \quad (8)$$

$$\mathrm{Var}_t[ARB_t] = \mathrm{Var}_t[DIS_t + \Delta IV_{t+1}]$$

$$= \mathrm{Var}_t[\Delta IV_{t+1}] \quad (9)$$

For a mean-variance optimizing arbitrageur, a higher variance for arbitrage profit, equation (9), must be met with a higher expected arbitrage profit, equation (8). As seen in (9), the variance of the arbitrage profit depends on the variance in the change in indicative value during the redemption lag, t to t+1. From (7), it is seen that a higher expected arbitrage profit could come from either a higher *discount* or a higher first moment of the change in indicative value, or a combination of both. Given that the intraday conditional mean of the change in indicative value is likely to be static throughout the trading day, the arbitrageur will most likely demand a higher *discount* to account for the increase in risk. Therefore, the higher volatility of the indicative value will put downward pressure on discounts, since arbitrageurs will allow the discounts to increase (i.e premium decreases) before conducting arbitrage. This results entirely from the redemption lag imposed by the issuer. Since indicative values tracks the underlying indices, it is really the volatility of the underlying indices that effect the severity of the limit to arbitrage. Therefore, the volatility of an ETN's underlying index is included as a limit to arbitrage.

iii. Issuer Suspension of New Units

Only an ETN issuer can create new units of an ETN, differing significantly from ETFs where authorized participants can create new ETF shares. The creation of new ETN units by the issuer is functionally equivalent to any borrower issuing more corporate notes of a similar issue. In the demand trader / arbitrageur framework, the lack of a creation mechanism for market arbitrageurs imposes a significant limit to arbitrage. However, rather than the market arbitrageur conducting the arbitrage when an ETN trades at a premium, the issuer does have the ability to act as issuer arbitrageur in a similar manner. When trader demand increases, thereby pushing up ETN premiums, an issuer can meet this demand by issuing new additional units of the desired ETN. In effect, the issuer is conducting arbitrage since it will issue new units at the inflated market price, while only owing the lower indicative value upon maturity.

Most of the time, the issuer embraces the role as issuer arbitrageur, issuing new units when trader demand increases, thus keeping premiums from reaching significant levels. However, the issuer has sole and complete discretion over the issuance of new units and is under no obligation to do so. In a number of cases, the issuer publicly declares that it has suspended the issuance of new notes of a particular ETN. At that point, the issuer no longer acts as issuer arbitrageur, leaving no arbitrage mechanism in the market and producing a formidable limit to arbitrage (i.e. a complete limit to arbitrage).

When an ETN becomes suspended and a complete limit to arbitrage is imposed on premiums, the ETN is subject to virtually unbounded premiums that may result from demand traders. Any increase in demand from demand traders, regardless of the reason, will put positive price pressure on ETNs because the positive demand shocks cannot be countered by arbitrage. Even the subset of demand traders that are purely irrational noise traders can push up premiums with no mechanism to dampen the noise trader shocks. Therefore, an indicator variable for ETNs that have been suspended by the issuer will be included as a limit to arbitrage.

Hybrid Factors

A number of other factors exist that impact the pricing of ETNs that can be considered as both demand factors and limits to arbitrage. These so called hybrid factors include the bid-ask spread, a suspension-segmented market interaction factor and the VIX level for volatility-linked ETNs.

i. Bid-Ask Spread

The liquidity of an asset has been shown both empirically and theoretically to affect asset prices and returns (Amihud and Mendelson (1986), Pastor and Stambaugh (2003), Amihud (2002), Chordia et al. (2001), Jones (2001)). More specifically, liquidity has been shown to be a positively priced factor in particular for investment funds (Cherkes et al. (2009) for closed-end funds, Piccotti (2014) for ETFs, Ramadorai (2012) for hedge funds). It is therefore reasonable to expect an ETN's liquidity to be a priced demand factor for ETNs. An ETN with higher liquidity should be more attractive to demand investors, thus facing higher investor demand than an ETN with lower liquidity. The positive demand pressure should lead to higher premiums for more liquid ETNs. However, determining an appropriate proxy for liquidity as an ETN characteristic will be important.

While liquidity is an ambiguously defined term (see, e.g. Hicks (1962), Lippman and McCall (1986)), higher liquidity is typically associated with lower relative bid-ask spreads, corresponding to lower transaction costs for the security. Lower transactions costs should put upward pressure on prices through higher investor demand. Indeed, liquidity in the form of lower bid-ask spreads has been shown to be associated with lower expected returns, i.e. the higher investor demand as predicted (Amihud and Mendelson 1986). In the case of ETNs, this higher investor demand for a given ETN would be expressed through higher premiums. Pontiff (2006) shows the expected relationship between liquidity and premiums on closed-end funds, using inverse stock prices and market capitalization as proxies for liquidity rather than bid-ask spreads. However, the reason for this is that the dataset in Pontiff (2006) precedes decimalization of stock prices, so most bid-ask spreads were static at 1/8 of a dollar and did not contain much liquidity information. Since the ETN dataset in this paper does not have the same pre-decimalization issue, the relative bid-ask spreads can be used directly as meaningful proxies for ETN liquidity and, therefore, as demand factors. The intuitive pricing prediction for this demand factor is that lower (higher) relative bid-ask spreads should correspond to higher (lower) ETN premiums, reflecting demand traders' preference for more liquid securities.

The relative bid-ask spread factor for issuer *i* on day *t* is calculated as:

$$\text{Bid-Ask Spread}_{i,t} = (\text{Ask}_{i,t} - \text{Bid}_{i,t}) / (\text{Mid}_{i,t}) \qquad (4)\ ,$$

where $\text{Mid}_{i,t}$ is the midpoint of the $\text{Bid}_{i,t}$ and $\text{Ask}_{i,t}$ prices.

It can also be argued that the bid-ask spread is a relevant limit to arbitrage factor as well as a demand factor. Since higher bid-ask spreads increase the cost of the arbitrage trade, then that will be a significant limit to arbitrage for market arbitrageurs. Given the potentially dual characterization of the bid-ask spread as a demand factor and limit to arbitrage factor, it will be characterized as one of the other depending on the model. In the cross-sectional regression on limits to arbitrage in section 3.6, the bid-ask spread will be treated as a limit to arbitrage since it is indeed a relevant limit to arbitrage for purposes of that model. In the panel regression on all factors in section 3.7, it will be characterized as a demand factor given its usefulness as a proxy for liquidity.

ii. Suspension-Segmented Markets Interaction

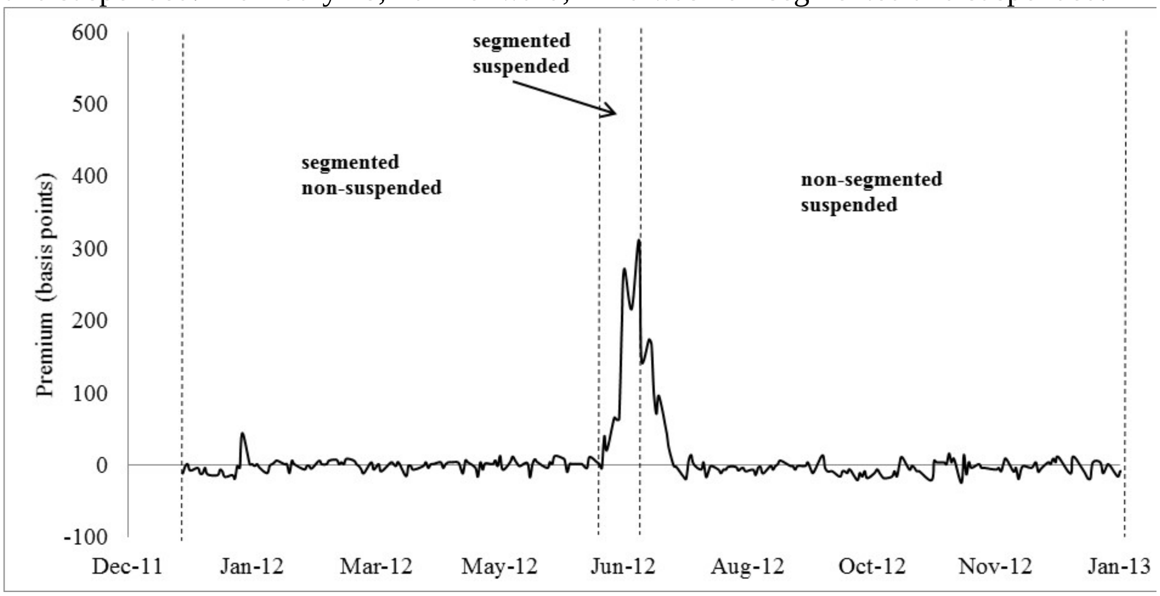
The issuer's suspension of an ETN is a significant limit to arbitrage that should put upward pressure on the premium for that ETN, since any positive shocks from demand traders cannot be dampened by arbitrage. The effect of suspension will be greater for ETNs that face higher demand than for ETNs with relatively lower demand. The most significant demand factor is the segmented factor, indicating whether an ETN offers unique exposure to a segmented market. Therefore, it should be the case that ETNs that are suspended and segmented experience higher premiums than if suspended and non-segmented.

Consider the potential effect of suspension on a non-segmented ETN. When the issuer suspends a non-segmented ETN, demand traders may still push up premiums due to the limit to arbitrage, but the premium level will be tempered by the existence of alternative products. Demand traders will push the premium to a certain extent, but once the premium becomes too expensive, they will find the alternative products more attractive and reduce demand for the suspended ETN. A suspended non-segmented ETN, therefore, will have a natural upper bound on the premium. Now consider the potential effect of suspension on a segmented ETN. In this case, there is no alternative product for demand traders to substitute, so the upper bound on premiums can reach significantly higher levels. Therefore, a hybrid factor is included that is indicator variable capturing the interaction of “suspended” and “segmented.”

To illustrate the substantial effect that the suspension-segmented factor has on premiums, the case of AMJ that was discussed in Chapter 2 is highlighted again briefly in Figure 3.1. The figure shows a time series of the premium on AMJ and also indicates its evolving status as both a segmented and suspended ETN. From inception through June 18, 2012, AMJ was not suspended and provided unique exposure to a segmented market (“segmented”). On June 19, JPMorgan suspended issuance of AMJ, so its status became suspended and segmented. The premium on AMJ jumped accordingly. On July 18, UBS issued a competing ETN, AMU, which provided exposure to the same underlying index as AMJ. Therefore, AMJ became non-segmented, but it remained suspended. As seen clearly in the graph, the changed from segmented to non-segmented caused a dramatic drop in AMJ’s premium despite it still being suspended.

Figure 3.1
The Daily Premium of AMJ

This figure plots the daily premium of the JPMorgan AMJ ETN. The plot shows three distinct time periods. From the earliest date through June 18, 2012, AMJ was segmented and non-suspended. From June 19, 2012 through July 17, 2012, AMJ was segmented and suspended. From July 18, 2012 onward, AMJ was non-segmented and suspended.



iii. VIX level

A number of ETN's provide exposure to volatility through a link to the VIX index. For purpose of ETN pricing, the dynamics of VIX movements become an important factor. A number of models of the VIX index illustrate a stochastic process that is mean-reverting (Whaley (1993), Grunbichler and Longstaff (1996), Detemple and Osakwe (2000), Lin and Chang (2009)). Given that the VIX is mean reverting, large increases in the level of the VIX are generally transitory shocks that dissipate in the short-term; that is positive jumps are likely followed by corresponding drops. Therefore, since high VIX levels are short-lived, an increase in a volatility-based ETN's indicative value due to the transitory increase in the VIX level will also be temporary. As a result, demand traders will likely discount the indicative value of a volatility-based ETN that is temporarily high due to jumps in the VIX, since the expectation is that the indicative will drop subsequently. The level of the VIX will therefore be treated as a demand factor. Furthermore, given that high VIX levels increase the volatility of the indicative value, due to the mean reversion of the index, market arbitrageurs will face increased fundamental risk when conducting arbitrage due to the redemption lag discussed above. Therefore, the level of the VIX is also a limit to arbitrage. Since the VIX level is potentially significant as both a demand factor and a limit to arbitrage factor, it will be grouped as a hybrid factor.

3.7 The Persistence of Demand Shocks and Limits to Arbitrage in the Cross Section

Under the demand trader / arbitrageur framework, the effect of an arbitrage-limiting factor is that it allows demand shocks to ETN premiums to persist for longer than if the arbitrage mechanism were not limited. Demand shocks can occur for various reasons, such as an increase in demand from rational speculators or simply from irrational noise traders. When a demand shock occurs, arbitrageurs are instrumental in dampening the shock to bring market prices back in line with the indicative value. However, limits to arbitrage impose frictions on the effectiveness of the arbitrage mechanism, thus inhibiting the ability of arbitrageurs to dampen the shock. As a result, the demand shocks persist for longer as the arbitrage process is less effective. This section will test this limit to arbitrage theory by considering demand shocks as exogenous and examining the significance of the limit to arbitrage factors in slowing down the price-correcting arbitrage mechanism.

As pointed out by Pontiff (1995) in the context of closed-end funds, premiums should reasonably be expected to be stationary in the long-run. When a shock to an ETN's long-run equilibrium premium occurs, an ETN with stationary premiums will mean revert back to the equilibrium over time. But the length of time for the mean reverting process can vary depending on the persistence of the shock. For some ETNs, the premium shock will be dampened quickly, while for other ETNs, the dampening will take more time as the shock persists for longer. The relative speed with which shocks are dampened is considered the error correction speed. The error correction speed is a measure of the efficiency of the arbitrage mechanism; faster error correction speeds correspond with more efficient arbitrage mechanisms. In this manner the error correction speed can be considered the *arbitrage speed*. The hypothesis under the demand trader / arbitrageur framework is that since the arbitrage mechanisms are instrumental in dampening premium shocks, the limit to arbitrage factors will affect arbitrage speeds. As limits to arbitrage increase, shocks will persist for longer periods of time and the length of the correction period will increase. If this hypothesis holds, then the limit to arbitrage factors can be combined with the demand factors, now as endogenous variables, in a fuller model that explains the ETN premium puzzle, which is done in section 3.8.

To test the limit to arbitrage hypothesis, I will empirically examine the effect of various limits to arbitrage factors on individual ETN's arbitrage speeds, i.e. the persistence of premiums or discounts, in the cross section of ETNs. The limits to arbitrage that are tested include the minimum redemption size, issuer suspension of new notes, the bid-ask spread, and the volatility of the underlying index. The results will indicate that these factors are significant in limiting the ability of arbitrageurs to dampen shocks with issuer suspension have the largest impact.

The following steps are employed to conduct the empirical test. First, I test the stationarity of individual ETN premiums, identifying those ETNs that exhibit mean reversion in daily premiums. Second, within that subset of ETNs with stationary premiums, each individual ETN's premium error correction speed (i.e. arbitrage speed) is calculated using the two-step error correction model established by Engle and Granger (1987). As explained above, the premium error correction term provides a measure of the persistence of a shock to the ETN premium. The hypothesis is that ETNs with lower limits to arbitrage should exhibit higher arbitrage speeds. Therefore, the final step to test this hypothesis entails a cross sectional regression conducted on the arbitrage speeds across all ETNs, regressed on the various limit to arbitrage factors that influence the costs and efficiency of arbitrage.

Stationarity and an Error Correction Model

To conduct the test of stationarity, I first estimate the cointegrating relationship between an ETN's indicative value and its market price with the regression:

$$P_{i,t} = a_i + b_i IV_{i,t} + \varepsilon_{i,t} \qquad (10),$$

where $P_{i,t}$ is the closing market price and $IV_{i,t}$ is the closing indicative value for ETN i on day t. The residuals, $\varepsilon_{i,t}$, are collected for each ETN and are used in the next step.

Using the residuals from the regression (10), I then conduct an augmented Dickey-Fuller test on 205 ETNs that had at least 12 months of daily trading data. This included ETNs that were still in existence as of the end of 2013 and ETNs that had been redeemed by the issuer prior to then. The test results showed 179 of the 205 or 87% of the ETNs rejecting a unit root at the 5% level, indicating stationarity for the premiums of 179 ETNs.

For the 179 ETNs exhibiting stationarity as determined by the augmented Dickey-Fuller test, I estimate the error correction model for the ETN premiums with the regression:

$$\Delta P_{i,t} = a_i + b_i\varepsilon_{i,t-1} + c_i\Delta P_{i,t-1} + d_i\Delta IVi_{,t} + \upsilon_{i,t} \qquad (11),$$

where $\Delta P_{i,t}$ is the one-day change in market price, $\Delta P_{i,t-1}$ is the lagged one-day change in market price, $\Delta IVi_{,t}$ is the one-day change in indicative value, and $\varepsilon_{i,t-1}$ is the lagged predicted residual from regression (10).

From equation (11), the estimate for b_i is the error correction term that measures the mean reversion speed of the ETN premiums. When a demand shock causes an ETN's market price to deviate further from its indicative value in either direction, the error correction term b_i indicates the speed with which that shock is dampened by arbitrageurs, thus re-aligning prices, i.e. the *arbitrage speed* for a given ETN. The sign on the error correction term b_i will be negative, indicating that the ETN exhibits mean reversion of the premiums; furthermore, lower values of b_i (i.e. more negative) correspond to faster arbitrage speeds, which is indicative of a more efficient arbitrage mechanism. For example, consider the comparison of a hypothetical ABC ETN that has an error correction term of -

0.95 and XYZ ETN that has an error correction term of -0.15. When a demand shock hits ABC on day t, the shock will be 95% corrected on day t+1. That is, the market price and indicative value will re-align by 95% within one day, since XYZ has an arbitrage speed of 95%. If that same demand shock were to hit XYZ, the shock would only be corrected by 15% within one day; ABC has an arbitrage speed of 15%. The shock to the premium would persist much longer for XYZ than for ABC. The arbitrage mechanism for ABC is much more efficient than the arbitrage mechanism for XYZ, illustrated by their respective error correction terms. If this were a positive demand shock, then XYZ would trade at a higher average premium than ABC, all else equal.

Table 3.3 shows the results of the error correction model for the 179 ETNs tested under regression (11). Summary statistics for the error correction terms b_i across issuers and across asset classes are produced. The first moment (mean) is listed along with the second moment (standard deviation) and minimum and maximum values. The entire sample of ETNs has a mean error correction term of -0.714, significant at a 1% level. Therefore, across all ETNs, demand shocks to the premiums are corrected by arbitrageurs at a daily rate of 71.4%, i.e. ETNs in aggregate have an arbitrage speed of 71.4%. The standard deviation of the aggregate error corrections terms is 0.292 with a minimum of -1.188 and a maximum of -0.028.

Table 3.3
Premium Error Correction Terms for ETNs

The table reports the results of a 2-step vector error correction model based on Engle and Granger (1987) for ETN premiums. The error correction terms for each ETN premium are estimated from the regression $\Delta P_{i,t} = a_i + b_i\varepsilon_{i,t-1} + c_i\Delta P_{i,t-1} + d_i\Delta IVi_{,t} + \upsilon_{i,t}$,

where $\Delta P_{i,t}$ is the one-day change in market price, $\Delta P_{i,t-1}$ is the lagged one-day change in market price, $\Delta IVi_{,t}$ is the one-day change in indicative value, and $\varepsilon_{i,t-1}$ is the lagged predicted residual from the regression $P_{i,t} = a_i + b_i IV_{i,t} + \varepsilon_{i,t}$.

		Premium Error Correction Speeds			
Panel A: By Issuer	# ETNs Cointegrated	Mean	SD	Min	Max
Barclays	72	-0.813	0.244	-1.056	-0.055
Credit Suisse	19	-0.791	0.247	-1.156	-0.378
Citigroup	1	-0.786	0.000	-0.786	-0.786
Deutsche Bank	30	-0.593	0.342	-1.188	-0.028
Goldman Sachs	2	-0.622	0.294	-0.916	-0.328
HSBC	1	-0.596	0.000	-0.596	-0.596
JPMorgan	1	-0.076	0.000	-0.076	-0.076
Morgan Stanley	6	-0.447	0.171	-0.770	-0.196
Royal Bank of Scotland	12	-0.714	0.257	-1.060	-0.076
Swedish Export Credit Corp	6	-0.589	0.115	-0.686	-0.320
UBS	29	-0.663	0.296	-1.014	-0.077
Panel B: By Asset Class					
Commodity	92	-0.741	0.296	-1.188	-0.028
Currency	13	-0.509	0.272	-0.956	-0.065
Equity	40	-0.621	0.274	-1.001	-0.076
Fixed Income	21	-0.859	0.249	-1.045	-0.213
Volatility	13	-0.820	0.130	-0.898	-0.378
Total	179	-0.714	0.292	-1.188	-0.028

The top panel of Table 3.3 shows the error correction terms grouped by issuer. Barclays, the largest ETN issuer, has a mean error correction term of -0.813, which is a daily correction of 81.3%. This is the fastest arbitrage speed among all issuers, indicating that the arbitrage mechanisms for the Barclays' ETNs are the most efficient among issuers. However, the distribution of arbitrage speeds among Barclays' ETNs is quite disparate. The fastest arbitrage speed among Barclays' ETNs is 105.6% (b_i of -1.056), meaning that the arbitrage process will almost immediately correct any mispricing. The slowest arbitrage speed for Barclays is at the other extreme at 5.5% (b_i of -0.055), meaning that the arbitrage process for that ETN is essentially broken and shocks to the premium persist for long periods of time.

The second largest ETN issuer, Deutsche Bank, has a significantly slower mean arbitrage speed of 59.3% (average b_i of -0.593), versus the 81.3% of Barclays. The slower arbitrage speed suggests that Deutsche Bank ETNs face more significant limits to arbitrage than Barclays' ETNs. This is likely due to the fact that Deutsche Bank has suspended the issuance of 75% of the ETNs it has issued. As hypothesized, issuer suspension is a significant limit to arbitrage and is likely responsible for the slow arbitrage speeds for Deutsche Bank. This hypothesis will be tested and confirmed in the cross sectional regression below. The lone JPMorgan ETN has the slowest arbitrage speed of 7.6% (b_i of -0.076), essentially indicating a broken arbitrage mechanism since demand shocks are quite persistent. Consistent with the Deutsche Bank hypothesis, the lone JPMorgan ETN with the slow arbitrage speed is AMJ, a suspended ETN.

But suspension is not the only limit to arbitrage. The Swedish Export Credit Corporation (SECC) has a relatively slow arbitrage speed of 58.9% with its maximum speed at only 68.6%, indicating an inefficient arbitrage mechanism. Suspension cannot explain the inefficient arbitrage mechanism for SECC, though, because it has never suspended any of its ETNs. However, SECC does have the highest minimum redemption sizes of all ETN issuers, which is another limit to arbitrage factor. As illustrated previously in table 1.12 of Chapter 1, the median minimum redemption size for SECC ETN's is 400,000 units, which is substantially higher than the 50,000 requirement of most ETNs. This relatively restrictive limit to arbitrage seems to have impacted the efficiency of the arbitrage mechanism for SECC, as evidenced by the slow arbitrage speed.

The bottom panel of Table 3.3 shows the error correction terms by asset class. The results indicate that ETNs linked to fixed income indices have the fastest mean arbitrage speed at 85.9% (b_i of -0.859) with a maximum speed of 104.5% and a minimum speed of 21.3%. At the other extreme, currency-linked ETNs have the slowest mean arbitrage speed at 50.9% (b_i of -0.509) with a maximum speed of 95.6% and a minimum speed of 6.5%. The other asset classes all fall within the range of 50.9% to 85.9%.

The results of the error correction terms in table 3.3 illustrate the vast cross-sectional disparity in arbitrage speeds. As hypothesized, much of the cross-sectional variation can be explained by variations in the efficiency of the arbitrage mechanism among ETNs. ETNs with efficient arbitrage mechanisms should have arbitrage speeds close to 100% (b_i close to -1.00), while broken arbitrage mechanisms lead to arbitrage speeds close to 0% (b_i close to 0.00). The limits to arbitrage factors, such as minimum redemption size and issuer suspension, are measures of the relative efficiency of an ETN's arbitrage mechanism, so should explain much of the arbitrage speeds.

Cross Sectional Regression

To test the significance of limits to arbitrage on arbitrage speeds, I conduct a cross-sectional regression of the individual ETN error correction terms on the limit to arbitrage factors. If the limit to arbitrage hypothesis holds, the limit to arbitrage factors will have significant explanatory power for the error correction terms. Since demand shocks are exogenous in this model, the demand factors should not have any significant explanatory power for the arbitrage speeds as they do not affect the arbitrage mechanism. A few select demand factors will be included in the regression to confirm their insignificance in relation to arbitrage. Note that the full panel regression in the following section 3.8 will endogenize the demand shocks, showing the overall significance of both demand factors and limits to arbitrage in the ETN premium puzzle.

The full cross-sectional regression takes the following form:

$$b_i = a_i + arbitrage_i + demand_i + e_i \,, \qquad (12)$$

where the dependent variable, b_i, is the error correction term for ETN *i* from regression (11) and $arbitrage_i$ is a vector of the limit to arbitrage factors and $demand_i$ is a vector of selective demand factors. The two vectors take the following form:

$$arbitrage_i = c_1 MIN\_REDEMPTION_i + c_2 BIDASK_i + c_3 INDEXVOL_i + c_4 SUSPENDED_i,$$

$$demand_i = d_1 CDS_i + d_2 SEGMENTED_i.$$

Descriptions of the independent variables in (12) can be found in Table 3.4. The results of the cross-sectional regression are presented in Table 3.5. Columns 1-3 show the regression exclusively on subsets of the limit to arbitrage factors, while the final column 4 shows the full regression that includes selected demand factors.

Three main results are illustrated in the cross sectional regression coefficients in Table 3.5, each confirming the hypotheses of the limits to arbitrage theory. First, all limit to arbitrage factors have statistically significant explanatory power for arbitrage speeds. As the severity of each limit to arbitrage factor for an ETN increases, the ETN’s arbitrage speed decreases accordingly. Second, the most significant limit to arbitrage factor is the issuer’s suspension of the ETN. Third, demand factors do not have any significant explanatory power for arbitrage speeds. Each of these results will be discussed in more detail.

Table 3.4
Independent Variable Definitions for Cross Sectional Regression

Arbitrage Variables	
MIN_REDEMPTION	= minimum number of notes required for redemption with the issuer, expressed in logs
BIDASK	= mean bid-ask spread as a percentage of midpoint price, expressed in basis points
INDEXVOL	= mean daily volatility of underlying index of ETN
SUSPENDED	= mean value of indicator variable equal to one if the issuer has suspended issuance of ETN and zero otherwise
Demand Variables	
CDS	= mean CDS price on issuer's 5-year senior unsecured notes
SEGMENTED	= mean value of indicator variable equal to one if ETN offers unique exposure to a segmented market and zero otherwise

Table 3.5
Cross Sectional Regression Results for Premium Error Correction Terms

The table reports the results of a cross sectional regression for a sample of exchange traded notes traded in the U.S. Only ETNs with a minimum of twelve months of trading data are considered. The dependent variable is each ETN's error correction term as estimated through a vector error correction model. Descriptions of the independent variables can be found in Table 3.4.

Independent Variables	(1)	(2)	(3)	(4)
MIN_REDEMPTION	0.236 ***	0.197 ***	0.186 ***	0.176 ***
	(3.07)	(2.60)	(3.13)	(2.82)
BIDASK		0.204 ***	0.229 ***	0.222 ***
		(2.89)	(4.14)	(3.97)
INDEXVOL			3.517 **	3.495 **
			(2.11)	(2.08)
SUSPENDED			1.004 ***	1.007 ***
			(8.86)	(8.86)
CDS				0.001
				(0.89)
SEGMENTED				0.031
				(0.55)
Constant	-3.38 ***	-3.05 ***	-2.99 ***	-3.10 ***
	(4.09)	(3.76)	(4.71)	(4.50)
F.E.	yes	yes	yes	yes
N	144	144	144	144
R-sq.	0.364	0.403	0.642	0.645

*** Significant at 1% level; ** significant at 5% level; *significant at 10% level

Result 1: *Limits to arbitrage factors are statistically significant explanatory variables for arbitrage speeds*.

As seen in column 1 of Table 3.5, an ETN's minimum redemption size is a statistically significant factor in slowing down the arbitrage speed, at a 1% level of significance. Given the coefficient of 0.236, a 1 standard deviation increase in the ETN's minimum redemption size results in a 0.145 increase in its error correction term. Thus, ETN's arbitrage speed slows by 14.5% for every 1 standard deviation increase its minimum redemption size. As hypothesized, higher minimum redemption sizes imposed by the issuer make it more difficult and more risky for market arbitrageurs to arbitrage away discounts, thus weakening the arbitrage mechanism. As a result, negative demand shocks persist for longer as minimum redemption requirements increase.

The regression in column 2 of Table 3.5 adds the bid-ask spread limit to arbitrage variable. In this regression, the minimum redemption size retains its statistical significance at a 1% level, as expected. The bid-ask spread is also a statistically significant factor in slowing down the arbitrage speed, at a 1% level of significance. Given the coefficient of 0.204, a 1 standard deviation increase in the ETN's relative bid-ask spread results in a 0.076 increase in its error correction term. Thus, an ETN's arbitrage speed slows down by 7.6% for every 1 standard deviation increase in its bid-ask spread. As hypothesized, as the relative bid-ask spread increases, the trading costs to conduct the arbitrage increase, thus lowering the arbitrage profits and weakening the arbitrage mechanism. As a result, demand shocks persist for longer as bid-ask spreads increase.

The regression in column 3 of Table 3.5 shows the results on all of the limit to arbitrage factors. In this regression, the minimum redemption size and bid-ask spread retain statistical significance, at a 1% level. The volatility of the underlying index is also a statistically significant factor in slowing down the arbitrage speed, at a 5% level of significance. Given the coefficient of 3.517, a 1 standard deviation increase in the volatility of the ETN's underlying index results in a 0.035 increase in its error correction term. Thus, an ETN's arbitrage speed slows down by 3.5% for every 1 standard deviation increase in the volatility of its underlying index. As hypothesized, the lag imposed by the issuer between a market arbitrageur's commitment to redeem the notes and the final determination of the indicative value increases the fundamental risk of the arbitrage opportunity, captured by the volatility of the underlying index. The increase in fundamental risk weakens the arbitrage mechanism. As a result, demand shocks persist for longer as the underlying index becomes more volatile.

The full limit to arbitrage regression in column 3 also shows that an ETN issuer's decision to suspend creation of new notes is also a statistically significant factor in slowing down the arbitrage speed, at the 1% level. Given the coefficient of 1.004, the effect of issuer suspension of an ETN is to increase the error correction term by 1.004. Thus, an ETN's arbitrage speed slows by 100.4% upon suspension, effectively indicating zero error correction, which is equivalent to the complete absence of an arbitrage mechanism. This dramatic effect is discussed in Result 2.

Result 2: *Issuer suspension is the most significant limit to arbitrage for ETNs*

The fact that issuer suspension of an ETN slows arbitrage speeds by 100.4% suggests that the arbitrage mechanism becomes entirely broken upon suspension. Of all the limit to arbitrage factors, suspension has the largest impact on the arbitrage mechanism by a wide margin. As hypothesized, when an issuer suspends creation of new notes for an ETN, the issuer effectively removes itself as issuer arbitrageur from the market, leaving only market arbitrageurs. Since market arbitrageurs have no mechanism to conduct pure arbitrage and dampen the shocks, any premiums that arise are left to persist indefinitely. The magnitude of the drop in arbitrage speed of 100.4% indicates that a positive demand shock to a suspended ETN will be a permanent premium shock rather than a transitory shock, since no arbitrage mechanism exists to correct the shock and re-align prices. This is a particularly troubling result since issuers retain complete and sole discretion over the decision to suspend issuance of an ETN. The efficiency of an ETN product in providing exposure solely to the underlying index, while not overexposing the investor to the volatility of the premium is entirely subject to the whim of the issuer.

The effect of suspension on the arbitrage mechanism is not symmetrical, which will have important implications for the explanation of the ETN premium price puzzle in section 3.8. Suspension only breaks the arbitrage mechanism for dampening positive premium shocks, while negative premium shocks are unaffected by suspension. This asymmetry means that discounts of suspended ETNs will be eliminated by arbitrage, while premiums will be left to persist. The result is an ETN that trades at an average positive premium. The magnitude of the positive premium will be determined by the demand factors. As will be shown in the full panel regression in section 3.8, the effect of suspension is greatest when it is combined with the strongest positive demand factor, namely unique exposure to a segmented market.

Result 3: *Demand factors do not have any significant effect on arbitrage speeds, so are neutral in terms of an ETN's arbitrage mechanism.*

The final column of Table 3.5 shows the full regression on the limit to arbitrage factors and a select few demand factors. The demand factors chosen were the CDS price of the issuer and the indicator variable for whether the ETN provides unique exposure to a segmented market. The inclusion of the demand factors in the cross-sectional regression did not impact the statistical significance of the limit to arbitrage factors, which all retain their respective levels of significance. As expected, neither the issuer's CDS price nor an ETN's unique exposure to a segmented market are statistically significant factors for error correction terms. This result in unsurprising as the demand factors have no apparent impact on the arbitrage mechanism. While the demand factors would affect the level of the demand shock that is introduced, the demand shock is exogenous in this model since only the strength of the arbitrage mechanism is tested. Other demand factors were also tested with none showing any statistical significance. Two were chosen for illustrative purposes, but others could have been added or substituted with no material change in the results.

Overall, the cross-sectional regression supports the hypotheses of the limit to arbitrage theory of the demand trader / arbitrageur framework. The upper and lower bounds on premiums will fluctuate with the strength of the arbitrage mechanism as determined by the limit to arbitrage factors. However, the limits to arbitrage are only part of the demand trader / arbitrageur story. While the limits to arbitrage dictate the persistence of demand shocks, the demand factors determine the magnitude of the shocks. It is the combination of the demand factors and the limits to arbitrage that explain the ETN premium pricing puzzle.

3.8 Explaining the ETN Premium Puzzle

The preceding section considered demand shocks to be exogenous and focused solely on a test of the limit to arbitrage hypotheses, explaining the impact of limits to arbitrage on the arbitrage mechanism for ETNs, as measured through arbitrage speeds. This section will now turn to a full test of the demand trader / arbitrageur explanation for the ETN premium puzzle. In this full explanation of the puzzle, demand factors will be endogenous to the model along with endogenous limits to arbitrage. Together, these factors explain much of the ETN premium puzzle.

The explanation of the ETN premium puzzle under the demand trader / arbitrageur framework hypothesizes that multiple dynamics in the ETN market lead to average positive premiums. First, various demand factors for ETNs cause demand traders to put price pressure on ETNs, thus resulting in the market price deviations from the indicative value. These demand factors should partially explain premiums in the panel data. Second, limits to arbitrage affect the ability of arbitrageurs to re-align prices when demand traders cause price deviations. The cross-sectional regressions in section 3.7 illustrate the significance of the limit to arbitrage factors. Finally, the most important dynamic under this framework is the interaction between the demand factors and the limits to arbitrage. The ETNs with the strongest demand factors and the weakest arbitrage mechanism (i.e. strongest limits to arbitrage) should see the highest levels of premiums or discounts depending on the specific factors. As it turn out empirically in the panel regression below, the most significant interaction is between the limit to arbitrage factor of suspension and the demand factor of unique exposure to a segmented market. An ETN that provides unique exposure to a segmented market is faced with strong upward price pressure from demand traders. If that same ETN has had the arbitrage mechanism weakened due to issuer suspension, then the increase in premiums from the demand traders will be left to persist at increasingly high levels. This dynamic is the primary explanation for the ETN premium puzzle.

The empirical test of the demand trader / arbitrageur framework is conducted through a panel regression on ETN premiums over time and across ETNs, taking the form:

$$Prem_{i,t} = a_i + demand_{i,t} + arbitrage_{i,t} + hybrid_{i,t} + e_{i,t} , \qquad (13)$$

where $Prem_{i,t}$ is the premium for ETN *i* on day *t*, expressed in basis points, and

a_i = constant representing premium not accounted for by demand or arbitrage variables

$$demand_{i,t} = b_1 BIDASK_{i,t} + b_2 FEE_{i,t} + b_3 CDSRETURN_{i,t} + b_4 SEGMENTED_{i,t} + b_5 TVIX_{i,t} + b_6 FINRA_{i,t} + b_7 CURRENCY_{i,t} ,$$

$$arbitrage_{i,t} = c_1 NO\_MINREDEM_{i,t} + c_2 SUSPENDED_{i,t} + c_3 INDEXVOL_{i,t} ,$$

$$hybrid_{i,t} = d_1 SUSPENDED\_SEGMENTED_{i,t} + d_2 VIX_{i,t}.$$

Descriptions of the independent variables in (13) can be found in Table 3.6.

Table 3.6
Independent Variable Definitions for Panel Regression

Demand Variables	
BIDASK	= bid-ask spread as a percentage of midpoint price in basis points
FEE	= annual fee charged by issuer in percentage points
CDSRETURN	= daily return of CDS price on issuer's 5-year senior unsecured notes
SEGMENTED	= indicator variable equal to one if ETN offers unique exposure to a segmented market on date *t* and zero otherwise
TVIX	= indicator variable equal to one if date *t* falls during TVIX's suspension from 2/21/2012–3/22/2012 and zero otherwise
FINRA	= indicator variable equal to one if date *t* falls within 1 month after FINRA's Investor Alert for ETNs on 7/10/2012 and zero otherwise
CURRENCY	= indicator variable equal to one if ETN is currency-linked and date *t* falls after the IRS tax ruling on 12/7/2007 and zero otherwise
Arbitrage Variables	
NO_MINREDEM	= total number of notes outstanding divided by the minimum number of notes required for redemption with the issuer
SUSPENDED	= indicator variable equal to one if the issuer has suspended issuance of ETN on date *t* and zero otherwise
INDEXVOL	= daily return of underlying index of ETN in basis points
Hybrid Variables	
SUSP_SEGM	= indicator variable representing the interaction of *SUSPENDED* and *SEGMENTED* variables, equal to one if ETN is segmented and suspended on date *t* and zero otherwise
VIX	= level of the VIX index

Table 3.7
Panel Regressions on ETN Premiums

The table presents the results of panel regressions on ETN premiums. The dependent variable is the daily premium in basis points. The definitions of the independent variables are found in Table 3.6. Column 1 is a regression on a subset of demand factors. Column 2 is a regression on the full set of demand factors. Column 3 is a regression on the set of arbitrage factors. Column 4 is the full panel regression on all factors. Column 5 shows the economic significance of the coefficients in column 4 based on a 1 standard deviation move in the factor. Numbers in parentheses are z-scores.

Independent Variables	(1)	(2)	(3)	(4)	1 SD
BIDASK_SPREAD	-0.146 ***	-0.146 ***		-0.192 ***	-17.02
	(9.65)	(9.66)		(12.79)	
FEE	-24.65	0.290		0.156	0.02
	(0.24)	(0.08)		(0.51)	
CDSRETURN	-30.96	-30.21		-16.62	-0.80
	(1.01)	(1.00)		(1.20)	
SEGMENTED		57.72 ***		33.80 ***	33.80
		(8.34)		(5.26)	
TVIX (2/21/12-3/22/12)		53.11 ***		48.25 **	48.25
		(10.91)		(9.98)	
FINRA (7/10/12-8/10/12)		-12.66 ***		-15.66 ***	-15.66
		(4.46)		(5.55)	
CURRENCY (post 12/7/07)		-15.46 ***		-9.67 **	-9.67
		(2.21)		(0.79)	
NO_MINREDEM			0.087 ***	0.085 ***	29.21
			(4.77)	(5.55)	
SUSPENDED			168.32 ***	14.99 ***	14.99
			(31.39)	(2.88)	
INDEXVOL			-0.065 ***	-0.064 ***	-20.48
			(10.80)	(10.81)	
SUSP_SEGM				273.95 ***	273.95
				(11.33)	
VIX				-2.31 ***	-15.71
				(3.82)	
Constant	14.21	-5.78	26.85 *	10.24	
	(0.45)	(0.18)	(1.70)	(0.36)	
F.E.	yes	yes	yes	yes	
N	133,147	133,147	133,147	133,147	
R-sq.	0.032	0.165	0.484	0.631	

*** Significant at 1% level; ** significant at 5% level; *significant at 10% level

The results of the panel regression of equation (13) are shown in Table 3.7. The sample of ETNs included in the regression are all ETNs issued since the inception of the first ETN in June 2006 with at least 12 months of trading data. The time period for the data is June 2006 through December 2013. The results of the panel regression identify a few main results:

(i) Overall, the identified factors under the demand trader / arbitrageur framework explain 63.1% of the premium variation under the model.

(ii) The issuer's suspension of new unit creation is the single most economically significant factor affecting ETN premiums. The suspension of an ETN adds 168 basis points to the premium. Moreover, the effect of suspension is greatest on those ETNs that offer unique exposure to a segmented market (i.e. no competing products exist that offer exposure to a similar index). This fact is represented by the interaction variable for suspension and segmented. The suspension of a segmented ETN adds 274 basis points to an ETN's premium.

(iii) The statistically significant demand factors are the bid-ask spread, unique exposure to a segmented market, the "TVIX effect," the FINRA warning, and the post-IRS currency indicator. The annual fee and credit risk are not significant demand factors. Together, the demand factors explain 16.5% of the premium variation under the model.

(iv) The statistically significant limit to arbitrage factors are the ratio of notes outstanding to the minimum redemption size, the issuer's suspension of new note creation, and the volatility of the underlying index. The bid-ask spread can also be characterized as a limit to arbitrage factor and is statistically significant. Together, the limit to arbitrage factors explain 48.4% of the premium variation under the model.

(v) The limit to arbitrage factors on their own explain substantially more of the premium variation that do the demand factors on their own. This indicates that the limits to arbitrage as a group have a greater impact on ETN pricing than do the demand factors as group. The largest impact, though, comes from the combination of the factors.

(vi) Despite ETNs being unsecured debt liabilities, the credit risk of the issuer is not a significantly priced factor.

The results of the panel regression will be discussed in more detail below.

Parsimonious Regression on Demand Factors

The results of the panel regressions on the demand factors are shown in columns 1 and 2 of Table 3.7. First, consider column 1, showing the regression on the subset of demand factors that exclude the indicator variables. The relative bid-ask spread is a significant demand factor, putting downward pressure on the premium of ETNs, while the annual fee and the CDS price are not statistically significant demand factors. The relative bid-ask spread is a measure of liquidity with higher spreads corresponding with lower liquidity, thus resulting in lower demand. Similar to the results found in other investment management contexts (Cherkes et al. (2009) for closed-end funds, Piccotti (2014) for ETFs, Ramadorai (2012) for hedge funds), the ETN market does reward liquidity as the negative sign on the bid-ask spread coefficient indicates that higher spreads result in lower premiums.

Regarding annual fees, while the significance of fees has been found in other investment management products (Ramadorai (2012), Cherkes et al. (2009), Berk and Stanton (2007)), there is no significant effect of annual fees on the premiums and discounts for ETNs. A partial explanation for this lack of significance could be the correlation between investor fees and segmented market exposure. Higher fees are likely to be associated with ETNs in highly segmented markets, either because the issuer must offset higher hedging costs or because the issuer can extract higher fees due to demand, or a combination of the two. Regardless, higher fees may proxy for higher trader demand. In that case, fees would produce offsetting effects: higher fees put negative pressure on premiums as is the case in the closed end fund literature (e.g., Boudreaux (1973), Pontiff (1996), and Gemmil & Thomas (2002)), while at the same time higher fees are indications of higher investor demand, which has positive price pressure. These two effects likely negate each other, leaving fees with no explanatory power.

Regarding credit risk, consistent with the partially related findings of Cserna, et al. (2013), credit risk is not a significantly priced demand factor for ETNs. As documented in Chapter 2, the ETN market largely ignored credit risk prior to the Lehman Brothers' bankruptcy filing. While the market subsequently priced credit risk into ETN premiums for a brief period of time, the significance was fleeting and dissipated within months. The lack of credit risk significance could be the result of a number of factors. It may be the result of investor inattention or ignorance of the risk, as was likely the case in the Lehman example. Alternatively, it may be that ETN investors have more confidence in the credit worthiness of ETN issuer than do investors in the CDS market. The fact that each of the ETN issuers, other than SECC, has been designated by the Financial Stability Board as global systemically important banks (G-SIBS) may suggest that the ETN market has considered these institutions as "too big to fail."[26]

Overall this subset of demand factors, which excludes the indicator variable demand factors, explains very little (3.2%) of the variation in premiums across all ETNs.

Next, consider column 2 of Table 3.7, showing the regression on the entire set of demand factors. The addition of the indicator variable demand factors increases the overall explanatory power of demand factors from 3.2% to 16.5% of the premium variation under

---

[26] Financial Stability Board, 2014, Update list of global systemically important banks, Nov. 6, 2014.

the model. Of the additional demand factors, the segmented factor is the most economically significant factor of the pure demand factors. ETNs that offer unique exposure to a segmented market have a premium increase of 58 basis points. As hypothesized, trader demand for an ETN product increases when no alternative competing products are available, thus putting positive pressure on the ETN premium.

The three other demand factors are also statistically significant. The TVIX coefficient has a positive sign, indicating that the suspension period from February 22, 2012 through March 22, 2012 (i.e. the “TVIX effect”), when Credit Suisse temporarily suspended issuance of TVIX, resulted in positive pressure on ETN premiums throughout the market during that period. Chapter 2 provided details of the overall effects of the TVIX suspension on the market. The FINRA coefficient has a negative sign, as the FINRA Investor Alert that warned investors about the risks of ETNs put downward pressure on ETN premiums for the month following the warning. Finally, the post-IRS currency factor also has a negative sign, as the adverse tax treatment imposed on currency ETNs by the IRS in December 2007 resulted in downward pressure on currency ETNs after the ruling.

As a group the demand factors explain roughly 16.5% of the premium variation in the model, leaving much to be explained. The limit to arbitrage factors will provide much greater explanatory power for ETN pricing.

Parsimonious Regression on Limits to Arbitrage Factors

Column 3 of Table 3.7 shows the results of the panel regression on the limit to arbitrage factors. The most prominent finding is that the limit to arbitrage factors as a group explain substantially more of the premium variation under in the model than do the demand factors. The R-squared of the panel regression on the demand factors alone was 0.165, compared to an R-squared of 0.484 for the arbitrage factors alone. The panel regression results indicate that limits to arbitrage across ETNs have a significantly larger impact on the pricing of ETNs than do the effects of demand traders in the market.

The most economically significant limit to arbitrage is the issuer suspension of new units. As shown in column 3, suspension of an ETN causes a 168 basis point increase in the premium. This illustrates the dramatic impact on ETN prices that issuers can unilaterally impose by suspending issuance. The magnitude of the effect of suspension on limiting the arbitrage mechanism was also highlighted in cross-sectional regression above in section 3.7. As hypothesized, by removing themselves as *issuer arbitrageur*, issuers that suspended issuance of an ETN effectively cause the upper bound on premiums of that ETN to increase substantially, allowing premiums to reach extreme levels (e.g. nearly 90% in the case of TVIX). The level of the effect of suspension becomes even greater when demand factors are also considered.

Restrictions on the redemption process also have a significant effect on the limits to arbitrage and consequently, on ETN prices. The limit to arbitrage factor in the panel regression is the ratio of an ETN's total notes outstanding to the minimum redemption size. The positive coefficient indicates that as the ratio increases, premiums increase. More intuitive is the converse, lower ratios correspond to lower premiums, which is expected since lower ratios are indications of greater limits to arbitrage. The lower the ratio, the more difficult and risky it is for *market arbitrageurs* to conduct arbitrage on discounts. Thus, discounts can reach deeper levels and persist for longer when the ratio is lower.

The final pure arbitrage factor, the volatility of the index return, is also a significant factor in the pricing of ETNs. As hypothesized in the discussion in section 3.6, higher volatility of an ETN's underlying index imposes greater fundamental risk on a *market arbitrageur* conducting arbitrage of a discount. This is due to lag between the investor's commitment to redeem the notes with the issuer and the ultimate indicative value received, thus adding uncertainty to the arbitrage profit available. As the volatility increases, the limit to arbitrage increases and discounts are likely to persist for longer and reach deeper levels. This is confirmed by the negative sign on the index volatility coefficient.

As a group the arbitrage factors explain roughly 48% of the premium variation under the model, which is an improvement over the pure demand factors. However, a combination of the demand factors and arbitrage factors, along with factors affecting both demand traders and arbitrageurs, has the greatest explanatory power for ETN pricing under this model.

Full Regression on Demand, Limits to Arbitrage, and Hybrid Factors

The complete empirical test of the model in equation (13) is expressed in the final column of Table 3.7. The combination of demand factors, arbitrage factors, and the two hybrid demand-arbitrage factors, explain 63% of the premium variation under the model. In addition to the demand factors and limit to arbitrage factors, this regression includes an interaction variable for the segmented demand factor and the suspended limit to arbitrage factor, capturing the effect of suspension on ETNs that offer unique exposure to a segmented market. The second hybrid factor is the level of the VIX, which affects both demand traders and arbitrageurs.

The demand trader / arbitrageur story becomes clearer in the full panel regression, primarily given the economic significance of the suspended-segmented interaction variable, and given the decline in economic significance of both the suspension factor and the segmentation factor as separate variables. The coefficient on the suspended-segmented interaction variable indicates that a segmented ETN that has been suspended by its issuer will experience upward pressure on its premium by 274 basis points. At the same time, suspension on its own now only accounts for a 15 basis point increase in premiums and segmentation on its own now only accounts for a 34 basis point increase. The demand trader / arbitrageur framework helps to explain the dynamics.

The suspension limit to arbitrage variable on its own results in a 168 basis point increase in premiums when the effect of demand factors are not also considered, as shown in the column (3) regression. However, as hypothesized, the weakening of the arbitrage mechanism that occurs from suspension should have the greatest impact on the ETNs with the strongest demand factors. The demand factor regression in column (2) shows that segmentation is the most meaningful demand factor, resulting in a 58 basis point increase when limits to arbitrage are not also considered. Therefore, combining the suspension factor with the segmented factor through the interaction variable illustrates the hypothesized result: a 274 basis point increase in premium. Once the model accounts for the effect of suspension on segmented ETNs, the residual effect of suspension on its own primarily captures the effect of suspension on non-segmented ETNs, which has a far lower impact on premiums: only 15 basis points. This is because demand traders can substitute suspended non-segmented ETNs with alternative competing products, thus preventing premiums on those ETNs from experience much of an increase. Furthermore, once the model accounts for the effect of segmentation on suspended ETNs, the residual effect of segmentation on its own primarily captures the effect of unique exposure to segmented markets for ETNs in which the issuer still conducts issuer arbitrage by creating new units, which will put an upper bound on the premiums for segmented ETNs that are not suspended: the premium increase drops to 34 basis points for those ETNs.

The other hybrid demand-arbitrage factor considered is the level of the VIX index, which is shown to be a statistically significant factor with a negative sign, as expected. Given the mean reverting tendency of the VIX index, a high level of the VIX will be viewed as a temporary shock to the index (Whaley (1993), Grunbichler and Longstaff (1996), Detemple and Osakwe (2000), Lin and Chang (2009)). Thus, even though the indicative value increases in volatility ETNs, demand traders view this as a temporary, so are likely to underprice the ETN accordingly. Furthermore, *market arbitrageurs* are likely to allow the negative premium generated by spikes in the VIX to persist for the same reason. For volatility ETNS, the fundamental price risk faced by *market arbitrageurs* is conditional on the level of the VIX, as the mean reversion tendency of the VIX increases the riskiness of the arbitrage through the one day lag between the arbitrageur's redemption commitment and the indicative value it will receive. As a result, *market arbitrageurs* are unlikely to attempt to capture the available arbitrage profit when ETNs trade at a negative premium. This also puts downward pressure on the ETN premium. The downward pressure imposed by both demand traders and arbitrageurs is evident in the factor's coefficient of -15.71.

Economic Significance of Premium Pricing Factors

Table 3.7 also presents one measure of the economic significance of the various demand and arbitrage factors by considering the economic effect of a one standard deviation increase in the relevant factor. For indicator variables, this is simply the level of the coefficient itself. As shown in column 5, the factors putting positive pressure on the ETN premium are: (i) suspended-segmented interaction variable, (ii) the TVIX suspension period, (iii) segmentation, (iv) notes outstanding to minimum redemption ratio, and (v) issuer suspension. The suspended-segmented interaction variable has the greatest economic significance at 274 basis points. The TVIX suspension period also had a substantial economic effect on premiums, generating a 48 basis point increase during the one-month period. The demand-trader factor of ETN segmentation, a proxy for the demand for unique exposure to segmented markets, generates a 34 basis point increase on its own (i.e. even in the presence of *issuer arbitrageurs*). The arbitrage-factor of the ratio of notes outstanding to the minimum redemption size generates a 21 basis point increase for every one standard deviation increase in the ratio. Finally, on the positive side is the suspension factor on its own (i.e. including non-segmented ETNs), which generates a 15 basis point increase in premium.

The factors putting negative pressure on the premiums are: (i) relative bid-ask spread, (ii) VIX level, (iii) FINRA's investor warning, and (iv) volatility of the underlying index. The relative bid-ask spread has the greatest economic significance on the downside, decreasing premiums by 17 basis points for every one standard deviation increase in the spread. The VIX level generates a 16 basis point decline in premium for every one standard deviation increase in the VIX. FINRA's investor warning about the risks of ETNs generated a 16 basis point decline in premiums. Finally, the volatility of the underlying index generates a 13 basis point decline in premium for every one standard deviation increase in index volatility.

Neither the annual fee charged to ETN holders nor the daily return of CDS prices have a statistically significant effect on premiums. The IRS's tax ruling for currency ETNs also loses statistical significance in the full regression, despite its significance in the demand-only regression.

3.9 Policy Considerations and Concluding Remarks

The ETN premium pricing puzzle is a consequence of the combination of factors that lead to investor demand for a product and the institutional features of ETNs that limit the arbitrage mechanisms that would otherwise keep market prices aligned with indicative values. The primary demand factor for an ETN is the unique exposure that it provides to an otherwise segment market. The primary limit to arbitrage is an issuer's suspension of an ETN, whereby the issuer no longer creates new units of the ETN. The combination of these two factors leads to substantial premiums for a number of ETNs. The levels of premiums and volatility of premiums experienced by ETNs subject to both factors severely compromises the integrity of the ETN structure as an efficient means for investor exposure to investment opportunities. As an investor, simply relying on the characteristics of a particular ETN that make it an attractive investment opportunity is inadequate. A prudent investor would also consider the limits to arbitrage associated with the ETN to determine whether investment in the ETN is wise. However, given that issuers have complete control and discretion over the most significant limit to arbitrage, suspension, even the most thorough due diligence by an investor may not be sufficient. The whim with which an issuer can impose suspension and consequently disrupt the market for an ETN poses a big risk for investors.

Market forces alone will not necessarily address these risks. Given the documented inattention of investors to the credit risk of Lehman Brothers in Chapter 2, it is clear that the assumption cannot be made that the ETN market fully internalizes the risks associated with ETNs. ETN investors may be as equally inattentive regarding the suspension risk that ETNs pose. As a result, this may be an instance where regulatory involvement could be beneficial. At the very least, in line with the Justice Louis Brandeis truism that "sunlight is said to be the best of disinfectants,"[27] improving the disclosure that surround the suspension of an ETN is a good start. Press releases by the issuer are arguably inadequate. A more effective approach would be a requirement that suspended ETNs receive a suffix affixed to the ticker, indicating that the particular product is under issuer suspension.

While other limits to arbitrage imposed by the issuers are less significant than suspension, they are still deserving of scrutiny. Minimum redemption size standards should potentially be implemented, such that the arbitrage mechanism is not diminished for ETNs trading at a discount. A related issue is the redemption lag, whereby the market arbitrageur is exposed to risk that the indicative value will move against his arbitrage position between his redemption commitment and the final determination of the indicative value. There is no clear reasoning for the imposition of such a lag, while the benefits for market efficiency may be significant.

At the heart of these issues is the lack of corporate governance over ETNs. Unlike ETFs, which have a board of directors who serve the best interest of the investors, ETNs have no similar corporate governance protections. Since the specific structure of ETNs does not lend itself to similar oversight as ETFs, this may be a compelling reason for the SEC to heighten its scrutiny of this growing financial product.

---

[27] Louis Brandeis, *Other People's Money and How Bankers Use It*, Martino Publishing (1914).

BIBLIOGRAPHY

Acharya, Viral V. and Lasse Heje Pedersen, Asset pricing with liquidity risk, *Journal of Financial Economics* 77, 375-410.

Amihud, Yakov, 2002, Illiquidity and stock returns: cross-section and time-series effects, *Journal of Financial Markets* 5, 31-56.

Amihud, Yakov and Haim Mendelson, 1986, Asset pricing and the bid-ask spread, *Journal of Financial Economics* 17, 223-249.

Alexander, Carol and Dimitris Korovilas, 2013, Volatility exchange-traded notes: curse or cure?, *Journal of Alternative Investments* Fall 2013, 52-70.

Bailey, Warren and Julapa Jagtiani, 1994, Foreign ownership restrictions and stock prices in the Thai capital market, *Journal of Financial Economics* 36, 57-87.

Barber, Brad M. and Terrance Odean, 2008, All that glitters: The effect of attention and news on the buying behavior of individual and institutional investors, *Review of Financial Studies* 21, 785-818.

Berk, Jonathan B. and Richard Stanton, 2007, Managerial ability, compensation, and the closed-end fund discount, *Journal of Finance* 62, 529-556.

Bonser-Neal, Catherine, Greggory Brauer, Robert Neal and Simon Wheatley, 1990, International investment restrictions and closed-end fund country prices, *Journal of Finance* 45, 523-547.

Boudreaux, Kenneth, 1973, Discounts and premiums on closed-end mutual funds: a study in valuation, *Journal of Finance* 28, 515-522.

Brandies, Louis D., 1914, Other people's money: and how the bankers use it, Martino Publishing.

Cherkes, Martin, Jacob Sagi and Richard Stanton, 2009, A liquidity-based theory of closed-end funds, *Review of Financial Studies* 22, 257-297.

Chordia, Tarun, Richard Roll and Avanidhar Subrahmanyam, 2001, Market liquidity and trading activity, *Journal of Finance* 56, 501-530.

Collin-Dufresne, Pierre and Robert S. Goldstein, 2001, Do credit spreads reflect stationary leverage ratios?, *Journal of Finance* 56, 2177-2208.

Cserna, Balzas, Ariel Levy, and Zvi Wiener, 2013, Counterparty risk in exchange-traded notes (ETNs), *Journal of Fixed Income* 23, 76-101.

DellaVigna, Stefano and Joshua M. Pollet, 2007, Demographics and industry returns, *American Economic Review* 97, 1167-1702.

De Long, J. Bradford, Andrei Shleifer, Lawrence H. Summers, and Robert J. Waldmann, 1990, Noise trader risk in financial markets, *Journal of Political Economy* 98, 703-738.

Detemple, Jerome and Carlton Osakwe, 2000, The valuation of volatility options, *European Finance Review* 4, 21-50.

Diavatopoulos, Dean, James Felton, and Colby Wright, 2011, The indicative value-price puzzle in ETNs: liquidity constraints, information signalling, or an ineffective system for share creation, *Journal of Investing* 20, 25-39.

Domowitz, Ian, Jack Glen and Ananth Madhavan, 1997, Market segmentation and stock prices: Evidence from an emerging market, *Journal of Finance* 52, 1059-1085.

Engle, Robert and C.W.J. Granger, 1987, Co-integration and error correction: representation, estimation and testing, *Econometrica* 55, 251-276.

Engle, Robert, and Debojyoti Sarkar, 2006, Premiums-discounts and exchange-traded funds, *Journal of Derivatives*, 27-45.

Eun, Cheol S. and S. Janakiramanan, 1986, A model of international asset pricing with a constraint on the foreign equity ownership, *Journal of Finance* 41, 897-914.

Financial Stability Board, 2014, Update list of global systemically important banks (G-SIBs), available at www.financialstabilityboard.org/wp-content/uploads/r_141106b.pdf

Gabaix, Xavier, David Laibson, Guillermo Moloche and Stephen Weinberg, 2006, The allocation of attention: Theory and evidence, *American Economic Review* 96, 1043-1068.

Geman, Helyette, Lovjit Thukral, and Colby Wright, 2012, Are ETNs realizing their potential? An empirical investigation of ETNs versus other exchange-traded products in the precious metals' space, *The Journal of Index Investing* Fall 2012, 23-33.

Gemmill, Gordon and Dylan C. Thomas, 2002, Noise trading, costly arbitrage, and asset prices: evidence from closed-end funds, *Journal of Finance* 57, 2571-2594.

Geske, R., 1977, The valuation of corporate liabilities as compound options, *Journal of Financial and Quantitative Analysis* 12, 541-552.

Goltz, Felix and Stoyan Stoyanov, 2013, The Risks of volatility ETNs: A recent incident and underlying issues, *The Journal of Index Investing* Fall 2013, 73-81.

Grunbichler, Andreas and Francis A. Longstaff, Valuing futures and options on volatility, *Journal of Banking and Finance* 20, 985-1001.

Hicks, J.R., 1962, Liquidity, *Economic Journal* 72, 787-802

Hirshleifer, David and Siew Hong Teoh, 2003, Limited attention, information disclosure, and financial reporting, *Journal of Accounting and Economics* 36, 337-386.

Hong, Harrison and Jeremy Stein, 1999, A unified theory of underreaction, momentum trading, and overreaction in asset markets, *Journal of Finance* 54, 2143-2184.

Huberman, Gur and Tomer Regev, 2001, Contagious speculation and a cure for cancer: a nonevent that made stock prices soar, *Journal of Finance* 56, 387-396.

Hull, J.C. and A. White, 2001, Valuing credit default swaps II: modeling default correlations, *Journal of Derivatives* 8, 12-21.

Jones, Charles M., 2002, A century of stock market liquidity and trading costs, available at SSRN: http://ssrn.com/abstract=313681.

Lee, Charles M.C., Andrei Shleifer, and Richard H. Thaler, 1991, Investor sentiment and the closed-end fund puzzle, *Journal of Finance* 44, 76-110.

Leland, Hayne and K. Toft, 1996, Optimal capital structure, endogenous bankruptcy and the term structure of credit spreads, *Journal of Finance* 51, 987-1019.

Lin, Yueh-Neng and Chien-Hung Chang, 2009, VIX option pricing, *The Journal of Futures Markets* 29, 523-543.

Lippman, Steven A. and John J. McCall, 1986, An operational measure of liquidity, *American Economic Review* 76, 43-55.

Longstaff, Francis, S. Mithal and E. Neis, 2005, Corporate yield spreads: default risk or liquidity? New evidence form the credit default swap market, *Journal of Finance* 60, 2213-2253.

Longstaff, Francis and E. Schwartz, 1995, Valuing risky debt: a new approach, *Journal of Finance* 50, 789-820.

Malkiel, Burton, 1977, The valuation of closed-end investment company shares, *Journal of Finance* 32, 847-859.

Merton, Robert, 1974, On the pricing of corporate debt: the risk structure of interest rates, *Journal of Finance* 29, 449-470.

Pahl, Joseph, 2012, Taxing exchange-traded notes and the future of variable prepaid forward contracts, available at SSRN: http://ssrn.com/abstract=2150359.

Pan, J. and Ken Singleton, 2008, Default and recovery implicit in the term structure of sovereign CDS spreads, *Journal of Finance* 63, 2345-2384.

Pastor, Lubos and Robert F. Stambaugh, 2003, Liquidity risk and expected stock returns, *Journal of Political Economy* 111, 642-685.

Peng, Lin and Wei Xiong, 2006, Investor attention, overconfidence and category learning, *Journal of Financial Economics* 80, 563-602.

Piccotti, Louis R., 2015, ETF premiums and liquidity segmentation, available at SSRN: http://ssrn.com/abstract=2417555.

Pontiff, Jeffrey, 1995, Closed-end fund premia and returns: implications for financial market equilibrium, *Journal of Financial Economics* 37, 341-370.

Pontiff, Jeffrey, 1996, Costly arbitrage: evidence from closed-end funds, *Quarterly Journal of Economics* 111, 1135-1151.

Pontiff, Jeffrey, 2006, Costly arbitrage and the myth of idiosyncratic risk, *Journal of Accounting and Economics* 42, 35-52.

Poterba, James M. and John B. Shoven, 2002, Exchange-traded funds: a new investment option for taxable investors, *American Economic Review* 92, 422-427.

Ramadorai, Tarun, 2012, The secondary market for hedge funds and the closed hedge fund premium, *Journal of Finance* 67, 479-512.

Ross, Stephen A., 2002, Neoclassical finance, alternative finance and the closed-end fund puzzle, *European Financial Management* 8, 129-137.

Shleifer, Andrei and Lawrence H. Summers, 1990, The noise trader approach to finance, *Journal of Economic Perspectives* 4, 19-33.

Stulz, Rene, 1981, On the effect of barriers to international investment, *Journal of Finance* 36, 383-403.

Weiss, Kathleen, 1989, The post-offering price performance of closed-end funds, *Financial Management* Autumn, 57-67.

Whaley, Robert E., 1993, Derivatives on market volatility: Hedging tools long overdue, *Journal of Derivatives* 1, 71-84.