SECURITIZED COMMODITIES FOR THE RETAIL INVESTOR
A discussion of exchange-traded funds and notes with quantitative analyses of commodity ETNs/ETFs on NYSE Arca.

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Preface

This thesis is a 30 credits paper which is a part of my 120 credits Master of Science in Business Administration degree at UMB. The thesis has been written with Professor Ole Gjølberg at the UMB School of Economics and Business as my supervisor. He has been flexible and supportive in the process and helpful in providing me with lots of background information. Professor Gjølberg also originally proposed the idea of choosing commodity exchange traded products as a research subject.

I would also like to thank Professor Espen Gaarder Haug at UMB for hints on utilizing options as management of counterparty default risk. Moreover, I am grateful to Deborah Fuhr for permission to use one of Blackrock's figures from their extensive research within the field of exchange traded products. Any shortcomings in the results of this paper are entirely my own.

Oslo, May 16, 2011

Ådne Jacobsen

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Executive summary

The unleveraged, non-inverse commodity ETP trackers analyzed in the thesis generally have low tracking errors. There are some exception in the case of the ETFs United States Oil Fund (OIL) and United States Natural Gas Fund (UNG) which not have been reliably trackers for parts of the research period, at least not when front month futures spot prices are utilized as their respective benchmarks.

When ETNs and ETFs that are tracking the same commodities are compared the results indicate that ETNs may not be gaining much in terms of returns or tracking error ability over the ETFs. The retail investor that is trading ETPs can probably just as well choose the physical ETF over the ETN, not least due to counterparty default risk of ETNs.

Derivative based mutual funds and ETPs in the broad commodity category seem to be quite similar in terms of returns even when mutual fund frontloads are accounted for. ETFs in the precious metal selection and derivative based ETPs in the energy selections seem to be a preferred choice over generally more equity based mutual funds and ETPs in terms of bringing diversification gains to a broad market portfolio.

In the choice of the mutual fund versus the ETN that is relating to DJ-UBS CI TR, the mutual fund is higher ranked by some of the risk adjusted measures. This is contrary to the findings for the S&P GSCI TR related securities, where the ETPs seem to be a preferred choice compared to the respective mutual fund of that index.

Deutsche Bank's optimal yield technology ETFs that optimizes effects of roll yield in futures markets might have a slight comparative advantage over comparable ETFs in the broad commodity and energy markets. For the precious metal markets the physical depot ETFs are probably preferable over Deutsche Bank's ETFs when comparing returns for single precious metal ETFs.

The quantitative results which I have calculated with traditional return/risk measures may not appropriately take into account the risk inherent in some of the ETP structures, e.g. the uncollateralized ETN. An option strategy for management of ETN counterparty default is suggested. Risks of busts due to bubble-like tendencies in some of the commodity markets, and the effects potential busts might have on the functioning of ETPs, is also challenging to include with traditional risk calculations based on historical data. However, the unleveraged, non-inverse commodity ETP trackers analyzed in this thesis subsequent to chapter 1 seem to generally have performed quite well in obtaining low tracking errors during the financial crisis a period which started off with high commodity prices similarly to what has been seen in commodity markets from 2009 onwards.

Thesis introduction

The topic in this thesis is to evaluate and analyze exchange traded products (ETPs) that are tracking a single commodity or a set of commodities. Quantitative analyses are done over different periods from 7 Jan 2007 – 1 Mar 2011 and the periods represent holding of the securities for two years or more. This paper could be useful for the commodity retail investor with access to exchanges that are listing ETPs. General properties of ETPs are pinpointed, properties which not only are applicable to commodity ETPs but also may apply to some of the other ETPs covering e.g. stock and bond indices.

Main focus is on straight tracking ETPs in the form of unleveraged and non-inverse exchange traded funds (ETFs) and exchange traded notes (ETNs). The pros and cons of the various structures are discussed. Empirical data is processed using well known methods of evaluation within finance in order to find annualized returns, risk adjusted performance and tracking errors. The commodity ETPs are divided into a broad derivative commodity category, a derivative energy category and a metal category. For comparison chapter 2 and chapter 3 includes mutual funds for the three commodity categories. Since the energy mutual funds hold equity and are more diversified than the energy derivative ETPs, the energy selection also includes energy equity ETFs to improve the comparison.

Chapter 1 is principally a qualitative and descriptive presentation of what ETPs are and the history and recent developments within that market. It seems natural to start off with the first stock-index ETFs introduced to the market in the 1990ties, but the main focus will be on commodities. The intent is to create a backdrop for potential ETPs investors and others with interest in the topic. Comparisons between different types of ETP investments are modeled to map dissimilarities in some of the security structures under the umbrella term ETP. These dissimilarities have impact on performances, risk characteristics and tax.

Chapter 1 is meant to serve as a reference for the rest of the dissertation. One of the causes for writing about this subject is that within academics commodity ETPs are relatively fresh and not broadly examined the way for example large cap versus small cap stock, mutual funds and index funds are. Therefore I have used some more space in the background chapter than perhaps the norm is in a thesis, and literature is discussed mostly in chapter 1. The majority of academic studies of ETPs involve share-index ETFs. As of today the bulk of the literature that is concerning commodity ETPs are found in newspapers and internet resources which could be negatively affected by the absence of scholarly peer review. However, there is an abundance of academic research on commodity markets, and parallels especially from the commodity futures market are drawn to partially encompass commodity ETPs.

Stylized facts of historical data from commodity ETPs will be presented in chapter 2 in the form of measures of volatility and return. Distribution characteristics will also be assessed. The proliferation of commodity ETPs started onwards from 2006/2007 and as such the quantitative analyses start in 2007. The different securities are compared, and tests undergone to check for significant disparities in variance and returns not only between different commodities but maybe more interesting; between ETPs covering the same or similar commodities.

In chapter 3 Sharpe and Treynor ratios are employed to risk adjust the returns obtained in chapter 2. The distribution of the historical data is assessed. Possible diversification gains for a broad investment portfolio are pointed out. Systematic risk is calculated to find the relationship of the commodity ETPs and the alternative security selections to movements in the total market benchmark, and unsystematic risk is indirectly described through Treynor.

Chapter 4 contains tracking error analyses of the commodity ETPs versus the index they are tracking. Chapter 4 does not include the mutual funds that are included in chapter 2 and 3, since the mutual are not passive index trackers the way the commodity ETP selection are. I have also not included the energy equity ETPs since they are equity trackers and not commodity trackers.

The thesis consists of 4 independent chapters. References are listed at the end of each chapter. Likewise with appendixes for those chapters that include such material. In the end of the thesis there is a general appendixes list with full names and information for all the securities analyzed.

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Chapter 1: Background chapter on exchange traded products (ETPs)

Summary chapter 1

Qualitative characteristics for some of the typical ETP structures are discussed. There is also a short historical introduction to the market of ETPs which started to exist approximately 20 years ago. Regulations and some general pro/cons are also briefly covered.

Some of the assumptions for further quantitative analyses are set in the pro/cons section. E.g. reasons for why tax and transaction cost not are accounted for in the quantitative analyses, elements that could be important for the ETP investor based on individual circumstances.

Issues on tracking errors for leveraged (bull) and inverse leveraged (bear) ETPs are addressed. Recent concerns launched from e.g. the International Monetary Fund regarding some of the ETP structures are included.

Keywords: Physical and synthetic ETFs, ETNs, collateral and counterparty risk.

1.0 Introduction

The purpose of this chapter is to give an overview of the history and characteristics for exchange traded products (ETPs) which could be useful for retail investors and others with interest in the subject. Reasons for using commodity ETPs in the portfolio are introduced. Several versions of ETPs exist, and the unleveraged and non-inverse ETP index trackers that are the focus of this thesis will be defined. Some of the other types of ETP classes are in addition also briefly accounted for, e.g. the bull/bear index tracker and the typical European style synthetic ETF.

General ETP pros/cons such as tax efficiency and accessibility of previously complicated asset classes are discussed, as well as some of the assumptions for further quantitative analyses.

Within the world of academics the ETPs are mostly researched through stock-index ETFs, but I am utilizing some parallels from securitized commodity literature from the futures market. Since the attention of the thesis is on unleveraged and non-inverse commodity ETPs that are tracking commodity indices, I will also discuss some of the typical commodity indices that are benchmarks for several of the ETPs. Even though commodity ETPs are not a thoroughly treated subject within academics lots of information can be found on investor related internet sites, in the financial newspapers and last but not least: by reading the prospectuses of the specific ETPs. Most of the literature references of the thesis are cited in this chapter.

An essential aspect for ETPs is to know the structural inequalities in the exchange traded fund (ETF) compared to the exchange traded note (ETN). Collateral risk and counterparty default risk which may be part of ETPs are described. Since analyzes in later chapters include both commodity ETN and ETFs some time is spent on mapping the typical characteristics of an uncollateralized ETN compared to the physically backed ETF. An example is given on how the retail investor with the help of options could manage the inherent counterparty default risk of an uncollateralized ETN.

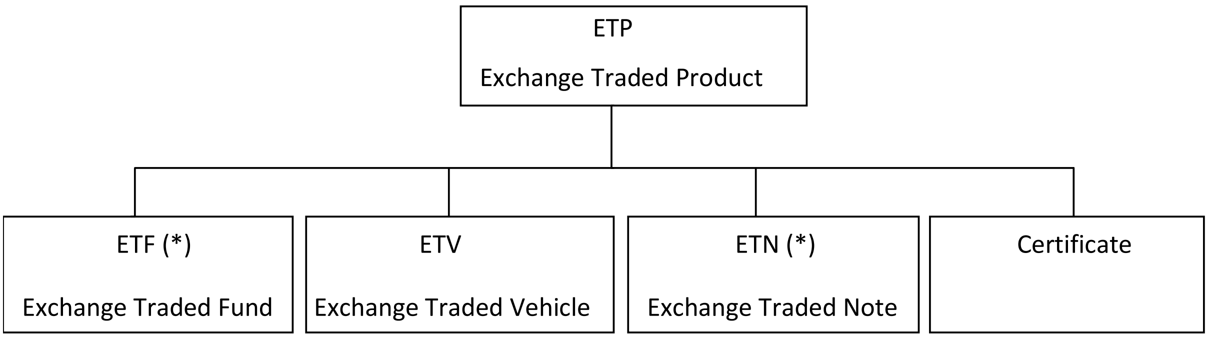
As of the time of writing this paper, some commodities are perceived by many to be an asset bubble. Several critics have raised concerns over the commodity ETP's role in the commodity price increases, and some are also concerned over what might happened e.g. to ETF investments if commodity prices were to experience a bust. A general overview of the recent criticism from IMF/BIS/FSB is given as well as responses from the ETP industry. Some of the issues are discussed with my own views.

1.1 Definition of ETP/ETPs

I will be the first one to admit that the world of exchange traded products (ETPs) initially may seem overwhelming. There is a great multitude of these securities and the concepts are relatively new in finance and thus not much treated within academic books. Some initial confusion could arise not least due to the ambiguity of terms which I will attempt to explain in the following section.

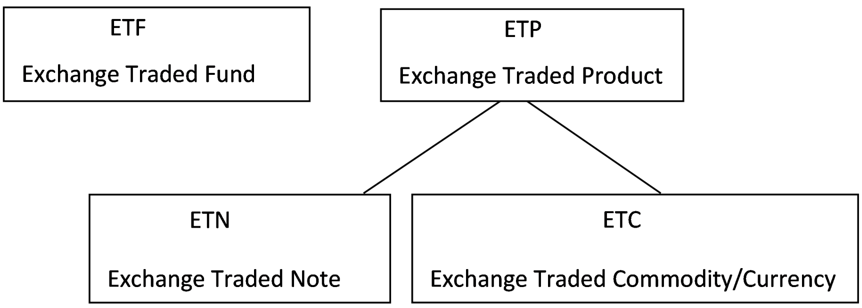
NYSE Euronext is the owner and operator of the NYSE Arca Stock Exchange. Below in Figure 1 is the NYSE Euronext ETP classification which also will be utilized in this dissertation since the exchange traded products in the quantitative analyses of this paper are listed at NYSE Arca.

Figure 1: The NYSE Euronext ETP classification (NYSE ETPs 2011)



Exchange traded products (ETPs) included in this thesis are the two sub classes named ETF and ETN which is marked by asterisk (*) in Figure 1. ETVs and certificates are not the topic of this dissertation. Someone who is looking into ETPs at other security exchanges may find that different classification occurs, as seen by the London Stock Exchange classification of Figure 2 below.

Figure 2: The London Stock Exchange classification (LSE Market 2011)



The ETN is equally classified by both the London Stock Exchange and the NYSE Euronext. However, London Stock Exchange has a unique category for ETFs which separates them from ETNs/ETCs by defining the umbrella term ETP differently than NYSE Euronext. The classification as seen in Figure 1 of the previous page differs from Figure 2 since it utilizes ETP as an umbrella term which includes the ETF while the ETC apparently is missing. The ETC label is missing from the London Stock Exchange because it is not used as a labeling term at NYSE Euronext. Nevertheless the ETC could be characterized as some sort of an ETN since the ETC has a swap based debt-like structure similar to the debt issued by ETNs (Blackrock 2011a).

Whenever[1] the words ETP or ETPs are used in this thesis it is meant be understood as an all-encompassing umbrella term that implicitly includes the ETC and which also includes the ETF similarly to the NYSE Euronext classification of Figure 1.

The proof of the pudding is in the eating, and it is probably more rewarding to look at the general operations and functioning of these products instead of maybe being confused by the ambiguity of labeling terms. More on the structure and operations of the ETPs will be discussed in section 1.6 and onwards.

1.2 Regulation of ETPs

Two of the most essential laws regarding ETPs in the US market are the Securities Act of 1933 and the Investment Company Act of 1940. The former is often referred to as “the truth in securities” law, and ensures that investors can make informed judgments when trading securities by regulating how information should be made publicly available. In addition, one purposes of the 1933 Act is to protect those involved in securities trading from fraud and deceit and to ensure that the securities markets are credible and trustworthy (SEC 2010b). The ETN is filed under the 1933 Act in the USA. The 1940 Act regulates how companies such as ETFs and mutual funds that engage primarily in investing, reinvesting and trading of securities are organized.

[1] There is one exception. BlackRocks’s, Figure 3 page 4, utilizes the London Stock Exchange classification.

Table 1: Overview of regulation and characteristics of ETPs and similar securities in the US market

	ETFs	ETNs	Mutual funds	Stocks
Filed under the 1940 Act	●		●	
Filed under the 1933 Act		●		●
Shares can be created and redeemed	●		●	
Investors can redeem shares to the issuer		●		
Contain Issuer Specific Credit Risks		●		●
Has a maturity date		●		
Can be traded throughout the day	●	●		●
Composed of an underlying portfolio of securities	●		●	
Can be sold short	●	●		●
Usually traded at or near Net Asset Value (NAV)	●	●	●	

The figure above displays the above mentioned laws concerning the ETFs, ETNs and mutual funds analyzed in this thesis, as well as some of the their general properties according to NYSE Arca (*NYSE ETPs* 2011). Several of the ETPs analyzed in this paper are registered as structured products or unit investments trusts and are not registered as funds although they may be characterized as for example an ETF.

There are of course several other laws and regulations involved in the US market, e.g. the Securities Exchange Act of 1934 which give SEC broad authority over all aspects of the security industry including brokers, clearinghouses, stock exchanges etc.

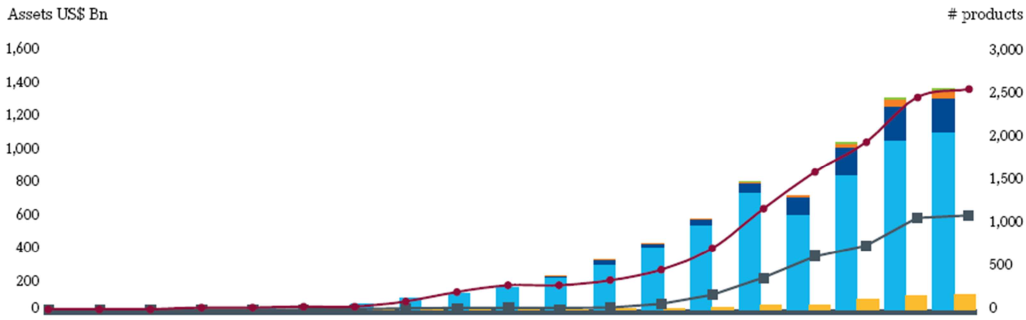
In Europe regulations differ somewhat from country to country but the Undertakings for Collective Investment in Transferable Securities Directives (UCITS) has the objective of allowing cross border trading of securities within the EU by setting up harmonized rules for EU members. If a UCITS compliant fund is authorized in one member state it should according to the UCITS objective be available to investors in all EU member states, but the objective has not been reached in reality due to various national laws e.g. when it comes to marketing. Several amendments have been made to the original UCITS directive and UCITS IV is the next version to be implemented by EU member states into national law (Kelleher 2011). The ETNs and ETCs in Europe are not regulated under UCITS since they are structured as special purpose vehicles with a debt like structure and not as funds.

There are differences in regulations that have an impact for ETPs available in Europe versus the USA, especially concerning the use of swap based structures available to retail investors, which will be elaborated more on in the section discussing the ETN structure.

1.3 Introductory history and development

It has been a tremendous growth of ETPs since the inception of the first ETF. Figure 3 displays the historical development of market caps and listed products.

Figure 3: Global ETF and ETP asset growth at end of February 2011



Assets (US$ Bn)	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	Feb-11
ETF total	0.8	1.1	2.3	5.3	8.2	17.6	39.6	74.3	104.8	141.6	212.0	309.8	412.1	565.6	796.7	711.1	1,036.0	1,311.3	1,367.4
ETF equity	0.8	1.1	2.3	5.3	8.2	17.6	39.6	74.3	104.7	137.5	205.9	286.3	389.6	526.5	729.9	596.4	841.6	1,053.8	1,101.0
ETF fixed income	–	–	–	–	–	–	–	0.1	0.1	4.0	5.8	23.1	21.3	35.8	59.9	104.0	167.0	207.3	212.5
ETF commodity	–	–	–	–	–	–	–	–	0.0	0.1	0.3	0.5	1.2	3.4	6.3	10.0	25.6	45.7	48.7
ETF other[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.6	0.6	1.8	4.5	5.2
ETP total	–	–	–	–	–	–	2.0	5.1	3.9	4.1	6.3	9.3	15.9	32.5	54.6	61.2	119.7	170.6	175.3
ETF/ETP total	**0.8**	**1.1**	**2.3**	**5.3**	**8.2**	**17.6**	**41.6**	**79.4**	**108.7**	**145.7**	**218.3**	**319.1**	**428.0**	**598.1**	**851.3**	**772.3**	**1,155.8**	**1,482.0**	**1,542.7**
# ETFs	3	3	4	21	21	31	33	92	202	280	282	336	461	713	1,170	1,595	1,944	2,460	2,557
# ETPs	–	–	–	–	–	–	2	14	17	17	18	21	63	170	371	615	739	1,065	1,092

Source: Blackrock (Blackrock 2011b). © BlackRock Advisors (UK) Limited. Reprinted with permission (Fuhr 2011) NB! BlackRock utilizes the London Stock Exchange classification where the ETF is separated from the ETP (Like in Figure 2, page3).

The first ETF was launched in Canada in 1990 (Blackrock 2011b), but some consider the late Nathan Most to be the creator of the ETF because he introduced it to the US market. His career was spent mainly in various commodities jobs and he was well into his seventies when the first US ETF eventually started trading. He spent six years developing the system that finally allowed ETFs to work on the American Stock Exchange when the Standard & Poor's Depository Receipt (SPDR) were introduced in 1993 (Bayot 2004). The first US ETFs covered broad stock indices. At the time of writing this thesis, the SPDR S&P 500 is the world's largest ETF measured by net assets of about US$ 90 billion.

The first commodity ETF was publicly listed in Canada in 2001 (Blackrock 2011b) and Gold Bullion Securities (GOLD) was the first publicly listed commodity ETC when it started trading in Australia and London in 2003. The provider of GOLD is ETF Securities and at the London Stock Exchange they also launched the world's first entire ETC platform (*ETF-Securites* 2010) in 2006. The proliferation of commodity ETPs started onwards from around 2006/2007 and I have chosen to start the quantitative analysis of this thesis with price series from 5 Jan 2007 because on that date several of Deutsche Bank's PowerShares ETPs started trading on NYSE Arca.

In 2006 Barclays introduced the two first ETNs (Wright et al. 2009). One of them is called iPath DJ-UBS Commodity Index Total Return (DJP) and it tracks the index implied in the name. The other one, iPath S&P GSCI Total Return Index (GSP), is also a commodity index tracker and they are both included in the analyses chapters. Barclays has since launched several additional ETNs under the iPath series, and other large investment banks such as Deutsche Bank, Credit Suisse, JPMorgan Chase and others has followed suit and released their own ETNs.

ETP popularity and growth has contributed to an increasingly number of sectors becoming available at the marketplace by single products covering a specific market sector. Due to the fact that broad sectors are covered with already existing ETPs, the securitized product suppliers have shown great creativity in inventing ETPs for what some might find to be exotic sectors of the economy such as nanotechnology equities[2], companies focusing on technology that minimizes global warming[3] or firms developing cancer treating therapeutic agents[4]. ETPs tracking the two former sectors in the previous sentence are still publicly listed, while the latter has been closed down. Some of these exotic ETPs have not gained sufficient popularity with the investors, and providers such as XShares and Claymore has discontinued whole series of their niche ETPs (Coleman 2008) (Hougan 2008).

Traditionally ETPs are passive index tracking ETF funds. In the recent years active ETPs have started to emerge, something that may seem as a paradox compared to the traditional tracker characteristics of these products. Still there should be no reason that the ETP structure could not encompass even larger parts of the role previously dominated by active mutual funds. For example, three ETNs based on Benjamin Graham's philosophy of identifying companies that trade at a discount to intrinsic value were launched in 2008 for large cap, small cap and the total market respectively (Bell 2008).

Research on active stock index-like ETFs seem to be in line with general research results from the active mutual fund industry with no significant alpha/excess return performance

[2] PowerShares Lux Nanotech ETF (PXN)
[3] ELEMENTS CS Global Warming ETN (GWO)
[4] HealthShares Emerging Cancer ETF (HHJ) - discontinued

(Vossestein 2010). Five active index-like ETFs were examined from May 2008 till October 2009 by Vossestein who found underperformance of the ETFs compared to passive ETFs as well as the benchmark. Stylized facts from other researchers of index-like active ETF performance also indicate underperformance to the benchmark (Rompotis 2009). Both Vossestein and Rompotis find that active index-like ETFs have larger tracking error than passive index ETFs. Due to the nature of active management in taking differentiated positions to a benchmark such results could be expected.

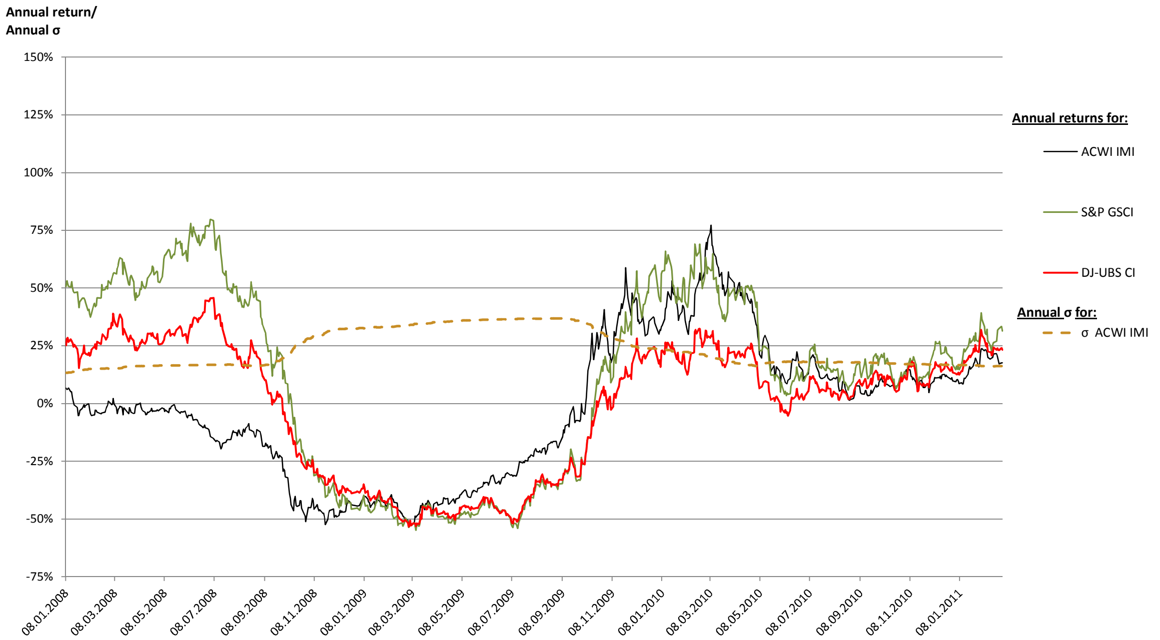
Other developments that have been present in the ETP market for some time is leveraged (bull), inverse (bear) and inverse leveraged ETPs. Leveraged and inverse leveraged ETPs are normally set up to yield a multiple to the daily return of an index such as a 2x, -2x, 3x or -3x the benchmark return. More on leveraged and inverse leveraged ETPs are included in section 1.8 onwards from page 22, and is exemplified by two gold bear/bull ETPs.

1.4 ETP pros/cons and some assumptions for further quantitative analysis

Probably the greatest advantage of ETP is that asset classes which previously were difficult to gain exposure to for other than specialists and institutional investors have been made available to retail investors. The exchange traded property of these products makes previously complicated positions available to retail investors who want to diversify the portfolio with, or place a bet on, assets classes such as commodities, industry sectors, emerging markets, debt obligations etc.

Commodities as an asset class is often less correlated with the total benchmark than e.g. equities (Gorton & Rouwenhorst 2006), but even commodities may not protect the portfolio in times of a total market crisis. Something that can be seen in Figure 4 below, represented by the annual/yearly return for the total market (ACWI IMI) versus S&P GSCI and DJ-UBS CI which are two of the perhaps most well-known commodity indices.

Figure 4: Rolling yearly return and standard deviation for total market versus return of commodities 2008-2011



The possibility of trading ETFs at the exchange's opening hours is also seen as an advantage by many. Warren Buffet on the other hand seem to prefer the passive mutual index fund over the passive ETF index-tracker because of the possibility for intraday speculation which exist with ETPs and is absent in the end of day transactions for mutual fund investors (Spence 2007). Retail investors may have a greater propensity to jump into sectors that seem promising and trade on hunches with ETFs compared to if they were owning mutual funds. A market timing trading strategy could be hard to pull off and also increases transaction costs.

Another of the ETP's advantages that often is cited is tax efficiency. Owners of active mutual funds that are selling stocks pass on capital gain/loss which has tax effects for investors in USA and many other countries. The tax efficiency of ETPs is mainly referring to passive ETF trackers versus active mutual funds, and to the ETN which do not pass on capital gain at all. Passive index mutual funds that only sell or buy stocks whenever there is a change in benchmark index constituents have similar tax properties to a passive index ETP. However, to the retail investor an ETF share is bought or sold on the exchange, and the ETF do not sell its holdings in order to pay off the ETF share seller due to the creation redemption process which is elaborated on in the next section. The mutual fund investor is trading with the mutual fund directly or indirectly through a broker, and the mutual fund may have to sell shares in order to pay off investors, thus the potential of realizing capital gain could be higher with mutual funds. Taxing of capital gain/loss and dividend is treated differently in various countries and I do not take into account tax effects otherwise than mentioning some of them in this section.

ETFs which mostly are passive in nature have low annual fees often referred to as the expense ratio. The annual fees covers e.g. management fees, administrative fees and operational costs incurred for the trading done inside of a fund (Morningstar 2011). The expense ratio is paid out of fund holdings. This diminishes the asset holding value of the fund, which again is indirectly accounted for in the market price of the ETF due to the net asset value (NAV) versus market price functioning of an ETF as discussed in the following section and onwards. Mutual funds also have expenses ratios which are accounted for in a mutual fund's NAV. In addition, several of the mutual funds' investors are charged a percentage of the investment in a loadfee which can become costly for the investor, e.g. a frontend load upon buying a mutual fund or a backend load when selling. Costs involved in the expense ratio do have tax reducing effects for funds in some countries, e.g. the US 12b-1 fees[5] (SEC 2008). ETF shares which are traded on the exchange do not have a loadfee, but no-loadfees also exist for some mutual funds. Several no-load mutual funds are included later on when comparing performance of commodity ETPs versus commodity mutual funds. Loadfees are counted in for mutual funds in this thesis in the cases of those specific mutual funds that actually have loadfees.

Another element when considering costs is the transaction cost incurred by the investor when trading securities. Investors trading at the exchange are charged a brokerage commission. Often in the form of a fixed fee for those who are trading for small amounts, while transaction cost are set at a decreasing percentage when the amount per trade increases. Mutual funds investors do not incur the security broker's transaction cost if they avoid using a broker and instead trade directly with the mutual fund by transferring money from their own bank account to the mutual funds account. Nevertheless, banks often have transfer fees when shifting money from an account in one bank to an account in another bank. Similarly, a retail investor's option of transferring money directly to a US mutual fund seem to be only available for persons who have a US social security number and a US bank account. This implies that non-US based individuals who want to buy a US mutual fund would have to do

[5] US Securites and Exchange Commission is re-examining the 12b-1 fees since the fee originally was allowed to deduct marketing expenses to attract investors in a struggling mutual fund market, while the fee nowadays is being increasingly used to pay brokers who sell mutual funds (Hamilton 2011)

this through an international broker or financial service institution, thus invoking brokerage fees. Since the transaction costs incurred by the investor vary dependent on different situations, e.g. as exemplified above, they are not taken into account in the quantitative analysis of this paper. ETP pro/cons are discussed further in the following sections on different ETP structures.

1.5 Structure and operation of the physical ETF (direct replication)

ETFs do not trade their shares directly at the exchange where the ETF is listed. Instead authorized participants, such as market makers and institutional investors that are qualified by the ETF, trade with the fund in a creation/redemption process. Large blocks of ETF shares called creation units are purchased from the ETF by authorized participants, and authorized participants can choose to split the block of shares and sell them in the secondary market. (*SEC on ETFs* 2010)

ETF creation units are often not paid for in cash, but instead with a basket of security assets specified by the ETF. The basket of assets could be all or some of constituents of the benchmark index. ETFs are open end funds and can issue shares (creation) when an authorized participant wants to exchange a basket of assets in-kind with an ETF block of shares. Likewise, the ETF can redeem shares (redemption) if an authorized participant wants to, by exchanging the block of shares in-kind with the basket of the underlying assets. A basket of asset could be a compound of the benchmark index constituents, but also in the case of several precious metal ETFs consist of physical delivery of the metal. Creation units can also for some ETFs be settled in cash, which is the instance e.g. for Deusche Bank's PowerShares series of commodity ETFs analyzed in this thesis.

"The Participant Agreement sets forth the procedures for the creation and redemption of baskets and for the payment of cash required for such creations and redemptions."

(*PowerShares prospectus* 2011)

The 'classic' ETF is seeking to replicate the value of the index by holding the constituent(s) of the benchmark index. This form of mimicking is called direct replication and also applies to funds that often are labeled plain vanilla ETFs, physical ETFs or physically backed ETFs(Greene 2010). At the next page is a diagram attempting to visualize the functioning of the physical ETF.

Figure 5: Operations of the physical ETF (direct replication)

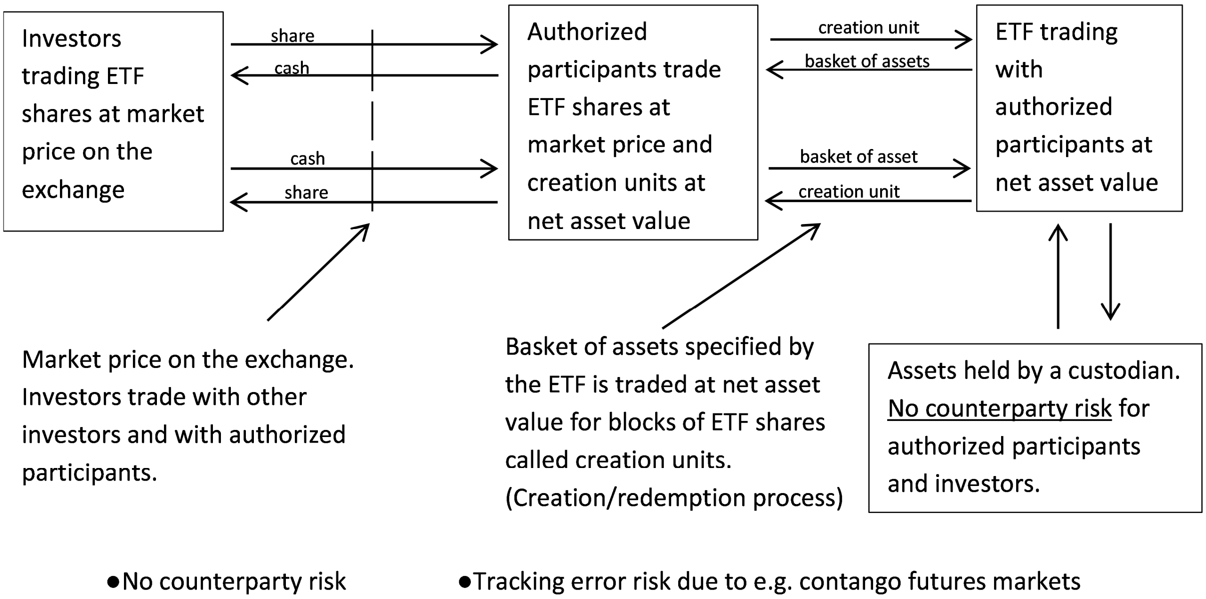


Figure 5 displays the processes behind the direct replication ETF. If the ETF were to go bankrupt the assets are held by a custodian and ring fenced from the possibility of being dragged into bankruptcy liquidation. The assets may be liquidated anyway if the ETF defaults and if a new management is not appointed. In that case counterparty risk is avoided since assets are the property of the investors and not the defaulted ETF.

Holdings of ETFs are valued at net asset value (NAV) which is equal to all fund assets marked to market minus the liabilities of the fund. It is normal that NAV of an ETF is posted on a per share basis. Liabilities occur for example due to management and operational cost of the ETF, and liabilities are paid by fund holdings but also in some cases for example by security lending of fund assets. NAV for the ETF is similar to NAV for mutual funds. A distinction between net asset value of mutual funds versus ETFs is that NAV for the ETP is posted more or less continuously throughout the trading day, while mutual funds which are traded off-exchange price their NAV once a day (Wallace 2006).

Authorized participants are often large financial institutions who also can act as one or several market makers for the ETF. Authorized participants can exploit arbitrage opportunities if the market price of an ETF deviates from its NAV, such that under normal market conditions the ETF’s NAV and its market price will not differ much from each other. It is essential for the functioning and credibility of an ETF tracker that it does not deviate too much from its benchmark index.

ETF deviations from the index (tracking error) and potential for arbitrage trading of authorized participants makes sure that the ETF most of the time is tracking its index closely like it seeks out to do.

1.5.1 Utilizing futures in ETFs

The physical size of precious metal is low compared to its high value. ETFs that are tracking precious metal can store their basket of assets such as physical gold or silver in a custodian bank or depot at a relatively low cost. It would be inefficient for most other commodity ETFs to hold the actual commodity since oil, gas and other bulkier goods would be expensive to store. Agriculture commodities are both bulky and may also be problematic to store if the commodity has limited durability and decreasing food quality when stored over long periods in a depot.

Several of the precious metals ETFs analyzed later on hold the actual physical commodity. However, instead of holding the physical commodity most of the ETFs in this paper track commodity indices by futures contracts. Futures backed ETFs have to roll their positions to avoid physical delivery and are exposed to roll yield which is the profit/loss from rolling futures. The roll yield is negative when the next futures contract that is bought to track a commodity is priced above the contract that is sold (contango), and roll yield is similarly positive if the next futures contract is priced below the contract that is sold off (backwardation). Especially severe contango markets can have a negative effect for the tracking ability of an ETF. When the price of the next futures which the ETF are rolling over to is considerably higher than the price of the futures which they are selling, this poses a challenge for the futures backed ETFs credibility to investors who might think they closely track the spot price. I will discuss the effect of negative roll yield more detailed using some empirical examples in chapter 4 when analyzing tracking error for the different ETPs.

When entering into a futures contract, the startup value of the contract is 0 both for the long and the short position, and the short/long investors have to put up a fraction of the futures face value as collateral in a margin account (Gorton & Rouwenhorst 2006). The investor on the losing end of the futures bet have to put up more collateral if the face value of the futures changes enough relative to the required margin. A margin account can be settled with cash, but also for some futures contracts with T-bills or specified high grade liquid securities (CME-Group 2011). If required collateral is not posted the intermediary/clearinghouse will close the position for the defaulted side and assume the position as counterparty. There is a limited counterparty risk in futures backed ETFs, like it is with ETFs holding the actual constituents of the benchmark.

1.5.2 Front running of futures

In the US market for 2010 the broad commodities mutual funds saw a US$ 11 billion net inflow compared to a US$ 1 billion net inflow for broad commodities ETFs. On the other hand precious metals mutual funds had a US$ 3.7 billion inflow compared to US$ 8 billion for precious metals ETFs (Mamudi 2011). That is, broad commodities mutual funds seem to be favored over broad commodities ETFs, while precious metals ETFs seem to be favored over precious metals mutual funds.

One possible reason is that broad commodity ETFs are backed by futures which are rolled at specific dates, while precious metals ETFs often hold the physical metal. The rolling of futures at specific dates could make the ETF vulnerable to front running of futures. If it is known in the market when the futures are rolled, speculators could buy futures ahead of the ETF roll dates and sell them in the market when the ETF is rolling, thus making a profit. This could especially be a hidden cost for futures rolled at pre-determined dates in markets with thin volumes. Broad commodity mutual funds are more secretive in their commodity strategy and are often also using swaps and notes in tracking commodities, thus they are also less exposed to roll yield.

Since most broad commodity mutual funds have existed prior to SEC's stop in registration of new funds that are using swaps (Section 1.6, page 16) the mutual funds may have a comparative advantage. Also, since mutual funds have a first mover advantage in covering broad commodities and longer history of proper functioning they could be seen as more reliable than the broad commodity ETFs by many investors.

1.5.3 Futures and the construction of commodity indices

Commodity ETPs included in this paper are set up to seek return according to a commodity index. Commodity indices which are covering a single commodity or a set of commodities are often calculated based on highly liquid futures markets of the index constituent(s). Commodity indices are normally labeled names such as spot index, excess return index and total return index, which is the case e.g. for the three most utilized variants of the S&P GSCI. All of the three S&P GSCI indices are based on the same basket of commodity futures rolled at the same time on the same dates of the month, but they reflect commodity futures in different ways.

A commodity spot price index, e.g. the S&P GSCI Spot Index, measures the price level of nearby futures contracts and not the returns earned by the investors (*S&P GSCI* 2007). The collateral aspect is not included in the spot price level which is measured by the futures prices alone, and the spot prices are not representative as the returns available to a futures investor.

A commodity total return index, e.g. the S&P GSCI Total Return Index, measure the returns of fully collateralized futures. The fully collateralized futures position of a commodity total return index signifies that the initial investment at face value of the contract is used to purchase T-bills. The interest bearing securities are used to cover the margin requirement either by exchanging the necessary amount into cash prior to margin posting (Analyst-Notes 2011) or by posting the necessary level of interest bearing securities directly as collateral when this is permitted by the futures contract. According to Standard & Poor's their commodity total return index is completely comparable to returns from an investment in for example S&P 500 (dividend reinvested) collateralized with a government T-bill. Thus for a specific commodity or set of commodities, the total return index is useful in measuring relevant investor returns compared to the spot index which conveys price levels without taking collateral into account.

A commodity excess return index, e.g. the S&P GSCI Excess Return Index, measure the return of the investment for uncollateralized futures. The uncollateralized futures position signifies that the investment always is kept in nearby futures, and this is a leveraged position compared to investing in collateralized futures. The calculation of a commodity excess return index do not take into account the interest earned from T-bills like the commodity total return index do. The S&P GSCI Excess Return index is (as far as I understand) similar to the S&P GSCI Spot Index, but different in that the excess return conveys returns while the spot index conveys prices. Standard & Poor's emphasize that a commodity excess return index is not directly comparable to an equity excess return index:

"The S&P GSCI Excess Return Index (unlike the excess return S&P calculates on equity indices) is not the return above cash ……..S&P GSCI Excess Return Index is comparable to the return on the pure portfolio of the S&P 500, without the T-bill investment"(S&P GSCI 2007)

Deutsche Bank's PowerShares ETFs included in this paper benchmark indices that are developed by Deutsche Bank. To avoid negative effects when rolling futures Deutsche Bank has introduced optimal yield indices constructed to minimize the effect of negative roll yield in contango markets and to maximize positive roll yield in backwardation markets. These indices are using rules based strategies of picking the futures that optimizes the returns. The DB optimal yield indices has excess return and total returns version similar to S&P GSCI.

The next figure is an example of the two different versions of one of the optimal yield indices from Deutsche Bank. The excess return version of the indices in the figure is the benchmark index for PowerShares DB Commodity Index Tracking Fund (DBC) analyzed later on.

Figure 6: Total return versus excess return of the Deutsche Bank Liquid Commodity Index Optimum Yield Diversified DBC benchmark index

The two indices are based at 100 on 5 Jan 2007. As seen in the figure the total return index is slightly outperforming the excess return. T-bill interest from a fully collateralized futures position included for the total return index causes the difference compared the uncollateralized futures position of the excess return index. A similar slight outperformance of the total return index over the excess return index would be seen if the respective indices of S&P GSCI are graphed for the same period.

1.6 Structure and operation of the synthetic ETPs (indirect replication)

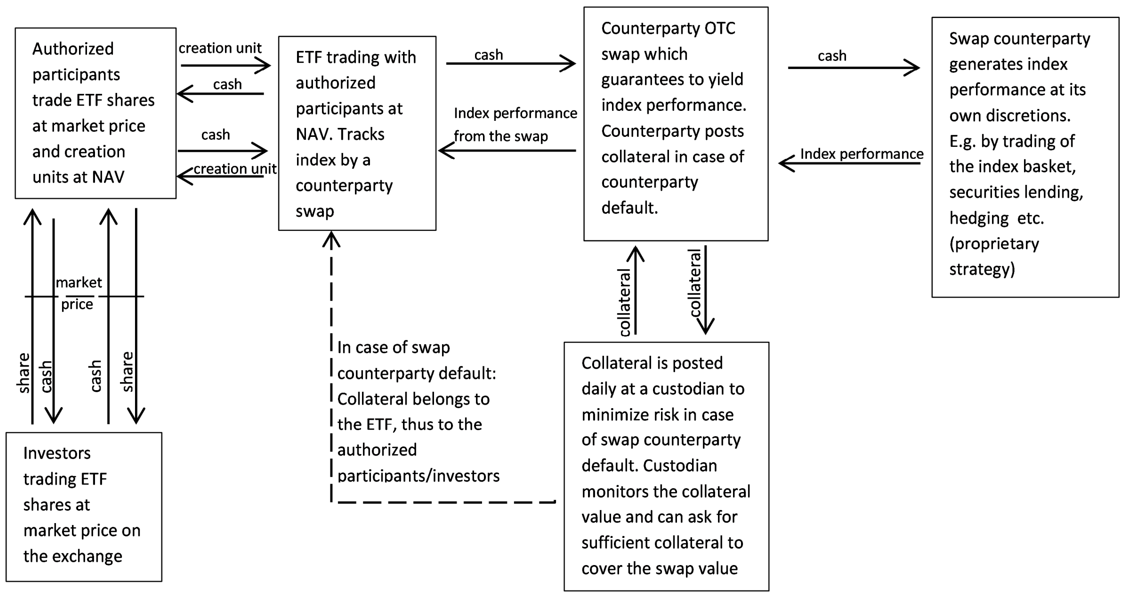
The synthetic ETP is an alternative offered by the financial industry to minimize tracking errors due to e.g. roll yield, management costs and transaction costs that take part in operating the holdings of a direct replication ETF. The synthetic ETP is also a way the industry can address illiquidity for certain markets. Low liquidity makes trading of the constituents of a benchmark more inefficient and complicated compared to a benchmark set in liquid markets. Tough competition amongst the providers in obtaining lowest possible tracking errors for their products could also be a cause for the growth in synthetic ETPs.

To address the challenges of certain illiquid markets and to minimize tracking error the synthetic ETP enter into an over the counter swap agreement which guarantees the return of the benchmark index. Investment banks often act as counterparty for the ETP in a swap, and the promised returns of the index are to be delivered whether the counterparty actually manages to replicate the returns of the index constituents or not. That is, the risk of tracking error is transferred to the swap counterparty. The strategy employed by counterparties to mimic the index return is proprietary and not available to the ordinary investor. Probably the counterparty uses hedging, security lending, active strategies and so on. Any potential excess profit after delivering the promised benchmark return belongs to the swap counterparty, thus making an incentive to guarantee the index return. The process of how a typical synthetic ETP is functioning is displayed in Figure 1 at the next page. The models are assembled partly from a Financial Times online article (Kaminska 2010), partly from the home page of ETF Securites (*Collateralised Swap* 2011) and partly from reading prospectuses etc. One of the differences in my synthetic ETP model and the model from the Financial Times online article is that I have included collateral risk. This is also pointed out in the recent synthetic ETF criticism from regulators and other large institutions, as I will come back to shortly.

The synthetic structure has gained a strong foothold in the European market, while the proliferation of swap based funds has been at least temporarily paused in USA by the Securities and Exchange Commission pending a thorough investigation of the use of derivatives in funds (Donohue 2010). Existing ETFs using swaps in USA prior to the SEC investigation are still operating. For example some of the US ETFs from the ProShares and the Direxion series use swaps to minimize tracking error. The ETPs in the quantitative analysis of this thesis are not synthetic ETFs.

Minimalized tracking errors of synthetic indirect replication come at a cost of less transparency and a more complicated structure compared to physical direct replication. The exact nature of collateral holdings provided by the swap counterparty is not publicly available for many ETPs. Eligible collateral are probably in most synthetic ETPs high rated securities, fixed income government bonds and equities such as listed on the ETF Securities homepage (*Collateralised Swap* 2011). The swaps may also be just partially collateralized and thus have partial counterparty risk, but could also not be collateralized at all with full counterparty risk. All dependent on the specific issuers' setup of the product (Blackrock 2011a)

Figure 7: Operations of the synthetic collateralized ETP (indirect replication)



- No counterparty risk due to collateral, but collateral value and liquidity could change in times of turmoil leaving the investors and authorized participants with collateral risk if the counterparty defaults
- Minimalized tracking error due to swap performance

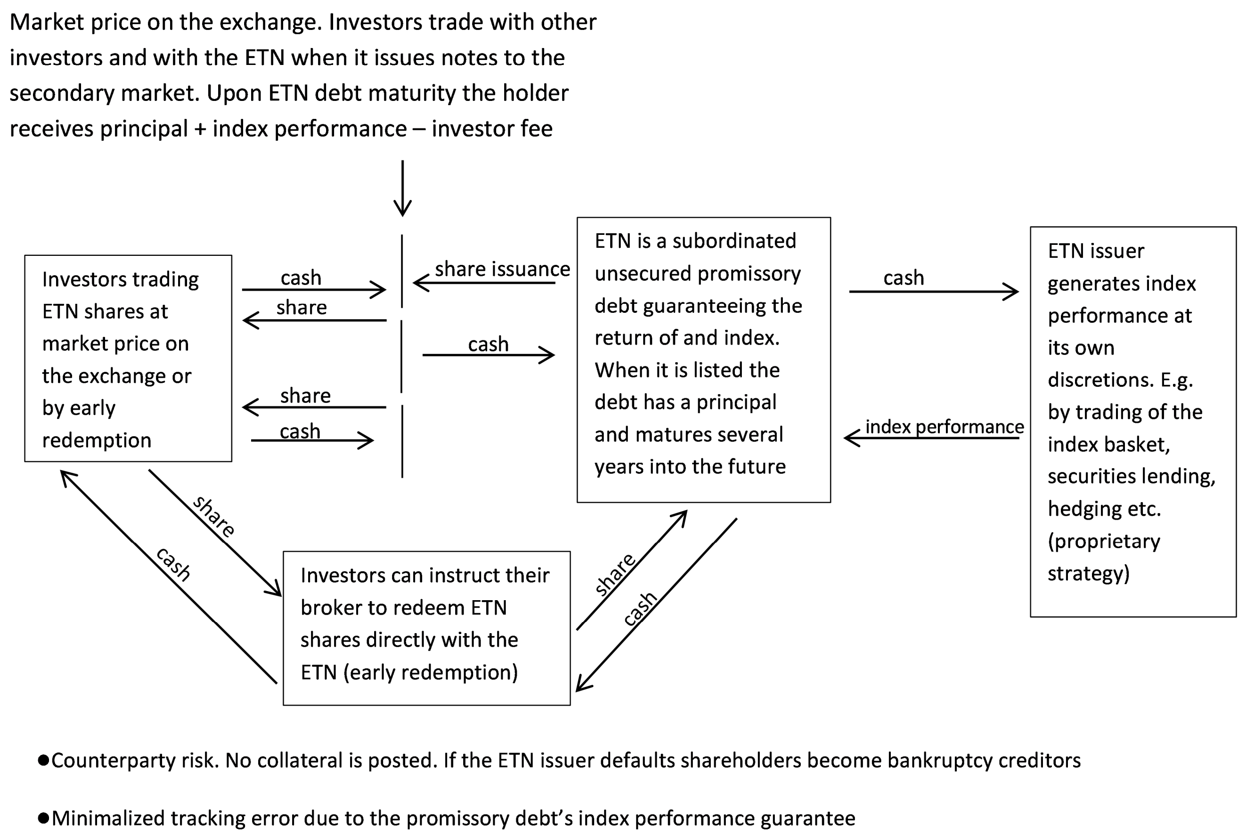
During the heights of the financial crisis fear of bankruptcy to the insurance company American International Group (AIG) caused suspension of trading in products from ETF Securities backed by AIG. More than 100 ETCs from ETF Securities were backed by AIG swaps. Market makers refused to trade those ETCs due to the uncertainty around AIG's existence and the risk of being unable to settle trades. AIG were saved by the US government and AIG swap backed ETC products started trading again. After this ETF Securities has taken steps in minimizing the counterparty risk by using fully collateralized swaps and diversifying risk by using several swap counterparties for their products (Rickets 2009).

1.7 Structure and operation of the exchange traded note (ETN)

The ETN stand out amongst ETPs mainly because it often is backed by unsubordinated unsecured promissory debt which minimalizes tracking error compared to an (direct replication) ETF. Unsubordinated debt indicates that the debt holder has priority over subordinated debt in case of debt issuer default. The providers of ETNs do not post collateral in Figure 8 below, and the portrayed structure is thus an unsecured debt. If the uncollateralized ETN provider were to go bankrupt the investors would become creditors in the bankruptcy proceedings.

Together with the uncollateralized ETN that is discussed in this section there also exists ETNs which are collateralized to different degrees and that have varying counterparty risk according to the degree of collateralization (NYSE 2008). The investor should read the specific ETN prospectus to assess the degree of counterparty risk.

Figure 8: Operations of an uncollateralized exchange traded note (ETN)



The ETN share is typically issued to the secondary market with a fixed date maturity that promises the return of the underlying index. When debt eventually matures the holder is guaranteed the principal of the debt and the return of the index except an investor fee. Shares can also be redeemed for cash, e.g. in the case of Barclays' iPath S&P GSCI Total Return Index ETN (GSP). According to the prospectus from Barclays they expect the investors to trade ETN shares in the secondary market but early share redemption is possible through a broker. Barclays specify that at least 50 000 shares must be presented in early redemption

(Barclays 2010). In this way there is an arbitrage opportunity for ETNs similar to what is available for authorized participants trading ETFs. Investors can trade shares when the ETN market prices deviate from the value of the underlying index, for example in buying shares when the ETN market price is below the index price the ETN is tracking. When the shares are accumulated into the required number for ETN redemption, shares can be exchanged with the issuer for cash, hopefully gaining a profit after ETN fees and transaction costs. I assume that it is mostly institutional investors that have in-depth market overview and low transaction cost that are available to exploit the arbitrage possibilities for ETNs. Nevertheless the arbitrage possibility keeps the ETN's market price close to the underlying index, which is often is cited as the greatest advantage of the ETN structure (low tracking error).

The uncollateralized ETN issuer does not post collateral with a custodian like direct replication physical ETFs or collateralized synthetic ETFs do. The inherent counterparty default risk of the uncollateralized ETN is an additional risk which is absent in e.g. the physical ETF. In 2008 the investors of Lehman Brothers backed Opta ETN series had to take great losses when they remained as promissory debt creditors in the bankruptcy proceedings. The Opta ETNs were tracking futures trading in corn, soya-beans, coffee and cotton (Mankelow 2009). Investors in ETNs backed by Bear Stearns were also heading in the same direction, but were saved when JPMorgan Chase acquired promissory debt obligations of the ETNs upon taking over Bear Stearns.

1.7.1 Investor management of ETN counterparty risk

Increased tracking ability of the uncollateralized ETN compared to the ETFs previously discussed comes at a cost of counterparty default risk. This risk should also be accounted for in some way by the investor. ETN investors which trade for large sums can limit the counterparty risk by purchasing credit default swaps (CDS) on the ETN issuer. CDS are mainly traded over the counter and with large sums per contract. Insuring ETN default by a CDS is not really a possibility for retail investors which maybe are trading for a few hundred or a few thousand dollars per trade.

A strategy which could be utilized for the retail investor who seeks to remove the default risk for example in holding an uncollateralized ETN could be to buy put options on the ETN issuer. The put options give the buyer the right, but not the obligation, to sell the underlying asset at the strike price upon expiration.

Table 2: Put options available for Barclays Bank as of April 2011 insuring US$ 1000 against default

Strike	Expiration	Bid	Ask	Vol.	Open interest	Cost	% cost (*)
$14	20 May 2011	not available	0.05	66	376	$3.6	0.4 %
$14	17 Jun 2011	not available	0.10	5	3930	$7.1	0.7 %
$14	16 Sep 2011	0.15	0.30	50	50	$21.4	2.1 %
$16	16 Dec 2011	0.85	0.95	4	22	$59.4	5.9 %
$10	20 Jan 2012	0.15	0.30	0	110	$30.0	3.0 %
$10	18 Jan 2013	0.40	0.85	0	60	$85.0	8.5 %

(*) Estimated cost do not include potential gain from selling the put option

Table 2 list some of the put options available for Barclays (BCS) gathered from Yahoo Finance as of April 2011. The cost column estimates the price of buying put options which would cover an investment of US$ 1000 in a Barclays backed uncollateralized ETN if Barclays goes bankrupt. I will try to explain by using the put option at the bottom of the table. The strike price is at US$10, and the expiration date is 18 Jan 2013. If an investor were to invest US$ 1000 and hold on to a Barclays ETN for a long period, the investor could buy options at the US$ 0.85 asking price to protect against default in Barclays. Since the option price is US$ 10, the investor would have to buy 100 options[6] for US$ 85 in order to cover his initial ETN investment of US$ 1000. If Barclays defaults and Barclays' share price hit 0, the options position would be worth US$ 1000 at expiry, thus covering the initial ETN investment.

However, the example is based on a few assumptions that may not be totally realistic. Transaction cost is not included in the example. In addition the volumes for option trading are low, and there is no guarantee that the asking price would stay at the same level when filling an option order at the exchange. The option order could just be partially filled, and the asking price could change for the rest of the order. If an ETN investor wants to hold on to Barclays ETN for a longer time than the expiration date of the option, she/he would have to roll the option at an unknown price in the future. Also, the cost could be lower than what is stated in Table 2 because Barclays will probably not go bankrupt. If the investor sells the ETN, the option could be sold off at an unknown price in the future, thus decreasing the cost displayed in Table 2. The Chicago Board Options Exchange list specific options on ETN providers which can be bought to remove ETN holders from the counterparty risk of the ETN product (CBOE 2011).

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[6] An option covers 100 shares of the underlying asset but is displayed on a per share basis (Yahoo 2005).

The point is that ETPs can have counterparty risk dependent on the degree of collateral posted by the specific ETP, a risk that the retail investor should consider. The counterparty risk of an ETP may vary because of differences in collateral coverage posted by the specific products. ETNs have minimalized tracking errors compared to a physical ETF, but the improved tracking error should be weighed against the counterparty risk according to the collateralization coverage of the ETN.

1.8 Examples of bull and bear ETPs and consequences to the investor

An investor who seeks a multiplier effect in relation to an index can buy ETPs who are set up to yield a return of for example +/- 200% or +/- 300% compared to an index. Leveraged ETPs (bull) and inverse ETPs (bear) are not the topic of the main analysis in this thesis, but a few words on them are included in this section. Often these bull and bear ETPs are set up in relation to liquid high volume indices e.g. broad share market indices or commodities such as oil, gold or silver (*Leveraged ETFs* 2011).

Table 3 on the next page report OLS regression result for ProShares bull and bear gold ETFs. According to the prospectus ProShares Ultra Gold (UGL) seeks a return of 200% compared to the daily performance of the benchmark index which is gold bullion measured in US$ by the London gold pm fixing. Table 3 also includes ProShares Ultra Short Gold (GLL) that seeks a daily return of -200% compared to the same index. Trading days that have prices for both the ETF and the index is included, while days that are missing prices for either the ETF or the index is excluded for both the index and the ETFs. End of week prices are used for weekly returns while mid-month prices are used for monthly returns.

The OLS regressions are a two variable regression with returns for UGL and GLL respectively as the dependent variable. The gold benchmark index is the independent variable. Since the gold index is set at approximately 3 pm GMT in London (LBMA 2011), the open price of UGL/GLL at NYSE Arca is chosen. Since NYSE opens at 9.30 am eastern the opening price of UGL/GLL yields the shortest time difference compared to the adjusted close price when measuring against the London gold pm fixing benchmark. Between 14th and 15th of April 2010 GLL (bear) had a 5 to 1 reversed share split which is adjusted for in the price series. UGL and GLL, like most ETPs in this thesis, do not pay dividend and as such there is no need to account for that in the price series of this example.

Strictly interpreted the alpha value tells how much better the fund in general did than the benchmark if the return of the index is zero. Likewise, negative alpha reports how much worse the fund in general did if the benchmark return is zero. A return of zero for the index would occur if the gold price of a particular day/week/month is equal to the gold price of the previous day/week/month. Null hypothesis for alpha is zero but the reported alpha values are expected to be less than zero due to operational costs of ETPs plus brokerage costs and market bid/ask spreads to the investor. Alpha give some clue on how much better or worse the security returns are compared to the benchmark returns over the period.

Beta tells how sensitive the fund performance has been in relation to the index, and null hypothesis is that beta is 2 for the bull gold UGL and -2 for the bear gold GLL.

Daily and weekly return series for UGL/GLL are negatively autocorrelated while monthly returns do not possess autocorrelation characteristics by the Durbin-Watson d test. Negative autocorrelation for daily and weekly returns are accounted for in the t-scores by using standard errors from the Newey-West HAC estimator, while t-scores for monthly returns is calculated by standard errors from the OLS regression.

Table 3: Performance to the benchmark for ProShares bull/bear gold ETPs by OLS. (4 Dec 2008 – 1 March 2011)

	Daily returns (n=546)				Weekly returns (n=117)				Monthly returns (n=27)			
Ticker	α	β	R^2	DW	α	β	R^2	DW	α	β	R^2	DW
UGL (2x gold)	0.00011	1.77	0.80	2.93●●	-0.00113	2.03	0.96	2.86●●	-0.00557	2.11	0.99	2.27
	(0.52)	(-5.42)●●			(-2.35)●	(0.63)			(-2.13)●●	(2.11)●		
GLL (-2x gold)	-0.00031	-1.86	0.78	3.06●●	-0.00066	-1.98	0.95	2.79●●	-0.00948	-1.72	0.99	2.26
	(-1.36)	(3.64)●●			(-1.17)	(0.32)			(-5.79)●●	(8.94)●●		
5 % t critical	1.96				1.98				2.06			
1 % t critical	2.58				2.62				2.78			

●= Significant 5% level ●●= significant 1% level

$$(return\ for\ ETP)_i = \alpha + \beta(return\ for\ benchmark)_i + \varepsilon_i$$

$$t\ scores\ in\ the\ table\ parenthesis\ = \frac{\hat{b} - b_0}{S.E._{\hat{b}}}\ , where\ b_0 = 0\ for\ \alpha\ of UGL\ and\ GLL$$

$$and\ b_0 = 2\ for\ \beta\ of\ UGL, \qquad b_0 = -2\ for\ \beta\ of\ GLL$$

Table 3’s alpha value for UGL when measuring over daily returns contradicts the expectation of a negative value, and indicates that daily returns for UGL are slightly higher than the index when the gold index benchmark has a zero return. All the other alpha values are negative as expected. Alpha values are not significantly different from the null hypothesis of zero alphas by critical t-levels of 1%, except for UGL over weekly returns and for both UGL/GLL when measured over monthly returns. Increasing alpha levels for decreasing measuring frequencies should come as no surprise since percentage returns normally differ more for monthly returns compared to for example daily returns. Alpha levels are in general small which is expected since they strictly interpreted represent the return for UGL/GLL when the index return is zero. As such for this period, like tracker funds are supposed to they did not possess any excess positive or negative return when the index yields zero return.

R^2 values are high, and increases over daily to weekly to monthly return periods. High frequency data, in this case daily returns, add more noise to the model than lower frequencies such as weekly and monthly returns. High R^2 should be expected since the regression is for two ETPs that are tracking a benchmark, and the benchmark should have a high explanatory power to movements in UGL/GLL prices.

Beta values are significantly different from 2 and -2 for UGL and GLL respectively when measured over daily and monthly returns. It is perhaps a bit surprising that the betas according to the t-scores for the model seem to fit better for weekly returns compared to monthly returns, but it indicates that the tracking ability for UGL/GLL is better over weekly returns than over monthly return.

So do beta values that are significantly different from the expectations a bad thing for the investor? Not necessarily, since a beta of 2.03 for UGL which is not significant from the null hypothesis of 2 for weekly returns and, and a beta of 2.11 for monthly returns which is significant suggests that someone who held a long position in the period analyzed above actually would get a return in excess of the 200% to gold.

Annualized geometric returns[7] for the holding period is 31.3% for the gold benchmark and 60.1% for UGL (bull) which is slightly less than perhaps expected by looking just at the 2x benchmark return label of UGL. For GLL (bear) annualized geometric return is -49.9% which is also less than the -2x multiplier. GLL seems to be further off than UGL by annualized geometric returns for the period, and as such the annualized geometric returns are slightly contradictory to the daily returns in Table 3.

The smaller than perhaps expected annualized return when looking at the multiplier labels of GLL and UGL depends on the type of return that is chosen. The negative deviation from the

[7] $Annualized\ geometric\ return{:} -1 + \prod_{i=1}^{n}\left(1 + \ r_{i,daily}\right)^{\wedge\left(\frac{Q}{n}\right)},\ \ where\ \ r_{i,daily} = \frac{price\ at\ trading\ day_i}{price\ at\ tradind\ day_{i-1}} - 1$

2x multiplier is even greater when measured by annualized logarithmic returns[8] which are 47% for UGL and 27.2% for the index, a negative deviation from 2x the return of the index at -7% compared to the deviation of -2,5% by the annualized geometric return. When measured by annualized arithmetic[9] returns UGL has however more than doubled the return of the index at 72.3% while the gold index return is 33.8%, a positive deviation of 4.7% compared to negative deviations when using geometric or logarithmic return.

The different annualized return methods and the OLS regression in Table 3 above are not necessarily correct ways of measuring deviations from the benchmark of leveraged bull and bear funds. They are examples of the problem by looking superficially at the multiple labels for bull or bear ETPs and the challenge of measuring these funds tracking errors. Another challenge when measuring bull and bear ETPs over longer periods is the compounding effect leveraged returns of a bull/bear tracker have on the actual money invested in the fund.

Figure 9: US$ 100 investment in ProShares bull/bear gold ETPs (4 Dec 2008 - 1 March 2011)

An investment of US$ 100 in UGL or GLL made on 4 Dec 2008 would yield the dollar value as graphed in the period above in Figure 9. The monetized value of the investment in Figure 9 is anno 1 March 2011 up to US$ 286 from the initial value of US$ 100, while the gold price indexed at base US$ 100 from the same initial date is up to US$ 184. That is, UGL is up

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[8] $Annualized\ log\ return: (\frac{\sum_{t=1}^{n} r_{i,log}}{n}) * Q \ ,\ where\ r_{i,log} = ln(\mathrm{p}_{\mathrm{i,t}}/\mathrm{p}_{\mathrm{i,t-1}}) = daily\ log\ return$

[9] $Annualized\ arit.return: \left[\left(\frac{\sum_{t=1}^{n} r_{i,daily}}{n}\right) + 1\right]^{\wedge Q} - 1 \quad ,\ where\ r_{i,daily} = \frac{price\ at\ trading\ day_i}{price\ at\ tradind\ day_{i-1}} - 1$

$Q = 244.5$

$= average\ no.of\ days\ p.a.with\ prices\ available\ in\ the\ dataset\ for\ both\ the\ security\ \&\ benchmark$

slightly more than perhaps expected if someone is using nominal returns calculated from the time of the initial investment. Measured by the nominal return[10] from the initial investment UGL is up 185.9% while the gold index is up 83.7%. When using nominal returns and just looking superficially at the 2x multiplier label, one could perhaps anticipate that the UGL should be up 2x83.7% which is 167.4%. Again, like for the annualized arithmetic return calculated at the page above, a positive deviation from the anticipated value by just looking at the 2x label of UGL.

For the bear investor who bought US$ 100 of the GLL gold bear fund the investment would be worth about US$ 21 at the end of the period, or about 80% less than the initial value. Of course a bear fund cannot be worth -2x83.7%, or -167.4% to the initial value which would leave the investor owing money to the fund. The point is that the effect from compounding of leveraged returns should be understood as something else than just a simple multiplier of the index returns, especially when holding positions over longer periods.

Gold which has experienced a bull rally marked over the period of Figure 9 at page 25, has due to the compounding effect on leveraged returns reached a pleasant US$ value for the investor who bought UGL in December 2008. Figure 10 below is a similar figure conveying price levels of a US$ 100 investment made about a year later at 1 December 2009 until 1 March 2011.

[10] $Nominal\ return\ from\ initial\ investment\ date: \frac{Price\ value\ at\ end\ of\ period}{Price\ value\ at\ initial\ investment\ date} - 1$

Figure 10: 100 US$ investment in ProShares bull/bear gold ETPs (1 Dec 2009 - 1 March 2011)

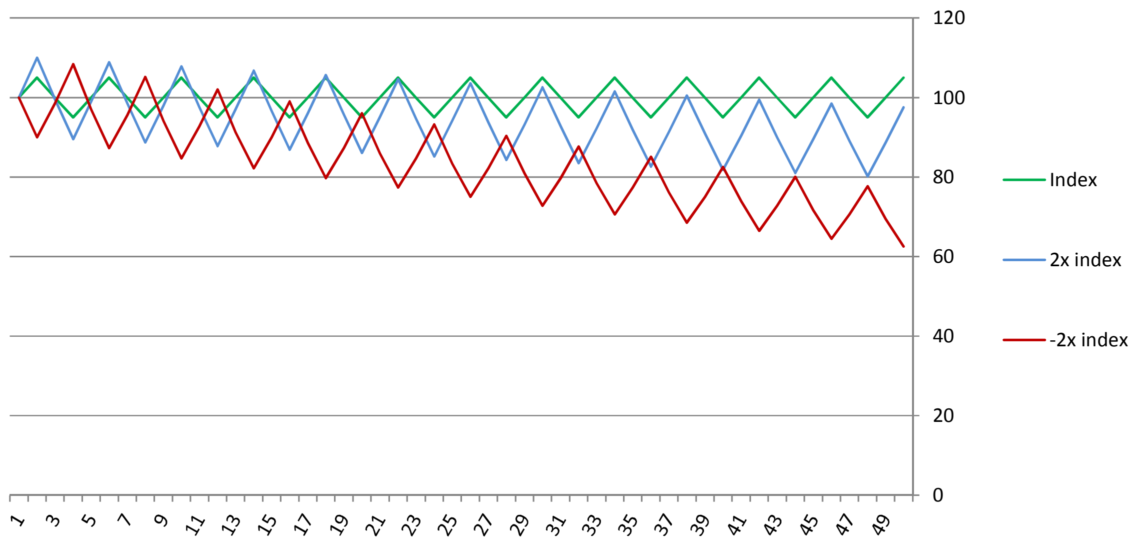
The monetized value of an initial investment of US$ 100 in the UGL bull ETF of Figure 10 is up to US$ 130 while the gold price index based at US$ 100 from the same initial date is up to US$ 119. One can see from Figure 10 that UGL, from August 2010 and onwards, did not yield the perhaps expected 2x multiple for somebody who bought UGL for US$ 100 on 1 Dec 2009. At around the turn of the month between January/February 2011 the UGL (2x gold) is about at the same price value as the gold benchmark, even though gold has increased more than US$ 10 from the initial base of US$ 100. Similarly, at around June 2010 GLL (-2x gold) is priced at US$ 90 while the gold benchmark is back to approximately US$ 100 which was the starting point for the indexed prices.

An OLS regression like the one in Table 3, page 23 performed over weekly returns for the one year shorter period of Figure 10 yields similar results. That is, alpha is slightly negative but not significantly different from 0 for the two ETFs when measured over daily, weekly as well as monthly returns. Beta over weekly returns for UGL (bull) is 2.07 and -2.07 for GLL (bear), while beta over monthly returns is 1.91 for UGL and -1.63 for GLL. Only the latter monthly return beta of GLL is statistically different from the null.

Someone being long in funds that deliver leveraged returns for an index could experience a pleasant surprise if bull markets and mainly positive daily returns are ahead in time, as seen for UGL compared to the gold index in Figure 9, page 25. For an excess return effect to occur compared to the 2x multiplier, the index also has to have a low concentration of negative returns compared to the concentration of positive returns. If not, the investor could be unpleasantly surprised as seen for UGL in some periods of the last half of Figure 10 above.

For leveraged bull and bear investments ETPs that are tracking indices in times of mean-reversion and high volatility, the compounding effect of leveraged returns could be damaging for the investments monetary value. Figure 11 below portrays the hypothetical price value of a US$ 100 investment in a bull and a bear fund with a 2x and a -2x multiplier to the index. The benchmark index is mean-reverting, shifting repeatedly between US$ 100 to 105 to 100 to 95 and back to 100 over a period of 50 observations.

Figure 11: Hypothetical 2x/-2x performance for trackers of a volatile mean-reverting benchmark index



The example above is purely hypothetical and the possibility of observing free floating market index movements like this is slim to nothing. It is useful in explaining why the investment value for UGL/GLL e.g. in Figure 10 at page 27, could be far off from what is perhaps expected by just looking at the multiplier that leveraged and inverse leveraged ETPs often are categorized under. Another challenge for these types of funds, which not is accounted for in Figure 11 above, is the rebalancing effect. According to Espen Sirnes (Sirnes 2009) bull/bear funds rebalance their holdings to the underlying benchmark to keep the leverage e.g. at the 2x or -2x multiplier. Espen Sirnes (2009) shows the disadvantage of rebalancing when the index price is low (selling at a low) and likewise when the index price is high (buying at a high).

The results discussed above in this section indicate in my opinion that an OLS regression may not be sufficient in measuring bear/bull funds over long periods, and that bear/bull funds not are index trackers similarly to the straight unleveraged and non-inverse trackers. The OLS regression is in the examples above measures returns over daily, weekly and monthly frequencies, but doing so may not very well represent effects from the compounding of leveraged and inverse leveraged returns on the monetary value of an investment.

Over different periods through 2006-2008 Ultra Short/Long ETFs from ProShares have been analyzed in order to assess their ability to provide twice the return, or twice the negative return of the underlying indices (Lu et al. 2009). Benchmark indices which the ProShares are tracking are gold which is looked at above in this section, as well as Dow Jones Industrial Average, S&P 500, NASDAQ 100 and Russel 2000. Lu et al. (2009) conclude that short-term investor with a holding period of no more than a month can safely assume that ProShares Ultra long (Ultra short) ETFs yields double return (double negative return) of the benchmark. Deviations from the benchmark seem to occur for the ProShares Ultra short ETFs with holding periods of 3 months or more. For the ProShares Ultra long ETFs, deviations appear with holding periods of 1 year or more. That is, leveraged ETFs from ProShare seem to be a better tracking device for short-term investor than for the long-term investor since tracking error increases with holding period, and ProShares' inverse leveraged ETFs are over time more likely to deviate from benchmark compared to ProShares' leveraged ETFs.

Another study covering performance of 44 double leveraged and 12 triple leveraged ETFs mainly with data from 2008 (Avellaneda & Zhang 2009) comes up with similar results as the referenced study above with Lu et al. (2009). That is, tracking errors of leveraged ETFs increase with holding period and bear ETFs have a tendency to deviate more than bull ETFs from the related benchmark. However, Avellaneda & Zhang (2009) propose a dynamic model for improving the replication of an underlying index. The model is empirically tested and suggests that weekly rebalancing of the investors holding of leveraged ETFs actually can mimic the underlying index, but also Avellaneda & Zhang (2009) concludes that:

"*…leveraged ETFs as currently designed may be unsuitable for buy-and-hold investors*."

The most potent warning to individual investors probably came from SEC staff and the Financial Industry Regulatory Authority (FINRA) when they issued an alert regarding the issues of holding leveraged and inverse ETFs over long periods (FINRA 2009).

Charupat & Miu (2010) find that bull/bear ETFs actually mainly are traded by retail investors with very short holding periods. This could be interpreted into that retail investors do take into account the compounded returns effect with leveraged and inverse ETFs, and use these funds for bets on short term market trends. Charupat & Miu also find that large premiums and discounts are prone to occur in these ETFs and that formation of premiums is different in bull versus bear funds.

1.9 Recent criticism and debate surrounding ETFs

One of issues for ETFs is their involvement during the flash crash of 6 May 2010. During the flash crash more than 20 000 trades across 300 securities were executed more than 60% below their fundamental values before they rebounded almost as quickly, all within a few minutes. In addition many of the 8000 securities that were trading in the flash crash experienced a fall-rebound within the 5% to 15 % range (CFTC 2010). According to some research 70% of the cancelled trades in the aftermath involved ETFs even though ETFs only represent 11% of the listed securities in the US market (Galland 2011). Some has speculated in that the cause for the flash crash was a fat finger order[11] executed in the market causing high frequency automated arbitrage strategies to run wildly. It is not found any evidence of a fat finger order according to the CFTC/SEC report referenced above. A highly volatile trading period prior to the flash crash event, illiquidity in the market, large order executions and automated high frequency trading all combined are probably the reasons. SEC imposed new rules expanding the existing circuit breakers[12] program to curb new flash crashes from happening (SEC 2010a). Prior to the flash crash the circuit breakers responded to extreme volatility of the DJIA index. Now a trade pause is activated by single stock movements of 10% or more within a 5 minute period for constituents of the S&P 500 and Russel 2000 indices as well as for certain ETPs. However, an incident similar to the 6 May 2010 flash crash happened again on 31 Mar 2011 when some US ETFs' values fell up to 98% and trades had to be cancelled again. This time the cause was probably a fat finger order, and the trade curbing did not set in because the ETFs involved were recently launched and not yet listed in the circuit breaker program (Cotterill 2011).

Separate reports criticizing ETFs were released in April 2011 from the International Monetary Fund (IMF), the Financial Stability Board (FSB) and the Bank for International

[11] Fat finger order: E.g. a US$ billion order unintentionally executed in the market while the order intentionally was planned as a US$ million order.
[12] Circuit breakers: Mechanisms imposed on exchanges, e.g. in response to the crash of 19 Oct 1987, intended to pause trading during extreme volatility in order to give the market time to assimilate information (NYSE 2011).

Settlements (BIS) (Flood 2011). The concern is mainly addressing practices by synthetic ETF issuers in Europe due to the fact that in USA the SEC already has taken actions by pausing new registrations for swap based funds. Nevertheless, I find that the criticism is not entirely irrelevant to the US market. ETFs using swaps already existed in USA prior to the pause in registrations of swap based funds by the SEC, and those are still operating (Donohue 2010). Securities lending discussed below could also be an issue in US ETFs, as well as the general concerns over ETFs and other funds' part in the increase of commodity prices.

"The recent increase in commodity price volatility has been partly attributed to the strong flows into commodities-based funds, particularly gold ETFs, amid mounting concerns that the flows are distorting prices away from fundamental factors." (IMF 2011)

It seems like inflows to commodity funds gets much of the blame for the rise in commodity prices and that commodities, especially gold, is seen as an asset bubble. IMF seems to lack empirical research sources for their concern over that gold ETFs in particular are causing a gold commodity bubble, but the general commodity fund criticism should come as no surprise on the background of the 2009-2011 commodity prices which are correlated with the growth in the securitized commodity industry. Other reasons for increasing commodity prices could also be:

- Equity market uncertainty which causes increased investments in commodities
- Low interest rates and government credit expansion which causes investors to buy into commodities to hedge inflation or like in George Soros' case to hedge deflation (WSJ-blogs 2011)
- Speculators jumping aboard the commodity asset class
- Human population growth which generates an increasing demand for food and other commodities
- Rise in commodity demand caused by economic growth in China and other emerging markets

Another part of the ETF criticism addresses concerns over what might happen if the market goes strongly bearish causing turmoil and a massive sell off e.g. in synthetic commodity ETFs backed by collateralized swaps. Swap collateral is generally not related to the commodity or underlying index which an ETF is tracking. Also, synthetic ETFs are often backed by swaps from banks that are within the same ownership sphere as the ETF, which also arise the question of conflict of interest if the bank sees the ETF swap collateral as a cheap way of funding illiquid securities the banks hold on their books (FSB 2011). Swap collateral could leave the ETF and investors with securities that are unsellable and impossible to mark to market in times of market stress. This could contribute to systemic risk

(Ramaswamy 2011) and push the financial system into a freeze if liquidity dries up. Perhaps something similar to what happened when leveraged structured debt products and synthetic financial securities on subprime debt helped initiating the financial crisis just a few years back. Likewise, the rating assessments of assets and collateral have not always been reassuring, and rating agencies have in the past been criticized for conflicts of interest in possible causes for the financial crisis. Another way of looking at it could also be to ask if it is realistic to verify the quality for some types of securities prior to unknown market stress events, e.g. securities like illiquid collateral on investments bank's books or debt obligations backed by small countries.

Security lending practices of direct replication ETFs which not uses swaps also raises concern. The question is what will happen if there is a massive sell off by investors in an ETF if a large part of the funds securities is lent out to the market. A cap on securities lending may be implemented in Europe by regulators if the ETF issuers do not address these concerns (Ross 2011).

Another challenge for the investor is that ETP market makers will refrain from setting a spread order in the market when there is high volatility and difficulties in price discovery for the underlying asset(s) of an ETP, a precaution which is mentioned under risk issues in prospectuses of ETPs.

The response from the ETF providers to the recent concerns from IMF/BIS/FSB is mixed. Deutsche Bank answers the concern by commenting that they are using independent collateral managers to ensure collateral quality for their synthetic ETFs. Other sees the reports as lobbying from the mutual fund industry that may have even lower standards of collateral transparency and which also uses securities lending as a source of income. On the other hand the head of ETF research at Blackrock, one of the world's largest asset managers and owner of the iShares[13] ETF series, meets the criticism by stating that it raises valid points (Flood 2011).

[13] iShares has close to US$ 600 billion of assets under management, and a 43% share of the global ETF market (Blackrock 2011b).

1.10 Conclusions chapter 1

I have attempted to model some the general properties and functioning of ETPs that exist in the market as of today. Other ETP versions and structures than those in this chapter do exist and the investor should always read the prospectus prior to an investment to assess the risks and characteristics of the specific ETP that is of interest.

A physical (direct replication) ETF, the type of commodity ETFs that are quantitatively analyzed later on, are generally safer investments compared to the synthetic (indirect replication) ETFs. In a physical ETF the assets of the ETF which normally is constituents of the underlying index is shielded from potential ETF default. If the ETF defaults and new management is not appointed the assets are owned by the investors. The ETF assets which are used to replicate the index are shielded by being posted in a client's account at a custodian. If the custodian defaults a new custodian would most likely be appointed, anyway the physical ETF's assets will be shielded from custodian bankruptcy by being held in a client's account.

The specific collateral posted in synthetic ETFs is generally not publicly disclosed and thus it represents an additional risk that may be difficult to assess. Also there are synthetic ETFs that are not fully collateralized like the model used in this chapter. The collateral risk is addressed in the recent concerns over the synthetic structure from IMF/BIS/FSB which also is partly included in this chapter. The investor may gain a smaller tracking error when investing in synthetic versus physical ETFs, and it may also be difficult to find physical ETF over synthetic ETFs for illiquid and narrower segments of the market.

When it comes to the ETN structure it is should be known to the investor that if the ETN issuer defaults there is generally not collateral posted, and the underlying benchmark assets/commodities are not held by the ETN in contrast to the physical ETF. ETNs are unsecured debt-like structures where the issuer of the debt promises the return of the underlying index. As such the retail investor could remove risk of default with the ETN issuer by holding options on the issuing firm.

Leveraged and inverse leveraged ETPs are not quantitatively analyzed later on in the thesis, but I have briefly analyzed two bull/bear gold ETFs in this chapter. Bull/bear funds may give exposure to the underlying indices, but are not reliable as index trackers over longer periods. There are challenges in how to measure risk adjusted returns of a bull/bear tracker, and how to account for the tracking ability of bull/bear funds. This could be a possible topic for further research.

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Chapter 2: Descriptive statistics for commodity ETPs and mutual funds

Summary chapter 2

For the broad commodity and the energy selection it seems like Deutsche Bank's optimal yield technology when rolling futures have a slight advantage to the comparable derivative ETPs at least for the whole period and sub period 1. For the precious metal selection the tendency is opposite, and physical deposit ETFs are higher ranked.

None of the tests for difference in means are significant on a 1% or 5% level in the pairwise testing for any of the securities within the respective commodity categories. A lot of the pairwise tests for differences in variances are significant on a 1% level.

There is no evident tendency in that ETPs are better ranked for the broad commodity and energy selections. For precious metal there seems to be a tendency in that ETPs are better ranked than the mutual fund counterparts for the whole period and in sub period 1 (2007-2009).

Keywords: Commodity ETPs and mutual funds, returns, total risk, distribution of returns.

2.0 Introduction

The purpose of this chapter is to calculate descriptive statistics such as returns, volatility and distribution characteristics for the main selection of 18 commodity ETPs. For comparison a second selection of 17 commodity mutual funds and a third selection of 5 equity ETPs are included. All the ETPs are listed on NYSE Arca and the mutual funds are all US based. The ETPs and the mutual funds are divided into a broad commodity category, an energy category and a precious metal category as described in section 2.1 below.

In addition the risk free rate of return based on daily percentage interest for the US 1 Year Treasury Constant Maturity Rate is included. The MSCI Barra All Country World Index Investable Market Index (ACWI IMI) is also included to represent the total market.

2.1 Data for the analyses of chapter 2

In the analyses of this chapter I will use daily returns in the period from, and including, 8 Jan 2007 up to and including 1 Mar 2011. For each security there are 1045 daily returns calculated from daily price data. The price series are divided into 3 periods. Annualized return is calculated in such a way that it represents the annualized return for a holding period of an investor who buys at the first day of the period and sells at the last day of the period. The issue of how to account for mutual fund frontloads is defined in Equation 2, page 42.

Whole period: The whole period has data of all trading days from, and including, 5 January 2007 up to and including 1 Mar 2011.

Sub period 1: Sub period 1 is the first sub period of the whole period, comprising all trading days including 5 Jan 2007 up to and including 27 Feb 2009.

Sub period 2: Sub period 2 is the second sub period of the whole period and incorporates all trading days including 1 Mar 2009 up to and including 1 March 2011. Due to the short existence of ETPs some securities listed later than 5 January 2007 are only included in sub period 2.

The securities that are included are divided into three general categories;

- <u>The broad commodity category</u>

The broad commodity category has 5 ETPs which track broad commodity indices. For comparison a selection of 5 mutual funds covering broad commodities is included. The broad commodity mutual funds utilize commodity derivatives and futures in a similar way as the broad commodity ETPs. The mutual funds are chosen based on the highest ranked broad commodity mutual funds from Morningstar’s mutual fund evaluations.

- <u>The energy category</u>

The energy commodity category has 5 ETPs which respectively track specific energy commodities. Another 5 broad energy equity mutual funds are included based on the highest ranked funds from Morningstar’s mutual fund evaluations. I haven’t been able to find mutual funds that track specific energy commodities, so in an attempt to improve the ETP versus mutual fund comparison another 5 ETPs holding broad energy equity is included.

- The metal category

The metal category has 8 metal ETPs. 2 of the ETPs track industrial metals while the remaining 6 track precious metals. For comparison 7 mutual funds that hold physical precious metals and metal related securities are included. The selection of precious mutual funds is based on the highest ranked precious metal funds from Morningstar's mutual fund evaluations.

Mutual fund assumptions

A specific mutual fund has different classes of shares dependent on the investor profile, typically called A, B, C, I, R or N shares. Especially the institutional classes of shares have high minimum investment requirements. Since this thesis is focusing on retail investors I have from each specific mutual fund chosen a class which has a low minimum investment requirement. The minimum investment requirements of the included mutual fund share classes are in the range of US$ 500 to US$ 3000. The mutual fund share classes for retail investor often have a loadfee, and I have chosen the front-load classes of shares. Front-loads are included in the return calculations. A complete list of minimum investment requirement, frontloads and class of share for each mutual fund can be found in Appendix A 2 at page 106.

Source of data

Source of price data for ETPs and mutual funds in this chapter is Yahoo Finance. Basis for the dataset is Yahoo's adjusted closing prices both for ETPs and mutual funds. The adjusted close price is according to Yahoo in adherence to standards from Center for Research in Security Prices (Yahoo 2011) in such a way that dividend is reinvested and splits are accounted for using appropriate multipliers.

Price data for the total market benchmark (ACWI IMI) is downloaded from the MSCI Barra website. The risk free of US 1 Year Treasury Constant Maturity rate is fetched from the website of Federal Reserve Bank of St. Louis.

Yahoo's adjusted close price represents the exchange traded market price for ETPs and the non-exchange traded net asset value (NAV) for mutual funds. Since mutual funds are not exchange traded they do not have an open market price equivalent to what is found for ETPs. An alternative to my approach of using NAV for mutual funds and the exchange traded market price for ETPs could be to use NAV for both mutual funds and ETPs. A retail investor's settlement when trading mutual funds is based on NAV, while buying or selling of ETPs are based on the exchange's quoted ask/bid spread prices and matching of orders. It is normal to find small differences between the NAV and market price for ETPs (MSSB-Research 2011). Market makers whom also are registered authorized participants can trade both at the exchange as well as directly with the ETP thus exploiting arbitrage opportunities in differences between NAV and market price of an ETP. This arbitrage opportunity does not exist for a non-authorized participant such as the retail investor who is limited to use the exchange for trading ETPs. Since the focus of the thesis is the retail investor I find it natural to use the exchange traded market price and not NAV for the ETPs, while NAV are used for mutual funds.

2.2 General considerations on Yahoo and other data sources for the thesis

It could be that the freely available adjusted close price series from the data provider Yahoo Finance are not entirely correct, especially concerning the validity of results from quantitative analyses of the mutual fund selection.

The relatively short time span of existence for the commodity ETPs makes it possible to verify that the stock splits which has occurred for iShares Gold Trust (IAU) and iShares Silver Trust (SLV) are reasonably accounted for in the price series. Likewise for the relatively low dividends that are paid out for the Deutsche Bank's PowerShare ETFs. The mutual funds in general have a considerably longer time span since inception and also sometimes pay large dividends. Thus Yahoo's adjusted close prices for the mutual funds are complicated to verify without comparing the adjusted close price series to information on splits/dividends and historical data which probably would be available from a commercial financial data provider.

When checking for errors in the adjusted close price data from Yahoo I found that it seems like the mutual fund The Invesco Energy - Class A (IENAX) has a dividend which not is correctly accounted for on 14 Dec 2007. I have attempted to adjust for the dividend in the adjusted close price of that day in the analysis of IENAX.

However, there might be other errors in the Yahoo data series that I have not discovered and which could affect the validity of some of the results, and if so I suppose potential errors would concern the adjusted close price series for some of the mutual funds and the broad energy equity ETPs that have existed several years prior to the commodity derivative based ETPs.

The results from the ETP analyses are safer to assume are valid. Not only because ETPs have shorter time spans since inceptions that make it possible to verify that any split/dividend adjustments are reasonable, but also because return series from ETPs are compared with price series from indices when analyzing tracking errors of ETPs. All price series of indices in this thesis are freely available from commercial/institutional financial data providers such as Dow Jones, Deutsche Bank, the US Energy Information Administration etc. Please refer to page Appendix A 1 at page 105 for a list of the sources to all the indices used for tracking error analyses.

2.3 Method

Annualized geometric return

Annualized geometric return is used in approximation of the procedure described in Global Investment Performance Standards (GIPS 2011). The annualized return in this thesis are based on adjusted close price, and differs from GIPS return in that I do not account directly for external cash flow effects caused for example by the redemption/creation processes of ETPs. However, the cash flow effects from the redemption/creation processes should be indirectly accounted for since the adjusted close price equal the net asset value of a mutual fund. Similarly for ETPs, the cash flows effects from the redemption/creation processes are indirectly accounted for since e.g. the ETFs market price at least ideally should reflect the ETFs net asset value. I use average estimates of the number of trading days per year instead of the actual number of trading days for a particular year described in the true time-weighted return method of GIPS. Annualized return is calculated as:

Equation 1: Geometric annualized return for securities without frontloads

$r_{geo.annualized\ excl.frontload} = -1 + \prod_{i=1}^{n}(1 + r_i)\hat{}(\frac{Q}{n})$, where

$r_i \quad = \dfrac{p_i - p_{i-1}}{p_{i-1}} = return$

$p_i \quad = adjusted\ close\ price\ of\ trading\ day\ i$

$p_{i-1} = adjusted\ close\ price\ of\ trading\ day\ preceding\ i$

$Q \quad = \ 252\ for\ daily\ returns$

$n \quad = total\ number$ of $return\ obsevation\ for\ the\ period$

All available trading days in the price series are included for annualized returns in this chapter. Q = 252 is an estimate of the number of average trading days per year. Returns and rankings based on daily data may differ somewhat to returns and rankings based, e.g. over weekly or monthly data.

There is a challenge in incorporating the frontload fees for mutual funds in the annualized return calculations. Some mutual funds do have a 0 percentage frontload, but if the frontload percentage is higher than 0 it should not be directly subtracted from the annualized return of Equation 1. Doing so would overstate the negative effect of the frontload. Frontloads should be annualized if to directly compare the annualized geometric return between mutual funds that do have frontloads and those mutual funds and other securities that do not have frontloads.

In order to incorporate frontloads in geometric annualized returns for those mutual funds that do have frontloads the following formula is employed:

Equation 2: Geometric annualized returns for securities with frontloads

$$r_{geo.annualized\ incl.front\ load} = -1 + \left[\left(1 + r_{geo.annualized\ excl.frontload}\right)^{\frac{n}{Q}} * (1 - frontload\%)\right]^{\frac{Q}{n}}$$

$r_{geo.annualized\ excl.frontload} = Equation\ 1$

Equation 2 could also be used to calculate geometric annualized return for mutual funds or other ETPs that do not have a frontload. If the frontload percentage is 0, then the return from Equation 2 will give an equivalent return to Equation 1 where frontload is not defined.

Annualized standard deviation

The measure of volatility which normally is used for financial basic descriptive statistics is the standard deviation (σ), and for the risk results presented in this chapter standard deviation is annualized as:

Equation 3: Annualized standard deviation

$$\sigma_{annualized} = \sigma_s * \sqrt{Q} \quad , \qquad where$$

$$\sigma_s = \sqrt{\frac{1}{(n-1)} \sum_{t=1}^{n} (r_i - \bar{r})^2} = sample\ standard\ deviation$$

$$\bar{r} \quad = \frac{\sum_{i=1}^{n} r_i}{n} = arithmetic\ daily\ mean\ for\ the\ period$$

$$Q \quad = 252 = estimate\ for\ daily\ returns\ per\ year$$

When standard deviations are calculated over weekly returns or monthly returns there are some differences compared to over daily returns. E.g. standard deviations over weekly returns where only the end of week day are utilized are slightly lower than standard deviations over daily returns. Also, the absence of four weekdays in end of week returns could cause differences in standard deviation rankings compared to rankings based on daily return series. I have chosen to use daily returns when calculating standard deviations since this seem more in accordance with the geometric returns method utilized to approximate the GIPS return mentioned above.

Skewness and kurtosis

In order to assess whether or not the returns are normally distributed and to indicate how the returns are distributed skewness and kurtosis are calculated for the data. Skewness which differs from zero describes asymmetry of the returns around the mean. If skewness is zero the returns are symmetric around the mean. A negative/left skew in a set of returns suggest that the returns in aggregate has a concentration of higher than mean return values compared to the number of lower than mean returns. A positive/right skew indicates a concentration of lower than mean returns compared to higher than mean return. A perfectly normally distributed set of observation has a skewness of zero and no asymmetry around the mean.

Equation 4: Skewness

$$Skewness = \frac{n}{(n-1)(n-2)}\sum_{i=1}^{n}\left(\frac{r_i - \bar{r}}{\sigma_s}\right)^3 \quad ,where$$

$$r_i \quad = \frac{p_i - p_{i-1}}{p_{i-1}} = daily, weekly\ or\ monthly\ return$$

$$\sigma_s = \sqrt{\frac{1}{(n-1)}\sum_{t=1}^{n}(r_i - \bar{r})^2} = sample\ standard\ deviation$$

Both skewness and kurtosis are calculated in Excel which uses equations that are set up differently than what one often find as standard formulas in academic books. The results are approximately equal to each other when both the standard formula and the Excel formula is used.

Kurtosis describes the peak of the distribution like when observations are viewed in a histogram. A perfectly normally distributed set of observation has a kurtosis of 3. Kurtosis in excess of 3 is leptokurtic and indicates that the probability of extreme values is higher than for the perfectly normally distributed set of observations, or in other words positive excess kurtosis reports the presence of fat tails in the distribution of returns.

Equation 5: Excess kurtosis

$$Excess\ kurtosis = \left\{\frac{n(n+1)}{(n-1)(n-2)(n-3)}\sum\left(\frac{r_i - \bar{r}}{\sigma}\right)^4\right\} - \frac{3(n-1)^2}{(n-2)(n-3)} \quad ,where$$

$$r_i \quad = \frac{p_i - p_{i-1}}{p_{i-1}} = \text{daily, weekly or monthly return}$$

$$\sigma = \sqrt{\frac{1}{(n-1)}\sum_{t=1}^{n}(r_i - \bar{r})^2} = sample\ standard\ deviation$$

$$\bar{r} \quad = \frac{\sum_{i=1}^{n} r_i}{n} = arithmetic\ mean\ for\ the\ period$$

Tests for normality in the distribution of returns

Two types of tests for normality of the return distribution are used. The first test is the Jarque Bera test which is applied in the following manner:

Equation 6: Jarque Bera normality test

$H_0: normal\ distribution \qquad H_A: non\ normal\ distribution$

$$Jarque\ Bera = \frac{n}{6}\left\{Skewness^2 + \frac{(Excess\ kurtosis)^2}{4}\right\}, where$$

$Jarque\ Bera_{asy} \sim x^2\ (2\ d.f.)$

Skewness and excess kurtosis is calculated as presented above. The Jarque Bera value follows a chi square distribution with 2 degrees of freedom and when the test value exceeds critical value at the chosen level of significance the null hypothesis is rejected. Since Jarque Bera is designed for large samples an additional test for normality of return distribution is employed. The second normality test used is from the PcGive software which utilizes a small sample correction (Doornik & Hansen 1994):

Equation 7: Doornik and Hansen normality test

$H_0: normal\ distribution \qquad H_A: non - normal\ distribution$

$$D\&H = z_1^2 + z_2^2 \sim x^2(2\ d.f.), where$$

$z_1 = transformed\ skewness$

$z_2 = transformed\ kurtosis$

Test for equality of variances

To test for significant differences in variances between pairs of returns for securities one could use the F-test of significance. The F-test of significance is not robust in the case of non-normality in the distributions. Results from the normality tests discussed later in this chapter reject that returns are normally distributed for most of the securities. In addition to the F-test of significance another test is therefore included which is less sensitive to departure from normality (Brown & Forsythe 1974). The modified Levene's test for equality of variances used in this thesis is defined as:

Equation 8: Brown and Forsythe's modified Levene's test for equality of variances

$H_0: \sigma_1 = \sigma_2 = \ldots = \sigma_k$ $\quad H_A: \sigma_i \neq \sigma_j \;\; for\ at\ least\ one\ pair\ (i,j)$

$$W = \frac{(N-k)\sum_{i=1}^{k} N_i(\bar{Z}_{i.}-\bar{Z}_{..})^2}{(k-1)\sum_{i=1}^{k}\sum_{j=1}^{N_i}(Z_{ij}-\bar{Z}_{i.})^2} \quad , where:$$

$Z_{ij} = |Y_{ij} - \tilde{Y}_{i.}|$

$Y = variable\ with\ sample\ size\ N\ divided\ into\ k\ return\ series$

$N_i = sample\ size\ of\ return\ series\ i$

$\tilde{Y}_{i.} = the\ median\ of\ return\ series\ i$

$Z_{i.} = the\ series\ of\ return\ means\ of\ Z_{ij}$

$\overline{Z}_{..} = the\ overall\ mean\ of\ Z_{ij}$

$reject\ H_0\ \ if\ W >= F_{(\alpha,k-1,N-k)}$

Brown and Forsythe’s modified Leven’s test can be applied for groups with several security returns or for a pair of at least two return series. The latter is used in this thesis. Three different versions of the test exists where $\tilde{Y}_{i.}$ inside the definition of Z_{ij} can represent the mean, the median or the trimmed mean. If the mean is used the test would be equivalent to the original Levene’s test. Subsequent analysis of skewness in this chapter reveals that the returns are skewed, and the median is utilized in Brown and Forsythe’s test of this paper because it has the highest ability to detect unequal differences for skewed data compared to the two alternatives (*Levene Test* 2003). Results from the equality of variances test are reported as p values from the upper percentage points of the F distribution.

I have also included the p-values from the F-test of significance in the result tables. The reason is that Brown-Forsythe’s test which utilizes the median may seem counterintuitive for some of the results. Securities that e.g. are ranked 9 and 12 according to the size of their standard deviation may have significantly different variances from each other, while the standard deviations ranked at 9 and 11 may not have significantly different variances from each other. One such coincidence can be found for metals securities in section 2.4.10, page 64. Nevertheless, Brown-Forsythe’s test is supposed to give more robust results than the F-test in the case of non-normal distributions.

Testing for differences of means in pairs of return series

The series are non-normal according to the normality tests and some of the series have equal variance while other have unequal variance according to the Brown and Forsythe's test as mentioned above. For those series that are non-normal and have unequal variance the test which is utilized for difference of means testing is:

Equation 9: Two sample t-test assuming unequal variances

$H_0: \bar{x} = \bar{y} \qquad H_A: \bar{x} \neq \bar{y}$

$$t - test = \frac{\bar{x} - \bar{y} - \delta}{\sqrt{\frac{\sigma_x^2}{n_1} + \frac{\sigma_y^2}{n_2}}}, where\ \bar{x}\ and\ \bar{y}\ are\ the\ means\ of\ each\ return\ series\ in\ a\ pair$$

$\delta = 0\ which\ is\ the\ hypothesized\ value\ of\ a\ 0\ mean\ difference$

The observations are ranked in an ascending order since it is suggested that doing so will increase the performance of the test (Ruxton 2006). The test may not perform well with small sized samples, but the sample sizes of 1045 should be more than enough to invoke the central limit theorem. Test result is reported as a p-value where alpha levels used are 1, 5 and 10%.

For those pairs that have equal variance according to Brown and Forsythe's test of Equation 8 I am using the Mann-Whitney in test when checking for differences in means.

Equation 10: Mann-Whitney U test for two samples assuming equal variances

$H_0: \bar{x} = \bar{y} \qquad H_A: \bar{x} \neq \bar{y}$

$$U = n_1 n_2 + \frac{n_2(n_2 + 1)}{2} - \sum_{i=n_1+1}^{n_2} R_i \quad , \quad where$$

$U = Mann - Whitney\ U\ test$

$n_1 = sample\ size\ 1$

$n_2 = sample\ size\ 2$

$R_i = rank\ of\ the\ sample\ size$

Mann-Whitney U test is a non-parametric test meaning that it doesn't rely on the assumption that the data are from a given probability distribution and p-values from Equation 10 is not equivalent with p-values from Equation 9. I assume that the p-values from both the two sample variance tests are close enough for the purpose of comparison in this paper.

2.4 Descriptive statistics for ETPs and mutual funds

Dividends and splits that are accounted for in the adjusted close price generate different results than if the descriptive statistics instead is calculated over the market close price. Especially some of the large dividends accounted for in the adjusted close prices of the equity based securities in the energy selection can be different from the market close price. Several derivative based ETPs and securities examined in this chapter have not paid dividend or undergone splits, and for them adjusted close price is equal to the market close price. Market close price = adjusted close price for physical and synthetic commodity ETPs in chapter 2 except for Deutsche Bank's (DB) PowerShares ETPs that pay out dividend from time to time, and for SLV and IAU which have undergone 1 to 10 splits. For inversed/leveraged ETPs such as UGL/GLL in section 1.8, page 22, splits may occur even more frequently.

From the differences in variance testing I will only refer to the values from Brown-Forsythe's version of the Levene's test, and not the F-test of significance. The testing is performed for the whole period.

2.4.1 Broad commodity ETPs and mutual funds - annualized geometric return

In the table below annualized geometric returns based on daily adjusted close price data are calculated for 5 ETPs[14] and 5 mutual funds[15] that cover the broad commodity sector mainly with derivatives. The ETFs are generally holding futures to track the index, while ETNs are tracking with unsecured promissory debt (similar to uncollateralized swaps).

The mutual funds included also utilize futures and other derivatives to gain exposure to the broad commodity sector. Under the investment objective in the table below the benchmark of a specific ETP is listed. Three of the broad commodity mutual funds do not have a benchmark, and are investing in commodities based more on a general broad commodity exposure strategy. As far as I know, the 2 mutual funds that have specific indices in the investment objective are not passive index trackers the way the ETPs are, but are generally relating to those indices.

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[14] Please refer to Appendix A 1, page 100, for list of full names and benchmark indices for the ETPs.

[15] Please refer to Appendix A 2, page 101, for a list of full names, front-loads and minimum investment for mutual funds.

Table 4: Broad commodity ETPs and mutual funds - annualized geometric return

Ticker	Type	Investment objective	Whole period 8Jan2007-1Mar2011 Return	Rank	Sub period 1 8Jan2007-27Feb2009 Return	Rank	Sub period 2 2Mar2009-1Mar2011 Return	Rank
GSG	ETF	S&P GSCI TR futures	-0.33 %	7	-18.7 %	4	23.9 %	8
GSP	ETN	S&P GSCI TR (prommisory debt)	-0.26 %	6	-19.7 %	6	25.8 %	5
DJP	ETN	DJ-UBS CI TR (prommisory debt)	2.16 %	3	-16.0 %	2	25.9 %	4
DBC	ETF	DB LCIOYD ER futures	7.57 %	1	-6.9 %	1	25.6 %	6
RJI	ETN	Rogers ICI (prommisory debt)	*		*		32.9 %	2
CRSAX	Mutual	DJ-UBS CI TR related derivatives	2.07 %	4	-16.1 %	3	23.9 %	7
SKNRX	Mutual	Commodity derivatives	1.85 %	5	-20.5 %	7	28.9 %	3
PCRAX	Mutual	Commodity derivatives	5.68 %	2	-19.1 %	5	36.7 %	1
QRAAX	Mutual	Commodity derivatives	-6.03 %	9	-27.1 %	9	19.8 %	9
RYMEX	Mutual	S&P GSCI TR related derivatives	-2.85 %	8	-21.0 %	8	18.3 %	10
Rf rate	Risk free	1 year treasury constant maturity	1.7 %		3.0 %		0.4 %	
ACWI IMI	Index	All market investable index	-1.5 %		-26.7 %		35.2 %	

All the broad commodity mutual funds included in the table above do have front-loads which are accounted for in the return calculations. For example, the annual 5.50% front-load in the case of PCRAX is annualized and subtracted from the annualized geometric returns as explained under Equation 2, page 42.

The highest ranked security for the whole period is DBC which is an ETF tracking the Deutsche Bank Liquid Commodity Index Optimum Yield Diversified Excess Return index (DB LCIOYD ER). DBC also has the highest return for sub period 1, which may suggest that Deutsche Banks's optimum yield strategy that aims to minimalize negative roll yield and maximize positive roll yield may give them a comparative advantage. DBC is only ranked as number 6 for sub period 2 so there is no definitive conclusion to the winner amongst the broad commodity securities. The main reasons for differences in returns for the different ETP trackers are probably disparities in index constituents. For example, a lower number of commodities are included in DB LCIOYD ER than what is included in e.g. the S&P Goldman Sachs Commodity Index Total Return (S&P GSCI TR) and the Rogers International Commodity Index (Rogers ICI).

PCRAX is the second highest ranked for the whole period and is ranked at number 1 in sub period 2. It is only ranked at 6 in sub period 2, and several of the other mutual funds are also in the lowest region in that period. Sub period 2 is characterized by negative returns for all the securities of Table 4 above, but the rankings may indicate that the commodity derivative based mutual funds held active positions that exaggerated negative returns in times of market stress during the financial crisis.

The third highest ranked for the whole period is DJP which track the DJ-UBS Commodity Index Total Return index (DJ-UBS CI TR). CSRAX is a mutual fund which also relates to DJ-UBS CI TR, and CSRAX is lower ranked than DJP in all the periods. This could be interpreted to that an investor who wants exposure to DJ-UBS CI TR should choose DJP over CSRAX since DJP has higher returns. However, DJP is an ETN and as discussed in the background chapter ETNs have an inherent risk of counterparty default that not is present in a mutual fund since the mutual funds physically hold the underlying securities. I have not assessed counterparty risk in the return calculations for ETNs but the risk of ETN issuer default could be accounted for by the investor, e.g. with an option on the issuer as demonstrated in section 1.7.1, page 20.

The annualized returns for the broad commodity securities do not clearly suggest that ETFs/ETNs in general exhibit higher returns than the mutual funds when front-loads are accounted for, but for all three periods mutual funds occupy the bottom 2 of the return rankings. There is no definitive conclusion to the ETP versus mutual find comparison since the PCRAX holds the top ranking in sub period 2 and is second highest for the whole period.

However, if a retail investor wants exposure to a broad commodity index, the returns for the periods are higher for ETFs/ETNs compared to mutual funds that are covering the same benchmark index. Both when it comes to DJ-UBS CI TR related securities and those that relate to S&P GSCI TR. RYMEX which relates to S&P GSCI TR is about 2% to 2.5% behind GSG and GSP for sub period 1 and 2 while the gap increases to about 5% to 6% for sub period 2. For CRSAX which relate to DJ-UBS CI TR the annualized return gap compared to the ETN counterpart DJP is very small for the whole period and sub period 1, while it is about 2% for sub period 2.

When testing for statistical differences in means between broad commodity securities I have tested for the whole period and over daily return series. P values from all the difference in means tests are very high and in the range of about 0.5 and close to 1. That is, when testing for difference in means of one security against another, none of the pairs exhibit rejection of the null hypothesis of equality of means[16]. Similar results of no statistical differences in means and high p values also seem to be present for return pairs over weekly and monthly

[16] Please refer to Table 16 at page 66 for an overview of results from testing differences in means and variances. The risk free rate is not tested and RJI is also excluded since it only has data for sub period 2.

return series, although I haven't tested all the pairs over weekly and monthly returns in contrast to over daily returns. High p values when testing for differences in means between the securities is indicative of return series that are closely related to another, which seem natural since they all cover the broad commodity sector.

2.4.2 Broad commodity ETPs and mutual funds - annualized standard deviation

The table below conveys annualized standard deviations for the broad commodity securities when calculated over daily returns. When standard deviations for the broad commodity securities are calculated over weekly returns they are slightly lower and have a few differences in the rankings compared to daily return calculations, as discussed under the Method section, page 41.

Table 5: Broad commodity ETPs and mutual funds - annualized standard deviation

Ticker	Type	Investment objective	Whole period 8Jan2007-1Mar2011 σ	Rank	Sub period 1 8Jan2007-27Feb2009 σ	Rank	Sub period 2 2Mar2009-1Mar2011 σ	Rank
GSG	ETF	S&P GSCI TR futures	30.6 %	8	33.6 %	7	27.0 %	10
GSP	ETN	S&P GSCI TR (prommisory debt)	30.2 %	7	33.1 %	6	26.8 %	9
DJP	ETN	DJ-UBS CI TR (prommisory debt)	22.9 %	2	24.5 %	2	20.9 %	3
DBC	ETF	DB LCIOYD ER futures	25.5 %	4	28.3 %	4	22.1 %	5
RJI	ETN	Rogers ICI (prommisory debt)	*		*		23.3 %	6
CRSAX	Mutual	DJ-UBS CI TR related derivatives	21.7 %	1	23.2 %	1	19.9 %	1
SKNRX	Mutual	Commodity derivatives	28.0 %	5	32.7 %	5	21.8 %	4
PCRAX	Mutual	Commodity derivatives	24.0 %	3	26.8 %	3	20.4 %	2
QRAAX	Mutual	Commodity derivatives	30.0 %	6	34.1 %	8	24.9 %	7
RYMEX	Mutual	S&P GSCI TR related derivatives	30.7 %	9	34.2 %	9	26.5 %	8
Rf rate	Risk free	1 year treasury constant maturity	0.11 %		0.10 %		0.01 %	
ACWI IMI	Index	All market investable index	22.6 %		25.7 %		18.6 %	

Trends of the standard deviations are even more inconclusive than the ranking trend from the annualized returns when comparing ETPs to mutual funds. The ETPs and the mutual funds are scattered all around in the ranking.

The mutual fund CRSAX which relates to the DJ-UBS CI TR has the lowest standard deviation for all three periods and is an obvious winner in terms of having the lowest volatility. DBC which is ranked at number 4 and tracks the the same index as CRSAX is relating to have a significantly different variance on a 1% alpha level[17]. CRSAX do not have

[17] Please refer to Table 16 at page 66 for an overview of results from testing differences in means and variances. The risk free rate is not tested and RJI is also excluded since it only has data for sub period 2.

a sigificantly different variance compared to DJP which is ranked as number 2 for the whole period, while PCRAX ranked at number 3 is significantly different from CRSAX on a 5% alpha level. Also, CRSAX do not have a significantly different variance to ACWI IMI, the market index. For all the other securities in Table 5 CRSAX do have a significantly different variance on a 1% alpha level.

Like for CRSAX one could perhaps expect that also RYMEX, the mutual fund related to the S&P GSCI TR, would have a lower standard deviation than the ETP counterparts which track the same index. This is not the case for RYMEX which has the highest standard deviation for the whole period and sub period 1, higher in those two periods than GSG and GSP which are tracking the same index as RYMEX. The differences in variances are not significant however in any combinations of RYMEX, GSG and GSP. Another of the mutual funds which have high annualized standard devation is QRAAX.

It is unexpected that CRSAX has the lowest standard deviation if one consider that broad commodity mutual funds, which are relatively undiversified, may take active positions which exaggerate negative/positive returns.

It is not unexpected that securities of Table 5 which are ranked close to each other do not have significant differences when testing for equality of variance, while those that are ranked further away from each other do have significant differences.

2.4.3 Broad commodity ETPs and mutual funds – skewness and kurtosis

When assessing the distribution of stocks one often find that they are skewed and possess fat tails. Characteristics which also is present for commodities (Gorton & Rouwenhorst 2006). Below is a table conveying skewness and excess kurtosis for the broad commodity selection. Only those securities that have data for the whole period is included in the table. The results are calculated for daily returns, end of week day returns, and mid-month day returns.

Table 6: Broad commodity ETPs and mutual funds - skewness and excess kurtosis (8 Jan 2007- 1 Mar 2011)

Ticker	Type	Investment objective	Daily		Weekly		Monthly	
			Skewness	Ex.kurtosis	Skewness	Ex.kurtosis	Skewness	Ex.kurtosis
GSG	ETF	S&P GSCI TR futures	-0.274	1.904	-0.575	1.433	-0.901	0.541
GSP	ETN	S&P GSCI TR (prommisory debt)	-0.289	1.653	-0.595	1.807	-0.855	0.559
DJP	ETN	DJ-UBS CI TR (prommisory debt)	-0.371	1.622	-1.001	2.516	-1.059	1.944
DBC	ETF	DB LCIOYD ER futures	-0.198	1.280	-0.647	1.928	-0.614	0.698
CRSAX	Mutual	DJ-UBS CI TR related derivatives	-0.239	1.937	-1.096	2.715	-1.057	1.891
SKNRX	Mutual	Commodity derivatives	-0.635	5.828	-0.925	3.953	-1.859	5.087
PCRAX	Mutual	Commodity derivatives	-0.361	3.305	-1.337	4.491	-1.352	3.491
QRAAX	Mutual	Commodity derivatives	-0.296	2.838	-1.131	3.415	-1.156	0.986
RYMEX	Mutual	S&P GSCI TR related derivatives	-0.268	2.180	-0.675	1.273	-0.913	0.312
ACWI IMI	Index	All market investable index	-0.210	6.293	-0.995	6.610	-0.906	1.064

All the broad commodity securities over the period have left/negatively skewed returns when measured over the different return periods. Skewness is increasing when measured by lower returns frequencies: One could expect this since monthly returns often are higher than daily returns although the mean are equal or close to equal when measuring with different frequencies over the same period. Gorton & Rouwenhorst (2006) find that commodity futures are positively skewed over the period of 1959-2004. But negatively skewed characteristics as in the table above is not surprising when taking into account the number of positive return observations for prices of commodities that have been present for 2007-2011 compared to the negative returns. Negative skew indicate that there is a concentration of higher than mean returns in proportion to lower than mean returns. For example, GSG has for daily returns 527 greater than mean returns while there are 518 smaller than mean returns. When counting over monthly returns GSG has 30 greater than mean returns while there are 20 smaller than mean returns.

Excess kurtosis, or leptokurtic characteristics, is also normal to find for securities. This indicate a presence of fat tails or an over representation of extreme negative/positive returns compared to what is expected by the normal distribution. The broad commodity security which has the highest excess kurtosis over daily and monthly return frequencies is the mutual fund DWS Enhanced Commodity (SKNRX). The values for SKNRX are suspiciously high and may indicate something wrong in the price serie for SKNRX from Yahoo.

As seen from annualized returns in Table 4 at page 49, SKNRX is ranked at 7 in the first sub period and at 3 in the second sub period, and it has more extreme returns compared to the rest of the selection, at least over daily and monthly frequencies.

It is also interesting to find that the mutual fund CRSAX have a higher kurtosis and are more negatively left skewed than the ETF DBC since they both are relating to the DJ-UBS CI TR index. This indicates that CRSAX have more extreme returns than DBC, but that the extreme returns seem to be more of the positive type than with DBC. For those securities that are relating to S&P GSCI TR, there are smaller differences when comparing mutual fund with ETPs.

The average skewness for all the broad commodity mutual funds is higher than the average for all the ETP counterparts, implying that the mutual have more returns in excess of the mean than the ETPs. Average kurtosis is also higher for the broad commodity mutual funds. Thus the mutuals on average have more extreme negative/positive returns than the broad commodity ETPs. Something that makes sense since mutual funds generally position themselves actively in the marked compared to an index tracker. Active positions that again could lead to increased positive or negative returns compared to a passive position.

2.4.4 Broad commodity ETPs and mutual funds – test for normality in the return distributions

The table below conveys the results from testing for normality in the distribution for broad commodity securities for daily returns, end of week day returns, and mid-month day returns. JB columns have values from the Jarque-Bera test while DH columns have values from the Doornik and Hansen test. Null hypothesis is that the return series are non-normal, and the ● symbol indicates that the null is rejected on a 5% alpha level.

Table 7: Broad commodity ETPs and mutual funds – tests for normality in the return distributions (8 Jan 2007- 1 Mar 2011)

Ticker	Type	Investment objective	Daily		Weekly		Monthly	
			JB	DH	JB	DH	JB	DH
GSG	ETF	S&P GSCI TR futures	170.9	93.4	30.5	13.9	7.4	9.0
GSP	ETN	S&P GSCI TR (prommisory debt)	133.4	73.7	42.3	17.6	6.7	7.4
DJP	ETN	DJ-UBS CI TR (prommisory debt)	138.5	67.8	93.4	27.8	17.2	8.4
DBC	ETF	DJ-UBS CI TR futures	78.2	51.4	48.7	18.7	4.2 ●	3.4 ●
CRSAX	Mutual	DJ-UBS CI TR related derivatives	173.3	98.3	110.1	32.9	16.8	8.4
SKNRX	Mutual	Commodity derivatives	1549.0	400.7	172.2	38.4	82.7	24.7
PCRAX	Mutual	Commodity derivatives	498.4	210.3	247.0	42.5	40.6	12.2
QRAAX	Mutual	Commodity derivatives	365.9	173.6	151.8	33.4	13.2	17.0
RYMEX	Mutual	S&P GSCI TR related derivatives	219.5	116.6	31.1	14.8	7.1	11.3
ACWI IMI	Index	All market investable index	1732.1	581.3	430.9	81.8	9.2	6.9

Earlier studies show that higher frequencies of securites returns, such as daily or weekly returns have a greatier propensity for non-normal distiributions than lower frequencies such as monthly returns. (Brown & Warner 1984) (Aparicio & Estrada 2001). Results in the table above with non-normality tests for broad commodity secuities confirm the earlier studies. All the test values have decreasing values when testing over daily to weekly to monthly returns.

Only the PowerShares DB Commodity Index Tracking Fund (DBC) exhibit normal distribution and only for monthly returns on a 5% alpha level with critical value 5.99. The commodity sector has experienced great market turbulence over the period, and combined with a relatively short measuring period of about 4 years and 3 months this could be part of the cause for the high non-normality in the period. Non-normality in returns for securites are not exactly a spectacular finding, like e.g. Benoit Mandelbrot and Eugene Fama demonstrated in their research (Mandelbrot 1963) (Fama 1965).

2.4.5 Energy related ETPs and mutual funds - annualized geometric return

In the next table annualized geometric returns based on daily data are calculated for 4 ETPs that are mainly tracking single energy derivative commodities and one ETP that track broad energy futures. There seem to be a lack of mutual funds that cover single energy commodities, probably because a single energy commodity is not a natural investment objective for mutual funds which often are relatively diversified. To increase the comparison value of ETPs versus mutual funds in the energy sector the selection includes 5 energy equity mutual funds together with 5 energy equity ETFs[18]. The energy equity ETFs and mutual funds mainly invest in equities related to oil, gas and other carbon energy sources, but may also hold stocks in e.g. nuclear power, renewable energy, energy exploration and research etc. Tests for significant differences in means are performed for the whole period[19].

Table 8: Energy related ETPs and mutual funds - annualized geometric return

Ticker	Type	Investment objective	Whole period 8Jan2007-1Mar2011		Sub period 1 8Jan2007-27Feb2009		Sub period 2 2Mar2009-1Mar2011	
			Return	Rank	Return	Rank	Return	Rank
DBE	ETF	Broad energy futures DB OYE ER	6.57 %	12	-10.96 %	1	29.15 %	12
USO	ETF	WTI futures near month	-3.94 %	13	-23.35 %	13	22.28 %	14
OIL	ETN	WTI by S&P GSCICO TR	-6.37 %	14	-27.80 %	14	23.63 %	13
DBO	ETF	WTI by DBCI OYCO ER	6.96 %	11	-11.24 %	2	30.57 %	11
UNG	ETF	Natural gas futures near month	*		*		-45.25 %	15
FANIX	Mutual	Energy broad equity	8.79 %	10	-18.20 %	10	47.57 %	5
IENAX	Mutual	Energy broad equity	10.37 %	5	-13.04 %	3	38.45 %	10
IEYAX	Mutual	Energy broad equity	9.59 %	8	-15.72 %	7	40.90 %	8
RYEIX	Mutual	Energy broad equity	8.85 %	9	-16.29 %	8	44.14 %	7
WEGAX	Mutual	Energy broad equity	9.94 %	7	-14.97 %	6	40.50 %	9
PXE	ETF	Energy broad equity	10.20 %	6	-19.26 %	12	53.70 %	2
IEO	ETF	Energy broad equity	11.27 %	4	-14.38 %	4	47.25 %	6
XOP	ETF	Energy broad equity	13.16 %	1	-14.42 %	5	52.56 %	3
PXI	ETF	Energy broad equity	12.06 %	2	-19.17 %	11	58.90 %	1
RYE	ETF	Energy broad equity	11.57 %	3	-16.55 %	9	52.19 %	4
Rf rate	Risk free	1 year treasury constant maturity	1.70 %		2.96 %		0.38 %	
ACWI IMI	Index	All market investable index	-1.45 %		-26.69 %		35.21 %	

The three energy commodity ETPs which invest in mainly single commodities (WTI) could be expected to be ranked close together, but this is only partially so. USO and OIL are ranked at 13 and 14 through all the periods while DBO which also mainly is relating to WTI is ranked higher for all the periods. Thus the annualized return winner amongst the WTI related ETPs are DBO which utilize Deutsche Bank's optimal yield technology when rollig futures

[18] Please refer to Appendix A 3, page 102 for a list of names and indices regarding the energy equity ETFs.
[19] Please refer to Table 17, page 67, for an overview of results from testing differences in means and variances. The risk free rate is not tested and UNG is also excluded since it only has data for sub period 2.

to maximise/minimise the positive/negative effect of roll yield. For the periods in the table above the optimal yield technique seems to give a comparative advantage to DBO over USO and OIL. A direct comparison is not enterly adequat since USO intend to track the percetage spotprice of WTI as measured by the NYMEX futures. OIL on the other hand promises the return from the S&P GSCI Crude Oil Total Return Index while DBO relates to WTI with an excess return index from Deutsche Bank. OIL and USO have a p-value close to 1 in the testing for difference in mean returns , while DBO has p-values of about 0.7 to USO and OIL. The ETN structure of OIL do not seem to be an advantage when it comes to returns compared to the ETF structure of USO. In the choice between USO and OIL as part of a WTI exposure an investor should probably, based on the results for the periods, go for USO (ETF) due to the counterparty risk inherent in OIL (ETN) which not is reflected in return calculations. The large disparity in sub period 1 of rankings for DBO versus OIL/USO is due to roll yield cost in a strong contango WTI futures market as I will return to in the chapter on tracking error.

DBE is the only derivative based ETF in the selection whose main objective is to track broad energy commdities, and as such they do not really have any ‘competitors’ in the derivative based ETP selection. DBE is also using Deutsche Bank’s optimal yield technology. All the energy derivative based ETPs are in the lower rankings of the table and have p-values in the region of 0.7 and upwards which signify that the differences in mean returns are very small and far from significant.

When it comes to the energy equity related securites there is a distinct tendency in that the equity based ETPs are better ranked than their mutual fund counterparts for the whole period and for sub period 2. For the whole period all the 4 of the 5 top rankings are held by broad equity energy ETPs. The highest ranked for the whole period is XOP which holds equity in oil and gas related companies. P-values for the different combinations of the energy equity based ETPs are very high and in the region of about 0.9 and upwards.

The mutal funds FANIX and RYEIX do not have front-loads while the other three mutual funds do have front-loads. In the table above front-loads are accounted for in the annualized returns but this do not seem to bring FANIX and RYEIX to a superior position to the other mutual funds.

In the testing for significant differences in mean returns similar results apply to the energy related securites as to the broad commodity related securites. None of the means are different from each other on the chosen alpha levels of 1% or 5%.

The most obvious distiction between the broad commodity selection and the energy selection is that p-values have a greater variety for the energy related securites. For example, several of the energy equity based ETPs have p-values in the range of about 0.2-0.7 when tested against the energy derivative based ETPs. Not a surprice since equity commodity ETPs are another type of investment than derivative commodity ETPs, and for the the whole period and sub period 2 the equity ETPs are in the upper part of the rankings while the derivative ETPs are ranked in the lower region.

2.4.6 Energy related ETPs and mutual funds - annualized standard deviation

The table below conveys the annualized standard deviation for the energy related ETPs and mutual funds calculated over daily returns. Energy is even less diversified than the broad commodity assets selection and standard deviations for the periods are considerably higher for the energy selection compared to the broad commodity selection in Table 5, page 51.

Table 9: Energy related ETPs and mutual funds - annualized standard deviation

			Whole period		Sub period 1		Sub period 2	
Ticker	Type	Investment	8Jan2007-1Mar2011		8Jan2007-27Feb2009		2Mar2009-1Mar2011	
		objective	σ	Rank	σ	Rank	σ	Rank
DBE	ETF	Broad energy futures DB OYE ER	32.6 %	1	36.1 %	1	28.5 %	1
USO	ETF	WTI futures near month	40.1 %	6	44.3 %	4	35.0 %	13
OIL	ETN	WTI by S&P GSCICO TR	40.8 %	7	44.8 %	5	36.1 %	14
DBO	ETF	WTI by DBCI OYCO ER	34.8 %	2	39.0 %	2	29.7 %	3
UNG	ETF	Natural gas futures near month	*		*		47.9 %	15
FANIX	Mutual	Energy broad equity	45.1 %	13	53.8 %	13	33.5 %	9
IENAX	Mutual	Energy broad equity	40.9 %	8	48.2 %	8	31.2 %	7
IEYAX	Mutual	Energy broad equity	37.4 %	3	42.9 %	3	30.4 %	4
RYEIX	Mutual	Energy broad equity	41.4 %	9	49.4 %	10	30.6 %	5
WEGAX	Mutual	Energy broad equity	38.8 %	5	45.1 %	6	30.6 %	6
PXE	ETF	Energy broad equity	42.7 %	11	51.2 %	11	31.3 %	8
IEO	ETF	Energy broad equity	45.1 %	12	53.6 %	12	33.8 %	11
XOP	ETF	Energy broad equity	45.6 %	14	54.4 %	14	33.9 %	12
PXI	ETF	Energy broad equity	38.8 %	4	46.1 %	7	28.9 %	2
RYE	ETF	Energy broad equity	42.1 %	10	48.8 %	9	33.5 %	10
Rf rate	Risk free	1 year treasury constant maturity	0.11 %		0.10 %		0.01 %	
ACWI IMI	Index	All market investable index	22.6 %		25.7 %		18.6 %	

Rankings based on standard deviation in Table 9 tend to have some opposite results to some of the rankings for the same energy securities selection based on returns as displayed in Table 8 page 56. That is, the derivative based energy ETPs that were ranked low in terms of returns are highly ranked in the standard deviations table, at least for the whole period and sub period 1. In sub period 2 there are some divergence among the derivative based ETPs from the two other periods in that USO and OIL are low ranked together with UNG. The two highest ranked positions are DBE at number 1 for all periods and DBO at number 2 for the whole period and sub period 1 and 3 in sub period 2. Again it seems like Deutsche Bank's optimal yield method for indices, which both DBE and DBO are relating to, have a positive effect compared to the other energy derivative based ETPs. DBO and DBE do not have statistically significant differences in variances to each other, while the variances for both DBO and DBE are significant from OIL and USO on a 1% alpha level. It is not entirely correct to compare DBE to the other derivative based energy ETPs since DBE has a broad energy investment objective while the others are single energy ETPs. Nevertheless, DBO is the winner in terms of lowest standard deviation amongst derivative ETPs that relate directly to WTI.

The broad energy equity ETF XOP, which had the highest annualized return for the whole period in Table 8 page 56, also has the highest standard deviation for the whole period and for sub period 1. XOP also has the highest standard deviation in sub period 2 among the equity based securities, and is only surpassed by derivative based USO, OIL and UNG. XOP is low ranked together with IEO at 12 and PXE at 10 for the energy equity ETFs in the whole period and they do not have significantly different variances from each other or from the derivative based USO and OIL. PXI is the highest ranked equity based ETF for all periods in terms of having the lowest standard deviation, and PXI's variance is significantly different from XOP and IEO at a 1% alpha level and from PXE at a 5% alpha level. PXI which is ranked at 4 for the whole period have a p-value of 0.064 against RYE and as such their variances are statistically different from each other at a 10% alpha level.

For the energy equity based mutual funds there is a great spread in their standard deviation rankings for the whole period and sub period 1, while they are closely ranked together for sub period 2. IEYAX was ranked in the middle amongst the mutual funds in terms of returns in Table 8 page 56, but is the winner for the mutual funds in terms of the lowest standard deviation for all periods. IEYAX is ranked at 3 for the whole period and sub period 1 and its variance is statistically different from IENAX at a 5% level and from FANIX at a 1% level but not significantly different to the other mutual funds.

There is no obvious tendency when comparing standard deviation for mutual funds versus the ETFs among the broad energy equity based securities. IEYAX have the lowest standard deviation for the equity based securities, but its variance is not statistically different from PXI and RYE for the chosen alpha levels when testing for differences in variances for the whole period. The energy mutual funds and the equity based ETF are scattered around in the rankings for all the three periods.

2.4.7 Energy related ETPs and mutual funds – skewness and kurtosis

The next table list skewness and excess kurtosis for energy related ETPs and mutual funds.

Table 10: Energy related securities - skewness and excess kurtosis (8 Jan 2007- 1 Mar 2011)

Ticker	Type	Investment objective	Daily		Weekly		Monthly	
			Skewness	Ex.kurtosis	Skewness	Ex.kurtosis	Skewness	Ex.kurtosis
DBE	ETF	Broad energy futures DB OYE ER	-0.025	1.689	-0.254	1.089	-0.757	0.201
USO	ETF	WTI futures near month	-0.052	1.716	-0.234	1.475	-0.392	0.430
OIL	ETN	WTI by S&P GSCICO TR	-0.140	1.866	-0.297	1.608	-0.402	0.518
DBO	ETF	WTI by DBCI OYCO ER	-0.085	1.666	-0.170	1.418	-0.466	0.548
FANIX	Mutual	Energy broad equity	-0.303	7.991	-0.771	5.554	-2.091	7.632
IENAX	Mutual	Energy broad equity	-0.231	7.290	-0.763	4.827	-2.048	7.061
IEYAX	Mutual	Energy broad equity	-0.171	6.036	-0.689	3.378	-1.798	5.580
RYEIX	Mutual	Energy broad equity	-0.137	8.754	-0.752	5.192	-2.036	6.842
WEGAX	Mutual	Energy broad equity	-0.222	6.344	-0.588	3.384	-1.744	5.349
PXE	ETF	Energy broad equity	-0.243	7.800	-0.936	4.698	-1.968	6.220
IEO	ETF	Energy broad equity	-0.141	8.436	-0.807	5.143	-2.061	7.216
XOP	ETF	Energy broad equity	-0.179	8.487	-0.846	5.121	-2.155	7.831
PXI	ETF	Energy broad equity	-0.513	7.936	-1.074	6.289	-2.259	8.364
RYE	ETF	Energy broad equity	-0.361	5.988	-0.240	5.160	-1.934	6.660
ACWI IMI	Index	All market investable index	-0.210	6.293	-0.995	6.610	-0.906	1.064

All the securities in the table are left/negatively skewed and as such the tendency is the same for energy related securities as for the broad commodity securities in Table 7, page 54. For the energy derivative based ETPs skewness is generally lower than the broad commodity derivative based ETPs for all periods. Kurtosis seem to be in the same range for the energy derivative based ETPs and the broad commodity derivative based ETPs when measured over daily and weekly returns, while over monthly returns the energy derivative based ETPs on average have a lower kurtosis than broad commodity derivative ETPs. It may seem unexpected that the energy derivative based ETPs have lower monthly kurtosis than broad commodity derivative based ETPs since one could believe that the latter are more diversified than the former and not as prone to fat tails. However, the broad commodity derivative ETPs of Table 7, page 54 which are tracking the S&P GSCI TR do have a weekly and monthly skewness/kurtosis which is similar to the WTI futures related ETPs in the table above. The similar skewness/kurtosis should be anticipated since S&P GSCI TR is heavy weighted with oil and gas related futures compared to the other commodity indices (*S&P GSCI Commodity Indices* 2011).

The broad energy equity securities in Table 10 above do have a distinctly higher kurtosis/skewness than the energy derivative based ETPs. This indicates a presence of both fat tails and a stronger overweight of above the mean returns for the energy equities compared to the derivative securities. Skewness/kurtosis is calculated over returns from price series that are adjusted for dividend and splits. When skewness and kurtosis for the equity based securities are recalculated over returns from market close price (not adjusted for dividends and splits) the results are similar with high excess kurtosis and skewness for all the energy equities.

There do not seem to be any evident tendency when comparing skewness/kurtosis for the energy equity based ETFs versus the energy equity mutual funds. They are all very similar to each other and are in the same range for negative skewness and excess kurtosis during all three periods that are examined.

2.4.8 Energy related ETPs and mutual funds – test for normality in the return distributions

The table below show results from testing for normality in the distribution for energy related securities over daily returns, end of week day returns, and mid-month day returns. JB columns have values from the Jarque-Bera test while DH columns have values from the Doornik and Hansen test. Null hypothesis is that the return series are non-normal, and the ● symbol indicates that the null is rejected on a 5% alpha level.

Table 11: Energy related ETPs and mutual funds – tests for normality in the return distributions (8 Jan 2007- 1 Mar 2011)

Ticker	Type	Investment objective	Daily		Weekly		Monthly	
			JB	DH	JB	DH	JB	DH
DBE	ETF	Broad energy futures DB OYE ER	124.3	84.8	13.1	10.1	4.9 ●	6.6
USO	ETF	WTI futures near month	128.7	86.8	21.7	16.1	1.7 ●	1.9 ●
OIL	ETN	WTI by S&P GSCICO TR	155.0	97.1	26.6	17.8	1.9 ●	2.1 ●
DBO	ETF	WTI by DBCI OYCO ER	122.1	82.2	19.2	15.6	2.4 ●	2.4 ●
FANIX	Mutual	Energy broad equity	2796.3	778.0	300.4	79.5	157.8	23.9
IENAX	Mutual	Energy broad equity	2323.2	704.0	231.7	63.8	138.9	24.2
IEYAX	Mutual	Energy broad equity	1591.3	554.8	120.3	39.0	91.8	19.4
RYEIX	Mutual	Energy broad equity	3340.3	909.4	264.1	72.7	132.1	24.6
WEGAX	Mutual	Energy broad equity	1760.9	585.5	116.1	43.7	85.0	18.3
PXE	ETF	Energy broad equity	2659.5	767.4	231.2	49.5	112.9	24.1
IEO	ETF	Energy broad equity	3102.3	867.1	262.7	67.2	143.9	24.2
XOP	ETF	Energy broad equity	3141.7	868.4	263.0	63.8	166.5	26.0
PXI	ETF	Energy broad equity	2788.1	699.3	399.4	67.8	188.3	29.1
RYE	ETF	Energy broad equity	1584.1	511.2	242.8	104.2	123.6	21.0
ACWI IMI	Index	All market investable index	1732.1	581.3	430.9	81.8	9.2	6.9

Table 11 has very obvious tendencies in that the energy derivatives based ETPs are normally distributed over monthly returns, and except that all the securities possess non-normal distribution characteristics over all periods. Results that are reported in the table are calculated over adjusted close price returns. I have tried to retest most of equity based security distributions series over market close prices instead of the adjusted close price, but those results are also similar to what is shown in the table above.

2.4.9 Metal related ETPs and mutual funds - annualized geometric returns

The selection in the table below is focusing on precious metal securities by including 6 precious metal ETFs and 7 precious metal mutual funds. In addition I have included two industrial metal ETPs. When 'physical deposit' is mentioned in the tables of this metal section it is implying that the fund holds the actual physical gold or silver. The term 'physical(ly)' mentioned elsewhere in the thesis e.g. for the broad commodity and energy selections signifies that a fund invest in commodities by holding futures.

Table 12: Metal related ETPs and mutual funds - annualized geometric return

Ticker	Type	Investment objective	Whole period 8Jan2007-1Mar2011 Return	Rank	Sub period 1 8Jan2007-27Feb2009 Return	Rank	Sub period 2 2Mar2009-1Mar2011 Return	Rank
DBP	ETF	Gold and silver futures (DBLCI OYPM ER)	21.78 %	7	15.68 %	4	28.66 %	12
IAU	ETF	Gold physical deposit	22.63 %	3	22.32 %	1	22.97 %	13
GLD	ETF	Gold physical deposit	22.59 %	4	22.30 %	2	22.90 %	14
DGL	ETF	Gold futures (DBLCI OYG ER)	20.28 %	8	19.23 %	3	21.41 %	15
SLV	ETF	Silver physical deposit	27.97 %	1	2.64 %	6	62.01 %	2
DBS	ETF	Silver futures (DBLCI OYS ER)	25.88 %	2	0.10 %	10	60.84 %	3
DBB	ETF	Industrial metal futures (DBLCI OYIM ER)	2.60 %	14	-26.80 %	14	47.00 %	6
RJZ	ETN	Industrial metal promissory debt	*		*		49.04 %	4
SGGDX	Mutual	Gold, equity, physical deposit, futures	19.39 %	9	6.26 %	5	35.23 %	11
TGLDX	Mutual	Gold & pr. metal, equity, physical deposit	21.96 %	5	-8.15 %	13	65.17 %	1
FGDAX	Mutual	Gold & pr. metal, equity, physical deposit , futures	16.40 %	13	0.44 %	9	36.28 %	10
IGDAX	Mutual	Gold & pr. metal, equity, physical deposit	17.51 %	11	-5.05 %	12	43.48 %	8
USAGX	Mutual	Gold & pr. metal, equity	21.93 %	6	1.68 %	7	48.05 %	5
EKWAX	Mutual	Precious metal equity and debt securities	19.00 %	10	0.94 %	8	41.91 %	9
BGEIX	Mutual	Gold & pr. metal, equity	16.64 %	12	-4.37 %	11	44.24 %	7
Rf rate	Risk free	1 year treasury constant maturity	1.70 %		2.96 %		0.38 %	
ACWI IMI	Index	All market investable index	-1.45 %		-26.69 %		35.21 %	

Out of all the mutual funds included in the metal selection only IGDAX has a loadfee[20]. This is probably due to the harsh competition amongst the securitized gold providers. Holding physical gold or silver also does not require a great deal of active management of a portfolio and the management cost should be lower in contrast to more active funds. IGDAX is ranked relatively low compared to the other securities for all periods, but e.g. FGDAX and BGEIX which do not have frontloads are actually ranked lower for the whole period

[20] IGDAX: 5.5% frontload.

When looking at gold related ETFs they are all in the top of the ranks in sub period 1 while they are ranked in the bottom in sub period 2. Gold and precious metal related mutual funds are ranked lower than their ETF counterparts in sub period 1 while several of the same mutual funds are ranked higher in sub period 2. Sub period 2 is characterized by a solid increase in gold prices but even higher increases for silver. The higher annualized returns for most of the precious metal mutual funds of that period probably reflect that they have a more diversified objective (precious metal) than the single gold ETPs.

None of the tests for differences in mean are significant at a 1% or 5% level[21] for the whole period. However, for the first time so far in the thesis there are significant differences at a 10% level, which occurs when testing the industrial metal related DBB against the two silver ETFs with tickers DBS and SLV. DBS and SLV are ranked at the two top positions for the whole period while DBB is ranked in the bottom. DBS is tracking Deutsche Bank's optimal yield silver excess return index. For precious metals it seems like the optimal yield technology when rolling futures not give an advantage in contrast to some of the results of the broad commodity and energy commodity selections discussed earlier in this chapter. DBS is ranked behind the physical deposit based SLV. Similarly, DGL which utilizes futures to track Deutsche Bank's optimal yield gold excess return index is ranked behind IAU and GLD that holds physical gold deposits.

The p-values from the testing for differences in mean are very high. Disregarding the results between DBB versus DBS and SLV noted in the previous paragraph, almost all of the p-values in the metal selection from differences in mean testing are in the range of about 0.5 and upwards.

For the comparison of returns in gold ETFs versus gold related mutual funds the ranking results for the whole period and sub period 1 is quite evident. Gold deposit ETFs such as IAU and GLD are higher ranked than the gold related mutual fund counterparts. However, when taking into account the results from sub period 2 the gold deposit ETPs are lower ranked than the gold related mutual funds. This is contrary to the results of the whole period and sub period 1. This could suggest that mutual funds gaining exposure to precious metals with different combinations of physical depot, futures and equity have an advantage in that they can adapt to increases in certain precious metals, such as the silver price increase of sub

[21] Refer to Table 18, page 68, for an overview of metal securities testing for differences in means and variances. Testing is only done for the whole period.

period 2. All the gold and precious metal mutual funds performed better in sub period 2 compared to the gold ETPs, and also have higher returns than DBP which track Deutsche Bank's optimal yield precious metal excess return index.The highest ranked fund in sub period 2 is the mutual fund TGLDX, closely followed by the silver ETFs SLV and DBS.

2.4.10 Metal related ETPs and mutual funds - annualized standard deviation

The next table contains annualized standard deviation for the metal related ETPs and mutual funds calculated over daily returns. Some of the standard deviations are very high, similarly to what is found for the energy selection of Table 9 at page 58.

Table 13: Metal related ETPs and mutual funds - annualized standard deviation

Ticker	Type	Investment objective	Whole period 8Jan2007-1Mar2011 σ	Rank	Sub period 1 8Jan2007-27Feb2009 σ	Rank	Sub period 2 2Mar2009-1Mar2011 σ	Rank
DBP	ETF	Gold and silver futures (DBLCI OYPM ER)	25.13 %	4	29.38 %	4	19.61 %	4
IAU	ETF	Gold physical deposit	22.61 %	2	26.68 %	2	17.27 %	1
GLD	ETF	Gold physical deposit	22.58 %	1	26.54 %	1	17.40 %	2
DGL	ETF	Gold futures (DBLCI OYG ER)	22.75 %	3	26.78 %	3	17.47 %	3
SLV	ETF	Silver physical deposit	37.12 %	7	42.10 %	7	30.90 %	8
DBS	ETF	Silver futures (DBLCI OYS ER)	38.34 %	8	43.93 %	8	31.28 %	9
DBB	ETF	Industrial metal futures (DBLCI OYIM ER)	33.54 %	5	35.08 %	5	31.70 %	10
RJZ	ETN	Industrial metal promissory debt	*		*		26.09 %	5
SGGDX	Mutual	Gold, equity, physical deposit, futures	34.22 %	6	39.29 %	6	27.81 %	6
TGLDX	Mutual	Gold & pr. metal, equity, physical deposit	39.95 %	9	46.95 %	9	30.70 %	7
FGDAX	Mutual	Gold & pr. metal, equity, physical deposit , futures	44.39 %	12	52.89 %	12	33.00 %	12
IGDAX	Mutual	Gold & pr. metal, equity, physical deposit	43.28 %	10	51.25 %	10	32.69 %	11
USAGX	Mutual	Gold & pr. metal, equity	47.00 %	13	55.87 %	13	35.15 %	14
EKWAX	Mutual	Precious metal equity and debt securities	44.22 %	11	52.24 %	11	33.63 %	13
BGEIX	Mutual	Gold & pr. metal, equity	48.22 %	14	56.23 %	14	37.85 %	15
Rf rate	Risk free	1 year treasury constant maturity	0.11 %		0.10 %		0.01 %	
ACWI IMI	Index	All market investable index	22.64 %		25.71 %		18.62 %	

For all three periods the gold related IAU, GLD and DGL are obvious 'winners' in that their standard deviations are lower for all periods compared to the mutual funds. Also the precious metal ETF DBP has a low standard deviation and is ranked at 4 through the periods. The p-values from testing for differences in variances from the whole period show that all the ETFs except DBS are statistically different from the mutual funds at a 1% alpha level[22].

The silver related DBS and SLV possesses the highest standard deviation in sub period 2, which is no surprise due to the massive increase in the silver price during the period. DBS and SLV is for the whole period closely ranked to SGGDX and TGLDX and they do not have significant differences in variances on a 1% alpha level, but DBS's variance is significantly

[22] Refer to Table 18, page 68for overview of the difference in variances and means testing.

different from SGGDX on a 5% alpha level. DBS and SLV do have unequal variances to all the other mutual funds at a 1% alpha level.

TGLDX was highest ranked for annualized returns of all the metal securities in sub period 2 of Table 12 on page 62, and was second ranked for annualized returns out of all the mutual funds for the whole period only surpassed by SGGDX. The mutual fund TGLDX is ranked at 9 in terms of standard deviation for the whole period, and its variance is significantly different from BGEIX (14) and USAGX (13) on a 1% alpha level. TGLDX's variance is also different from EXWAX (11) on a 5% alpha level. However, the variance of TGLDX (9) is not different from FGDAX which is ranked at 12. It may seem counterintuitive that TGLDX and FGDAX, ranked at 9 and 12, do not have significantly different variances, while the variances of TGLDX and EXWAX ranked at 9 and 11 are significantly different on a 5% level. This is because Brown-Forsythe's test utilizes the median of the return observations.

2.4.11 Metal related ETPs and mutual funds – skewness and kurtosis

The next table list skewness and excess kurtosis for metal related ETPs and mutual funds.

Table 14: Metal related ETPs and mutual funds – skewness and kurtosis (8 Jan 2007- 1 Mar 2011)

Ticker	Type	Investment	Daily		Weekly		Monthly	
		objective	Skewness	Ex.kurtosis	Skewness	Ex.kurtosis	Skewness	Ex.kurtosis
DBP	ETF	Gold and silver futures	-0.053	6.224	-0.321	2.142	0.319	1.968
IAU	ETF	Gold physical	0.123	6.863	-0.033	2.485	0.329	2.378
GLD	ETF	Gold physical	0.141	5.934	-0.040	2.358	0.351	2.435
DGL	ETF	Gold futures	0.073	7.494	-0.023	2.267	0.285	2.330
SLV	ETF	Silver physical	-0.650	6.371	-0.632	1.232	0.266	0.753
DBS	ETF	Silver futures	-0.715	8.453	-0.676	1.375	0.312	0.859
DBB	ETF	Industrial metal futures	-0.018	0.656	-0.594	0.898	-0.116	0.043
SGGDX	Mutual	Gold, equity, physical deposit, futures	0.235	5.570	-0.141	0.775	1.018	3.678
TGLDX	Mutual	Gold & pr. metal, equity, physical deposit	0.022	5.243	-0.217	1.967	0.880	3.877
FGDAX	Mutual	Gold & pr. metal, equity, physical deposit , futures	0.498	8.740	-0.031	1.376	1.516	6.738
IGDAX	Mutual	Gold & pr. metal, equity, physical deposit	0.174	5.900	-0.158	1.755	0.864	4.823
USAGX	Mutual	Gold & pr. metal, equity	0.307	6.963	-0.132	2.010	1.256	5.915
EKWAX	Mutual	Precious metal equity and debt securities	0.301	6.538	-0.086	1.343	1.250	5.268
BGEIX	Mutual	Gold & pr. metal, equity	0.413	7.044	-0.062	1.196	1.496	6.326
ACWI IMI	Index	All market investable index	-0.210	6.293	-0.995	6.610	-0.906	1.064

Skewness is positive over daily and monthly returns for the metal related securities and differs from the energy and broad commodity selections that are negatively skewed for all periods. The metal related securities are however also all negatively skewed when measured over weekly returns, which imply that weekly returns for metals have more positive than negative returns compared to when measured over daily and monthly returns. Skewness is generally closer to 0 for the metal related securities, thus the returns are to a higher degree symmetrically distributed around the mean for the metal selection than for the broad commodity and energy selections.

Excess kurtosis is generally high for all the metal securities over daily returns, except for the industrial metal tracking DBB. This reflects that the precious metal market is a volatile market similar to the energy market previously discussed. A dissimilarity between the energy and the metal selection of section 2.4.7, page 60, is that kurtosis is for metal generally equal for both the ETFs and the mutual funds, while there was a greater disparity between the high kurtosis of energy equities compared to the lower kurtosis for the energy derivative based ETPs. This is probably because several of the mutual funds which hold precious metal equity also hold gold deposit and as such their return distributions are more equal to the returns of precious metal deposit/derivative based ETFs. Also it may reflect that precious metal equity is more correlated with the prices of precious metals than what is the case of energy equity versus gas/oil prices.

Excess kurtosis tends to be higher for the precious metals when measured over daily and monthly returns than over weekly. Thus there is a strong presence of fat tails in daily/monthly distributions for the period while the fat tails seem to be less prominent for the weekly returns.

2.4.12 Metal related ETPs and mutual funds – test for normality in the return distributions

The table below show results from testing for normality in the distribution for metal related securities over daily returns, end of week day returns, and mid-month day returns. JB columns have values from the Jarque Bera test while DH columns have values from the Doornik and Hansen test. Null hypothesis is that the return series are non-normal, and the ● symbol indicates that the null is rejected on a 5% alpha level.

Table 15: Metal related ETPs and mutual funds – tests for normality in the return distributions (8 Jan 2007- 1 Mar 2011)

Ticker	Type	Investment objective	Daily		Weekly		Monthly	
			JB	DH	JB	DH	JB	DH
DBP	ETF	Gold and silver futures	1687.5	588.6	45.2	27.2	8.9	9.6
IAU	ETF	Gold physical	2053.6	665.0	55.9	38.3	12.7	12.4
GLD	ETF	Gold physical	1536.6	545.5	50.3	35.3	13.4	12.7
DGL	ETF	Gold futures	2446.1	750.4	46.5	33.3	12.0	12.3
SLV	ETF	Silver physical	1841.2	454.5	28.2	13.5	1.8 ●	2.8 ●
DBS	ETF	Silver futures	3200.5	664.2	33.6	6.4	2.3 ●	3.3 ●
DBB	ETF	Industrial metal futures	18.8	16.9	20.0	11.7	0.1 ●	0.4 ●
SGGDX	Mutual	Gold, equity, physical deposit, futures	1360.3	487.5	36.7	6.2	36.8	13.1
TGLDX	Mutual	Gold & pr. metal, equity, physical deposit	1196.8	467.1	17.2	25.4	37.8	16.2
FGDAX	Mutual	Gold & pr. metal, equity, physical deposit , futures	3369.1	807.3	28.8	15.4	113.7	19.9
IGDAX	Mutual	Gold & pr. metal, equity, physical deposit	1520.9	537.4	37.1	21.9	54.7	23.1
USAGX	Mutual	Gold & pr. metal, equity	2127.5	645.9	16.6	27.2	86.0	21.2
EKWAX	Mutual	Precious metal equity and debt securities	1877.2	593.9	13.1	14.7	70.8	17.7
BGEIX	Mutual	Gold & pr. metal, equity	2189.9	625.6	20.4	12.3	102.0	18.5
ACWI IMI	Index	All market investable index	1732.1	581.3	430.9	81.8	9.2	6.9

Only SLV and DBS, the two silver ETFs, and the industrial metal ETF DBB possess normal distribution and only when measured over monthly returns. All the other securities in the table above do not reject the null of a non-normal distribution for any of the measuring frequencies. Like for the skewness/kurtosis calculations in the previous table the gold related ETFs and precious metal mutual funds are relatively similar to each other in terms of values when testing for normal distributions. Something that should be expected since the test for non-normality of distributions is calculated on the basis of skewness and kurtosis.

2.5 Conclusions chapter 2

When comparing the ETPs of the broad commodity selection it seems like DBC which uses Deutsche Bank's optimal yield technology when rolling futures have an advantage to the other ETPs for the whole period and sub period 1. DBC has considerably higher annualized returns for those periods. In sub period 2 DBC is lower ranked but the returns are not that far away from the other broad commodity ETPs. For the energy selection DBO which also utilize optimum yield are also higher ranked than the other ETPs that relate to WTI oil. For the precious metal selection the tendency is opposite, in that those ETFs that hold physical deposit are higher ranked than the precious metal ETFs that uses the optimal yield technology.

None of the tests for difference in means are significant on a 1% or 5% level in the pairwise testing for any of the securities within the respective commodity categories. Generally there are high p-values which should be expected for securities within a specific commodity category. For the testing in differences of variances results indicate that there are differences, especially within the energy and metal selections.

For the ETP versus mutual fund comparison it is a bit surprising to see that there is no clear tendency in that ETPs are better ranked for the broad commodity and energy selections, although several of the mutual funds have frontloads that are accounted for in the returns. For precious metal there seems to be a tendency in that ETPs are better ranked than the mutual fund counterparts for the whole period and in sub period 1(financial crisis). This could indicate that precious metal ETPs are a preferred choice in a downwards trending market, since funds also hold precious equity which may be at disadvantageous. Also the precious metal mutual funds have significantly higher standard deviations than their ETF counterparts. Nevertheless, several of the precious mutual funds are higher ranked in sub period 2 (2009-2011) which may suggest that holding a precious metal mutual fund in an up upward trending market may be a good idea, maybe because the precious mutual funds better can manage their holdings to encompass rising trends in different precious metals and equities than the more narrow commodity ETP trackers. Further research can perhaps be done to see whether the ETPs or the mutual funds are beneficial for diversification in a broad portfolio. When it comes to those two ETPs and the mutual funds that relate to S&P GSCI TR the ETPs seem to be better ranked than the mutual fund. This does not apply to the mutual fund and the ETP that relate to DJ-UBS CI TR, where the differences in returns and standard deviation are very small.

For the ETF versus the ETN comparison there are not any evident results which suggest that ETNs are beneficial over the physical ETFs, and probably the investor should go for the physical ETF instead of an ETN when those two alternatives exist for a specific commodity exposure. At least so if the investor not manages the counterparty default risk of the ETN issuer, e.g. with and option like discussed in 1.7.1, page 20.

Appendixes chapter 2

Table 16: Broad commodity ETPs and mutual funds – Two sample tests for equality of variances and differences in means (8 Jan 2007 – 1 Mar 2011)

	GSG	GSP	DJP	DBC	CRSAX	SKNRX	PCRAX	QRAAX	RYMEX	ACWI IMI
GSP	0.769 0.711 0.946									
DJP	0.000●● 0.000●● 0.983	0.000●● 0.000●● 0.981								
DBC	0.000●● 0.000●● 0.752	0.000●● 0.000●● 0.749	0.002●● 0.001●● 0.731							
CRSAX	0.000●● 0.000●● 0.966	0.000●● 0.000●● 0.964	0.161 0.083 0.877	0.000●● 0.000●● 0.742						
SKNRX	0.000●● 0.002●● 0.889	0.000 0.014● 0.641	0.012● 0.000●● 0.890	0.842 0.002●● 0.646	0.000●● 0.000●● 0.905					
PCRAX	0.000●● 0.000●● 0.777	0.000●● 0.000●● 0.891	0.546 0.135 0.742	0.016● 0.050● 0.964	0.050● 0.001●● 0.771	0.052 0.000●● 0.639				
QRAAX	0.203 0.275 0.756	0.322 0.821 0.788	0.000●● 0.000●● 0.786	0.004●● 0.000●● 0.576	0.000●● 0.000●● 0.766	0.005●● 0.013● 0.711	0.000●● 0.000●● 0.595			
RYMEX	0.818 0.910 0.935	0.953 0.629 0.978	0.000●● 0.000●● 0.925	0.000●● 0.000●● 0.700	0.000●● 0.000●● 0.908	0.000●● 0.003●● 0.837	0.000●● 0.000●● 0.723	0.301 0.477 0.810		
ACWI IMI	0.000●● 0.000●● 0.862	0.000●● 0.000●● 0.862	0.009●● 0.702 0.817	0.000●● 0.000●● 0.572	0.180 0.176 0.959	0.000●● 0.000●● 0.730	0.002●● 0.060● 0.592	0.000●● 0.000●● 0.941	0.000●● 0.000●● 0.919	

Every box with numbers has the p value from a two sample test with:

-----> p value from Brown-Forsythe's version of Levene's test in the first line (equality of variance)
-----> p value from F-test of significance in the second line (equality of variance)
-----> p value from testing for difference of means in the third line (difference of mean)

When testing equality of variance

●● = null hypothesis of equal variance is rejected at alpha level of 1%
● = null hypothesis of equal variance is rejected at alpha level of 5%

Due to non-normality in the return series the Brown-Forsythe's version of Levene's test is more robust than the F test of significance when testing for equality of variance

When testing for difference in means

●●●= null hypothesis of equal means rejected at alpha level of 10%
(none of the means are significantly different from each other at alpha level of 10%)

If Brown-Forsythe's version of Levene's test is significant the mean difference tests are conducted on ranked observations with a two sample t-test for difference in means assuming unequal varianc
If Brown-Forsythe's version of Levene's test is not significant, the mean difference tests are conduc with the Mann-Whitney test.

Table 17: Energy ETPs and mutual funds – Two sample tests for equality of variances and differences in means (8 Jan 2007 – 1 Mar 2011)

	DBE	USO	OIL	DBO	FANIX	IENAX	IEYAX	RYEIX	WEGAX	PXE	IEO	XOP	PXI	RYE
USO	0.000●● 0.000●● 0.763													
OIL	0.000●● 0.000●● 0.700	0.678 0.569 0.988												
DBO	0.113 0.036● 0.967	0.000●● 0.000●● 0.737	0.000●● 0.000●● 0.676											
FANIX	0.000●● 0.000●● 0.795	0.892 0.000●● 0.212	0.818 0.001●● 0.223	0.001●● 0.000●● 0.833										
IENAX	0.001●● 0.000●● 0.731	0.305 0.004●● 0.236	0.166 0.021● 0.246	0.043● 0.000●● 0.768	0.294 0.364 0.907									
IEYAX	0.168 0.000●● 0.430	0.001●● 0.024● 0.614	0.000●● 0.005●● 0.560	0.942 0.020● 0.438	0.002●● 0.000●● 0.970	0.048● 0.000●● 0.907								
RYEIX	0.006●● 0.000●● 0.835	0.071 0.311 0.292	0.030● 0.657 0.592	0.175 0.000●● 0.421	0.081 0.005 0.757	0.510 0.061 0.860	0.180 0.001●● 0.956							
WEGAX	0.039● 0.000 0.785	0.008●● 0.279 0.598	0.002 0.098 0.282	0.527 0.000●● 0.397	0.013● 0.000●● 0.994	0.175 0.000●● 0.880	0.511 0.242 0.933	0.482 0.036● 0.970						
PXE	0.001●● 0.000●● 0.784	0.301 0.041● 0.225	0.160 0.140 0.240	0.035● 0.000●● 0.821	0.291 0.080● 0.930	0.985 0.401 0.982	0.040● 0.000●● 0.963	0.488 0.302 0.830	0.158 0.002●● 0.850					
IEO	0.000●● 0.000●● 0.736	0.083 0.000●● 0.266	0.935 0.001●● 0.284	0.001●● 0.000●● 0.772	0.891 0.989 0.869	0.234 0.371 0.942	0.001●● 0.000●● 0.909	0.059 0.006●● 0.914	0.008 0.000●● 0.938	0.231 0.083 0.941				
XOP	0.000●● 0.000●● 0.685	0.285 0.000●● 0.223	0.868 0.000●● 0.231	0.000●● 0.000●● 0.721	0.719 0.705 0.971	0.159 0.198 0.938	0.000●● 0.000●● 0.857	0.035● 0.002●● 0.849	0.004 0.000●● 0.839	0.155 0.034● 0.957	0.822 0.695 0.922			
PXI	0.239 0.000●● 0.242	0.001●● 0.267 0.586	0.000●● 0.093 0.534	0.836 0.001●● 0.241	0.002●● 0.000●● 0.992	0.042● 0.000●● 0.946	0.898 0.253 0.700	0.156 0.034● 0.747	0.447 0.979 0.773	0.035● 0.002●● 0.998	0.001●● 0.000●● 0.947	0.000●● 0.000●● 0.895		
RYE	0.001●● 0.000●● 0.754	0.184 0.110 0.183	0.089 0.305 0.196	0.067● 0.000●● 0.791	0.187 0.028● 0.981	0.812 0.197 0.926	0.074 0.000●● 0.750	0.666 0.560 0.785	0.251 0.007●● 0.813	0.793 0.653 0.965	0.143 0.029● 0.893	0.092 0.010● 0.998	0.064 0.007●● 0.926	
ACWI IMI	0.000●● 0.000●● 0.587	0.000●● 0.000●● 0.897	0.000●● 0.000●● 0.976	0.000●● 0.000●● 0.567	0.000●● 0.000●● 0.478	0.000●● 0.000●● 0.414	0.000●● 0.000●● 0.442	0.000●● 0.000●● 0.490	0.000●● 0.000●● 0.431	0.000●● 0.000●● 0.454	0.000●● 0.000●● 0.424	0.000●● 0.000●● 0.385	0.000●● 0.000●● 0.418	0.000●● 0.000●● 0.424

Every box with numbers has the p value from a two sample test with:

-----> p value from Brown-Forsythe's version of Levene's test in the first line (equality of variance)
-----> p value from F-test of significance in the second line (equality of variance)
-----> p value from testing for difference of means in the third line (difference of mean)

When testing equality of variance

●● = null hypothesis of equal variance is rejected at alpha level of 1%
● = null hypothesis of equal variance is rejected at alpha level of 5%

Due to non-normality in the return series the Brown-Forsythe's version of Levene's test is more robust than the F test of significance when testing for equality of variance

When testing for difference in means

●●●= null hypothesis of equal means rejected at alpha level of 10%
(none of the means are significantly different from each other at alpha level of 10%)

If Brown-Forsythe's version of Levene's test is significant the mean difference tests are conducted on ranked observations with a two sample t-test for difference in means assuming unequal variance.
If Brown-Forsythe's version of Levene's test is not significant, the mean difference tests are conducted with the Mann-Whitney test.

Table 18: Metal ETPs and mutual funds – Two sample tests for equality of variances and differences in means (8 Jan 2007 – 1 Mar 2011)

	DBP	IAU	GLD	DGL	SLV	DBS	DBB	SGGDX	TGLDX	FGDAX	IGDAX	USAGX	EKWAX	BGEIX
IAU	0.015● 0.001●● 0.995													
GLD	0.018● 0.001●● 0.998	0.938 0.962 0.931												
DGL	0.017● 0.001●● 0.913	0.975 0.844 0.889	0.964 0.807 0.958											
SLV	0.000●● 0.000●● 0.691	0.000●● 0.000●● 0.685	0.000●● 0.000●● 0.683	0.000●● 0.000●● 0.621										
DBS	0.000●● 0.000●● 0.736	0.000●● 0.000●● 0.731	0.000●● 0.000●● 0.730	0.000●● 0.000●● 0.667	0.655 0.293 0.987									
DBB	0.000●● 0.000●● 0.474	0.000●● 0.000●● 0.456	0.000●● 0.000●● 0.457	0.000●● 0.000●● 0.517	0.812 0.001● 0.054●●●	0.470 0.000●● 0.054●●●								
SGGDX	0.000●● 0.000●● 0.974	0.000●● 0.000●● 0.976	0.000●● 0.000●● 0.957	0.000●● 0.000●● 0.901	0.089 0.009●● 0.155	0.034● 0.000●● 0.784	0.101 0.520 0.448							
TGLDX	0.000●● 0.000●● 0.830	0.000●● 0.000●● 0.829	0.000●● 0.000●● 0.827	0.000●● 0.000●● 0.764	0.127 0.018● 0.416	0.288 0.185 0.415	0.058 0.000●● 0.269	0.001●● 0.000●● 0.868						
FGDAX	0.000●● 0.000●● 0.933	0.000●● 0.000●● 0.935	0.000●● 0.000●● 0.933	0.000●● 0.000●● 0.873	0.001●● 0.000●● 0.815	0.005●● 0.000●● 0.849	0.000●● 0.000●● 0.538	0.000●● 0.000●● 0.959	0.076 0.001●● 0.712					
IGDAX	0.000●● 0.000●● 0.871	0.000●● 0.000●● 0.871	0.000●● 0.000●● 0.870	0.000●● 0.000●● 0.809	0.001●● 0.000●● 0.864	0.003●● 0.000●● 0.899	0.000●● 0.000●● 0.487	0.000●● 0.000●● 0.903	0.051 0.010● 0.981	0.910 0.414 0.752				
USAGX	0.000●● 0.000●● 0.761	0.000●● 0.000●● 0.759	0.000●● 0.000●● 0.757	0.000●● 0.000●● 0.703	0.000●● 0.000●● 0.978	0.000●● 0.000●● 0.990	0.000●● 0.000●● 0.424	0.000●● 0.000●● 0.799	0.001● 0.000● 0.921	0.150 0.065 0.752	0.172 0.008●● 0.982			
EKWAX	0.000●● 0.000●● 0.864	0.000●● 0.000●● 0.864	0.000●● 0.000●● 0.863	0.000●● 0.000●● 0.803	0.000●● 0.000●● 0.874	0.001●● 0.000●● 0.908	0.000●● 0.000●● 0.486	0.000●● 0.000●● 0.896	0.024● 0.001●● 0.981	0.666 0.903 0.828	0.742 0.487 0.927	0.300 0.049● 0.914		
BGEIX	0.000●● 0.000●● 0.878	0.000●● 0.000●● 0.879	0.000●● 0.000●● 0.877	0.000●● 0.000●● 0.822	0.000●● 0.000●● 0.876	0.000●● 0.000●● 0.907	0.000●● 0.000●● 0.514	0.000●● 0.000●● 0.907	0.000●● 0.000●● 0.977	0.027● 0.008 0.951	0.031● 0.000●● 0.997	0.441 0.407 0.175	0.068 0.005●● 0.879	
ACWI IMI	0.001●● 0.001●● 0.190	0.263 0.983 0.126	0.231 0.945 0.156	0.252 0.861 0.165	0.000●● 0.000●● 0.153	0.000●● 0.000●● 0.179	0.000●● 0.000●● 0.723	0.000●● 0.000●● 0.265	0.000●● 0.000●● 0.236	0.000●● 0.000●● 0.329	0.000●● 0.000●● 0.283	0.000●● 0.000●● 0.246	0.000●● 0.000●● 0.286	0.000●● 0.000●● 0.323

Every box with numbers has the p value from a two sample test with:

-----> p value from Brown-Forsythe’s version of Levene's test in the first line (equality of variance)
-----> p value from F-test of significance in the second line (equality of variance)
-----> p value from testing for difference of means in the third line (difference of mean)

When testing equality of variance

●● = null hypothesis of equal variance is rejected at alpha level of 1%
● = null hypothesis of equal variance is rejected at alpha level of 5%

Due to non-normality in the return series the Brown-Forsythe's version of Levene's test is more robust than the F test of significance when testing for equality of variance

When testing for difference in means

●●● = null hypothesis of equal means rejected at alpha level of 10%

If Brown-Forsythe’s version of Levene's test is significant the mean difference tests are conducted on ranked observations with a two sample t-test for difference in means assuming unequal varianc
If Brown-Forsythe's version of Levene's test is not significant, the mean difference tests are condu
with the Mann-Whitney test.

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Chapter 3: Risk adjusted performance of commodity ETPs and mutual fund

Summary chapter 3

Metal mutual funds tend to have higher systematic risk and lower Treynor rankings compared to the precious metal commodity tracking ETFs. Mutual funds for the broad commodity selection are quite equal to the ETP counterparts, but the ETP seem to be beneficial for specific S&P GSCI TR exposure.

In the ETF versus ETN comparison the findings still seem to indicate that the investor should hold the EFT if there is such an alternative in the exposure strategy, similar to the findings in chapter 2.

Also like in chapter 2; Deutsche Bank's optimal yield strategy could be advantageous among the ETFs in the broad commodity and the energy selections.

Keywords: Treynor & Sharpe for commodity ETFs, ETNs and mutual funds.

3.0 Introduction

This chapter is based on the results from chapter 2. Returns are adjusted for risk, and may improve the comparison between the ETPs and the mutual funds. The risk adjusted annualized geometric returns will be calculated by Sharpe and Treynor ratios. Securities that have positive excess return are rewarded by the Sharpe ratio if they have low total risk (standard deviation) while returns by the Treynor measure are rewarded if they have low systematic rick (beta). For portfolios one often sees that risk adjustment is calculated with several other measures e.g. M^2, Information Ratios and Appraisal Ratios etc. Securities analyzed here are non-diversified commodity related securities that probably to many investors would constitute only a part of a broader and more diversified portfolio. I have not included several of the measures which perhaps are more related to portfolio risk adjusted returns, since only single securities are analyzed. Also, several of the other measures of portfolio risk adjusted returns often give equal or approximately equal rankings of securities/portfolios compared to e.g. Sharpe or Treynor ratios (Fyksen 2006).

Securities which are analyzed in this chapter are the same as from chapter 2. The total selection consist of 18 derivative based commodity ETPs, 17 commodity mutual funds and 5 commodity equity ETPs. The risk free rate of return used for Sharpe and Treynor ratios is based on daily percentage interest for the US 1 Year Treasury Constant Maturity Rate. The MSCI Barra All Country World Index Investable Market Index (ACWI IMI) represents the total market. Data are divided in to three periods in the same way as for chapter two, and the periods are listed in the table headings.

3.1 Method

3.1.1 Sharpe ratio

There is a challenge in interpreting standard Sharpe ratios in bear markets when securities often may have negative excess returns over the risk free rate, such as the case is for several of the securities especially in sub period 1 (2007-2009). For negative excess returns the typical meaning of the Sharpe ratio is ‘inverted’ compared to its meaning for positive excess return over the risk free rate.

Typically, if positive excess return is present for a specific security/portfolio it is rewarded by Sharpe ratios when it has lower standard deviation compared to another security/portfolio with equal return and higher standard deviation. The Sharpe ratio would then have a higher positive value for the former security/portfolio versus the latter in the previous sentence.

If negative excess return is present a specific security/portfolio would be penalized for having lower standard deviation compared to another security/portfolio with equal return and higher standard deviation. Sharpe ratio would then have a lower negative value for the former security/portfolio than the latter in the previous sentence. As such rankings of Sharpe ratios get confusing.

Several possible solutions to the dilemma of negative excess returns for Sharpe ratios have been suggested. E.g. changing the interpretation of the Sharpe ratio:

“The fund with the maximum Sharpe ratio is that fund with the highest probability of outperforming the risk-free rate, not necessarily the fund with the largest excess return per unit of risk”(McLeod & Vuuren 2004)

Another addition to the negative excess return dilemma is put forward by Craig L. Israelsen, who suggests an adjustment to Sharpe ratio calculation for negative excess returns so that it is easier to interpret Sharpe values for both positive and negative excess returns. The practical solution is cited to be:

"This adjustment results in using the inverse of the annualized standard deviation of returns in the denominator. This is the equivalent of developing a ranking metric that is the product of the excess return multiplied by the standard deviation of the excess return…….. There would be no adjustment for ranking portfolios if the average excess return were positive"(Thompson 2010)

Israelsen's adjusted Sharpe ratio is partly implemented in this thesis. That is, I am not using the standard deviation of the excess return over the risk free rate but the standard deviation (total risk) of the security. In this thesis Sharpe ratio is defined over daily return frequencies as:

Equation 11: Sharpe ratio (SR)

$$If\ (r_s - r_{rf}) > 0\ then\ SR = \frac{(r_s - r_{rf})}{\sigma_s},\ if\ (r_s - r_{rf}) < 0\ then\ SR = (r_s - r_{rf}) * \sigma_s\ ,\ where$$

$r_s = Annualized\ geometric\ return\ for\ a\ security$

$r_{rf} = Annualized\ geometric\ return\ for\ the\ risk\ free\ rate$

$\sigma_s = Annualized\ sample\ standard\ deviation\ for\ a\ security$

The annualized geometric return for a security is calculated by Equation 1 on page 42 for ETPs and mutual funds that do not have a frontload. For those mutual funds that have frontloads the annualized geometric return is calculated by Equation 2 from page 42 in order to include the frontload in risk adjusted measures. Similar to how frontloads are accounted for in the annualized returns of chapter 2. A security's sample standard deviation is annualized by Equation 3, page 43.

The version of the Sharpe ratio that use the standard deviation of a portfolio/security's excess return instead of the standard deviation (total risk) of the security show slightly different results compared to Sharpe ratios calculated in this paper. However, in checking some of the selections, I haven't found that using the standard deviation of the excess return over the risk free rate affect the ranking results compared to utilizing the standard deviation (total risk) of a security.

3.1.2 Treynor ratio

In this thesis Treynor ratios are calculated over daily returns as:

Equation 12: Treynor ratio (TR)

$$If\ (r_s - r_{rf}) > 0\ then\ TR = \frac{(r_s - r_{rf})}{\beta_s},\ if\ (r_s - r_{rf}) < 0\ then\ TR = (r_s - r_{rf}) * \beta_s\ ,where$$

$$r_s = Annualized\ geometric\ return\ for\ a\ security$$

$$r_{rf} = Annualized\ geometric\ return\ for\ the\ risk\ free\ rate$$

$$\beta_s = \beta_{of\ security\ \ to\ the\ total\ market} = \frac{covariance(r_{s,daily\ returns\ for\ security\ s}\ ,\ \ r_{b\ daily\ returns\ for\ the\ benchmark})}{variance(r_{b\ daily\ returns\ for\ the\ ACWI\ IMI\ benchmark})}$$

Treynor ratio is adjusting a security's excess annualized returns over the annualized risk free rate by utilizing the beta (β) of the security in the denominator instead of the total risk used in the Sharpe ratio. Treynor is adjusting for the systematic risk (β) of a security and rewards securities with increasingly lower betas ceteris paribus. A portfolio with a high systematic risk will tend to be more diversified by adding securities with high Treynor ratios, since securities with low betas tend to correlate less with the total market than securities with high betas.

Securities that have decreasingly lower betas will only get higher Treynor values if the excess return is positive, similar to the dilemma of negative Sharpe ratios discussed above. If the excess return is negative, a decrease in systematic risk would lower the negative Treynor value compared to a security that has the same return and a higher beta value. Thus I have calculated the Treynor ratios differently for positive versus negative excess returns, similarly to the way the Sharpe ratios are calculated in the previous section.

3.2 Sharpe and Treynor ratios for the commodity selections

In the following sections I will discuss the results from the rankings according to the Sharpe and Treynor values based on the same selection of securities over the same periods as in chapter 2.

3.2.1 Broad commodity ETPs and mutual funds – Sharpe ratios

The table below shows the results from measuring Sharpe ratios over daily returns for all the derivative related broad commodity securities.

Table 19: Broad commodity ETPs and mutual funds - Sharpe ratios

			Whole period		Sub period 1		Sub period 2	
Ticker	Type	Investment	8Jan2007-1Mar2011		8Jan2007-27Feb2009		2Mar2009-1Mar2011	
		objective	SR	Rank	SR	Rank	SR	Rank
GSG	ETF	S&P GSCI TR futures	-0.0062	7	-0.073	5	0.869	8
GSP	ETN	S&P GSCI TR (prommisory debt)	-0.0059	6	-0.075	6	0.949	7
DJP	ETN	DJ-UBS CI TR (prommisory debt)	0.0200	3	-0.046	3	1.218	4
DBC	ETF	DB LCIOYD ER futures	0.2305	1	-0.028	1	1.142	6
RJI	ETN	Rogers ICI (prommisory debt)					1.399	2
CRSAX	Mutual	DJ-UBS CI TR related derivatives	0.0173	4	-0.044	2	1.185	5
SKNRX	Mutual	Commodity derivatives	0.0052	5	-0.077	7	1.309	3
PCRAX	Mutual	Commodity derivatives	0.1659	2	-0.059	4	1.777	1
QRAAX	Mutual	Commodity derivatives	-0.0232	9	-0.102	9	0.777	9
RYMEX	Mutual	S&P GSCI TR related derivatives	-0.0140	8	-0.082	8	0.677	10

For the whole period the Sharpe ratio rankings are equal to the annualized return rankings of Table 4 from page 49. The reason for this is probably that the securities in broad commodity selection all use approximately similar derivative based strategies, which induces annualized standard deviations in a narrow range (about 22% to 31%) for the whole period. As such there is no evident indication from the Sharpe ratios to the investor on holding ETPs over mutual funds or vice versa for broad commodity exposure.

For sub period 1, which is characterized by higher volatility and a bear market, there are some small changes in the Sharpe ratio ranking compared to the annualized return rankings of period 1. As seen in the table above, the ETF GSG is ranked at 5 while it was ranked at 4 for the annualized returns. The mutual fund PRCAX is rank at 4 while it was ranked at 5 by the annualized returns for the period. Similarly, DBC has switched ranks from 2 to 3 while CRSAX has switched from 3 to 2 compared to the annualized returns.

For sub period 2 there is only one change in the rankings when comparing Sharpe rations to annualized returns. The change applies to the ETN GSP which has switched ranking from 5 to 7, while CRSAX has switched from 7 to 5.

Sharpe ratios as such do not make the general comparison between broad commodity ETPs and mutual funds any more evident. The mutual funds and ETPs for this commodity category are scattered all around in the rankings.

Still, the investor that wants exposure to the S&P GSCI TR index should according to the Sharpe ratios of the periods in the table choose an ETP over the mutual fund that relates to the same index. On the other hand, for the DJ-UBS CI TR which both DJP and CRSAX relate to, the Sharpe ratios show that CRSAX had lower risk adjusted returns for sub period 1 than DJP. This is slightly different to when measured over annualized returns, where DJP was ranked one or two places higher than CRSAX for all the periods. This may suggest that if an investor wants exposure to DJ-UBS CI TR, then holding long the DJP (ETN) will not add any particular gain compared to holding long the mutual fund CRSAX.

3.2.2 Broad commodity ETPs and mutual funds – Treynor ratios

Table 20: Broad commodity ETPs and mutual funds – Treynor ratios

			Whole period		Sub period 1		Sub period 2	
Ticker	Type	Investment objective	8Jan2007-1Mar2011		8Jan2007-27Feb2009		2Mar2009-1Mar2011	
			Treynor	Rank	Treynor	Rank	Treynor	Rank
GSG	ETF	S&P GSCI TR futures	-0.0148	7	-0.134	5	0.249	8
GSP	ETN	S&P GSCI TR (prommisory debt)	-0.0145	6	-0.144	6	0.266	7
DJP	ETN	DJ-UBS CI TR (prommisory debt)	0.0079	3	-0.094	3	0.347	3
DBC	ETF	DB LCIOYD ER futures	0.0944	1	-0.054	1	0.320	6
RJI	ETN	Rogers ICI (prommisory debt)					0.390	2
CRSAX	Mutual	DJ-UBS CI TR related derivatives	0.0071	4	-0.083	2	0.340	4
SKNRX	Mutual	Commodity derivatives	0.0015	5	-0.234	9	0.328	5
PCRAX	Mutual	Commodity derivatives	0.0728	2	-0.102	4	0.514	1
QRAAX	Mutual	Commodity derivatives	-0.0568	9	-0.199	8	0.220	9
RYMEX	Mutual	S&P GSCI TR related derivatives	-0.0323	8	-0.145	7	0.195	10

Ranks based on Treynor ratios for broad commodities show similar results to the ranks from the Sharpe ratios. For the whole period the rankings are the same both in the Treynor table above and in the Sharpe ratio table on the previous page and also for the annualized returns in Table 4, page 49. There are some small disparities between the Sharpe and Treynor rankings for the mutual funds in sub period 1. The three lowest ranked mutual funds SKNRX, QRAAX and RYMEX have switched places with each other compared to Sharpe ranking. SKNRX has the highest beta values[23] of all the securities for all periods. Especially for the

[23] Please refer to Table 25, page 86, for an overview of the betas for all securities.

sub period 1, SKNRX's beta value is higher than the other mutual funds, which helps induce a low ranking by the Treynor ratio of that period. CRSAX which is second or highest ranked among the broad commodity related mutual funds in the Treynor table of the previous page gets a high ranking partly because it has the lowest beta values through all periods. The betas are generally in a closer range to each other for the whole period and sub period 2, while the range is greater in the bear market of sub period 1. Also in sub period 2 there are only small ranking differences between the Sharpe and Treynor ratio, and only for those securities that are ranked in the middle of the Treynor table.

When comparing the securities that relate to the same index, such as GSG, GSP and RYMEX which relate to S&P GSCI TR, the indications are the same as discussed under the broad commodities Sharpe table and for annualized returns of Table 4, page 49. That is, if the retail investor wants exposure to S&P GSCI TR, also the Treynor ratios suggest that GSG and GSP are slightly better performers compared to RYMEX for exposure to S&P GSCI TR.

The indications for the S&P GSCI TR related securities are not holding for the DJ-UBS CI TR related securities. The mutual fund CRSAX has a slightly higher Traynor value than the ETN DJP in sub period 2, but the Traynor values for all periods are very close to each other. This could suggest that holding the mutual fund CRSAX could be less risky than holding DJP due to the counterparty risk of the DJP ETN structure. The two securities that relate to the DJ-UBS CI TR have low beta values compared to other securities in the broad commodity selection. This is probably due to that the DJ-UBS CI TR is weighted with a maximum of 15% for any of the commodity constituent. The DJ-UBS-CI TR seems to have an advantage in terms of low systematic risk. As such, for a portfolio with high market risk the DJ-UBS-CI TR index to greater degree adds diversification to the portfolio compared to other broad commodity indices of the selection.

The differences in Sharpe and Treynor ratios for GSP (ETN) versus GSG (ETF) which both track S&P GSCI TR are very small for all periods. Again, this may imply that the inherent counterparty risk of the GSP (ETN) may not be worthwhile compared to holding GSG (ETF) in the choice of an ETP to track that particular index. Similar to what already has been discussed for GSP and GSG for the annualized returns in section 2.4.1, page 48.

3.2.3 Energy related commodity ETPs and mutual funds – Sharpe ratios

Table 21: Energy related commodity ETPs and mutual funds - Sharpe ratios

Ticker	Type	Investment objective	Whole period 8Jan2007-1Mar2011 SR	Rank	Sub period 1 8Jan2007-27Feb2009 SR	Rank	Sub period 2 2Mar2009-1Mar2011 SR	Rank
DBE	ETF	Broad energy futures DB OYE ER	0.149	12	-0.050	1	1.011	12
USO	ETF	WTI futures near month	-0.023	13	-0.117	13	0.625	14
OIL	ETN	WTI by S&P GSCICO TR	-0.033	14	-0.138	14	0.644	13
DBO	ETF	WTI by DBCI OYCO ER	0.151	11	-0.055	2	1.017	11
UNG	ETF	Natural gas futures near month	*		*		-0.219	15
FANIX	Mutual	Energy broad equity	0.157	10	-0.114	12	1.410	6
IENAX	Mutual	Energy broad equity	0.212	6	-0.077	3	1.221	10
IEYAX	Mutual	Energy broad equity	0.211	7	-0.080	4	1.333	8
RYEIX	Mutual	Energy broad equity	0.173	9	-0.095	8	1.431	5
WEGAX	Mutual	Energy broad equity	0.212	4	-0.081	5	1.311	9
PXE	ETF	Energy broad equity	0.199	8	-0.114	11	1.704	2
IEO	ETF	Energy broad equity	0.212	5	-0.093	6	1.389	7
XOP	ETF	Energy broad equity	0.251	2	-0.094	7	1.540	4
PXI	ETF	Energy broad equity	0.267	1	-0.102	10	2.024	1
RYE	ETF	Energy broad equity	0.234	3	-0.095	9	1.546	3

For the derivative based ETPs the rankings for all the periods are equal to the rankings from annualized returns in Table 8, page 56. As such there is not much additional information from the whole period Sharpe ratios that has not already been discussed in chapter two for the derivative based energy ETPs versus the energy equity based securities.

For the broad energy equity ETPs and mutual funds there are some changes in the rankings compared to ranks from the annualized returns. The most evident changes for the whole period is that IENAX which was ranked at 5 for annualized returns is now ranked at 8 and WEGAX which was ranked at 7 for annualized returns is now ranked at 4. This implies that IENAX has a higher total risk relative to the excess return compared to WEGAX.

Again, when comparing the energy equity mutual funds to the energy equity ETFs there is a trend in that the ETFs are better ranked than the mutual funds for the whole period and sub period 2. The Sharpe ratio average for all the broad energy equities is higher than for the mutual funds for the whole period and sub period 2, and the ETFs are generally better ranked for those periods. Sub period 1 is not so evident, since IENAX, IEYAX and WEGAX all are higher ranked than the energy equity ETPs.

When comparing energy equity ETPs versus their mutual fund counterparts the Sharpe ratio values seem to suggest that an investor who held energy equity ETPs over the whole period would benefit compared to holding energy mutual funds over the same period. However, there are greater disparities in the Sharpe ratio rankings for the energy equity ETPs when comparing the different periods with one another. The mutual funds are more evenly ranked through all the periods. This could suggest that the mutual funds benefited in terms of not being so vulnerable in the bear market period of 2007-2009, possibly because they held more actively managed positions comparing to the energy equity ETPs of the selection which presumably invest in a more fixed relation their energy equity indices[24].

3.2.4 Energy related commodity ETPs and mutual funds – Treynor ratios

Table 22: Energy related commodity ETPs and mutual funds – Treynor ratios

			Whole period		Sub period 1		Sub period 2	
Ticker	Type	Investment objective	8Jan2007-1Mar2011 Treynor	Rank	8Jan2007-27Feb2009 Treynor	Rank	2Mar2009-1Mar2011 Treynor	Rank
DBE	ETF	Energy broad futures	0.067	5	-0.084	1	0.295	8
USO	ETF	WTI futures	-0.050	13	-0.197	3	0.191	14
OIL	ETN	WTI promissory debt	-0.073	14	-0.233	4	0.195	13
DBO	ETF	WTI futures	0.068	4	-0.092	2	0.291	10
UNG	ETF	Natural gas Futures	*		*		-0.226	15
FANIX	Mutual	Energy broad equity	0.044	12	-0.353	14	0.314	6
IENAX	Mutual	Energy broad equity	0.060	7	-0.237	5	0.273	12
IEYAX	Mutual	Energy broad equity	0.058	9	-0.251	6	0.293	9
RYEIX	Mutual	Energy broad equity	0.048	11	-0.297	11	0.314	7
WEGAX	Mutual	Energy broad equity	0.059	8	-0.255	7	0.289	11
PXE	ETF	Energy broad equity	0.058	10	-0.333	13	0.379	2
IEO	ETF	Energy broad equity	0.062	6	-0.272	9	0.317	5
XOP	ETF	Energy broad equity	0.074	2	-0.279	10	0.355	4
PXI	ETF	Energy broad equity	0.075	1	-0.315	12	0.448	1
RYE	ETF	Energy broad equity	0.073	3	-0.261	8	0.373	3

The most striking disparity in the Treynor rankings is that USO and OIL are higher ranked in sub period 2 compared to their respective rankings for annualized returns and Sharpe as previously discussed. A higher Treynor ranking is no shock since the energy derivative based ETPs track single commodities which have lower systematic risk than the broad energy equity based securities.

Beta values[25] for the 5 energy derivative based ETPs are lower for all periods. In the whole period; betas for derivative based ETPs are in the range of about 0.7-0.9 while the broad energy equities are in the range of about 1.4-1.6. For sub period 2 the beta values (except for the natural gas ETF UNG) for the energy derivative based ETPs are in the range of 1.0-1.2 while the broad energy equity based beta values are slightly lower than before and in the

[24] Please refer to Appendix A 3, page102, for an overview of the relating energy equity indices of the ETPs..
[25] Please refer to Table 25, page 85, for an overview of the betas for all securities.

range of about 1.3-1.5. That is, when assessing the three periods the WTI related ETPs and the broad energy derivative based DBE have increased systematic risk in sub period 2 while the broad energy equity securities have slightly lowered systematic risk in sub period 2. An investor whom held derivative based commodity ETPs in the portfolio of sub period 1 would have been better diversified than when holding the same ETPs in sub period 2. Especially for sub period 1 the Deutsche Bank‘s ETP products DBE (broad energy futures) and DBO (WTI futures) would have been beneficial since DBE and DBO also has the highest annualized return in sub period 1 compared to the other energy securities.

When assessing the Treynor values of the broad energy ETFs versus the broad energy mutual funds the results are quite similar to what has been found for annualized returns and Sharpe ratios. The energy broad equities are higher ranked than their mutual fund counterparts for the whole period. In sub period 1 there is no tendency of higher Treynor rankings of the energy equity ETPs versus the mutual funds. In sub period 2 however, the broad energy – equity ETPs are ranked high by Treynor’s ratio just like for the whole period.

Once more, the results seem to imply that holding broad energy ETF equities in general would be a preferred choice over holding broad energy mutual funds for the whole period and sub period 2. And again it seems like the more actively managed energy equity mutual funds in the bust period of 2007-2009 was not necessarily a bad choice compared to the more index relating ETF counterparts.

3.2.5 Metal related commodity ETPs and mutual funds – Sharpe ratios

When 'physical deposit' is mentioned in the tables of this metal section it is implying that the fund holds the actual physical gold or silver. The term 'physical(ly)' mentioned elsewhere in the thesis e.g. for the broad commodity and energy selection signifies that a fund invest in commodities by holding futures.

Table 23: Metal related commodity ETPs and mutual funds - Sharpe ratios

Ticker	Type	Investment objective	Whole period 8Jan2007-1Mar2011 SR	Rank	Sub period 1 8Jan2007-27Feb2009 SR	Rank	Sub period 2 2Mar2009-1Mar2011 SR	Rank
DBP	ETF	Gold and silver futures (DBLCI OYPM ER)	0.799	4	0.433	4	1.442	6
IAU	ETF	Gold physical deposit	0.926	1	0.726	2	1.309	9
GLD	ETF	Gold physical deposit	0.925	2	0.729	1	1.294	10
DGL	ETF	Gold futures (DBLCI OYG ER)	0.816	3	0.608	3	1.204	13
SLV	ETF	Silver physical deposit	0.708	5	-0.001	6	1.995	2
DBS	ETF	Silver futures (DBLCI OYS ER)	0.631	6	-0.013	9	1.933	3
DBB	ETF	Industrial metal futures (DBLCI OYIM ER)	0.027	14	-0.104	14	1.471	5
RJZ	ETN	Industrial metal promissory debt	*		*		1.865	4
SGGDX	Mutual	Gold, equity, physical deposit, futures	0.517	7	0.084	5	1.253	11
TGLDX	Mutual	Gold & pr. metal, equity, physical deposit	0.507	8	-0.052	13	2.110	1
FGDAX	Mutual	Gold & pr. metal, equity, physical deposit , futures	0.331	12	-0.013	10	1.088	15
IGDAX	Mutual	Gold & pr. metal, equity, physical deposit	0.365	11	-0.041	11	1.319	8
USAGX	Mutual	Gold & pr. metal, equity	0.430	9	-0.007	7	1.356	7
EKWAX	Mutual	Precious metal equity and debt securities	0.391	10	-0.011	8	1.235	12
BGEIX	Mutual	Gold & pr. metal, equity	0.310	13	-0.041	12	1.159	14

The gold ETFs and the gold & silver ETF DBP of the metal selection are evidently higher ranked by Sharpe ratios than the mutual fund counterparts for the whole period and sub period 1. This should be expected since the precious metal ETPs for those two periods exhibited high returns and low standard deviations versus most of the mutual funds in the analyses of chapter 2. In sub period 2 the silver ETFs SLV and DBS are high ranked as should be expected due to the silver price increases, and it is a bit unexpected that TGLDX manages to get a higher ranking for the period. TGLDX seem to have had a rewarding management of the portfolio for sub period 2, while they are ranked at the bottom of sub period 1 among all the precious metal securities in the selection. The industrial metal ETF DBB is the only security which is ranked lower than TGLDX in sub period 1. Probably TGLDX has an active positioning strategy that makes them prone to exaggerating positive as well as negative results, and TGLDX has one of the lowest beta values of all the mutual funds[26].

IGDAX which is the only mutual fund in the metal selection that has a frontload (5.5%) is not ranked very well, neither compared to the ETFs or several of the other mutual funds.

[26] Please refer to Table 26, page 90, for an overview of all the beta values for the securities

Again it seems like gold ETFs that hold physical deposit, such as IAU, GLD and SLV, are higher ranked than the ETFs that track futures with the optimal yield technology. Deutsche Bank's optimal yield technology when rolling futures seems to have given a competitive advantage in several of the periods for the broad commodity and energy selections but not so for metal. The two physical gold deposit ETFs with tickers IAU and GLD are ranked at 1 and 2 for the whole period and sub period 1 closely followed by DGL. The same three gold ETFs are only ranked at 9, 10 and 13 respectively in sub period 2 due to the silver price increases of that period. The optimal yield silver futures tracker DBS is also ranked slightly lower than the physical deposit ETF SLV.

The most stable performer according to the Sharpe ratio rankings are the gold & silver futures tracker DBP, which also utilize the optimal yield technology from Deutsche Bank. Here the ranking seem to suggest that the optimal yield technology from Deutsche bank may be an advantage compared to the precious metal mutual funds which also has an investment objective in gold & silver.

3.2.6 Metal related commodity ETPs and mutual funds – Treynor ratios

Table 24: Metal related commodity ETPs and mutual funds - Treynor ratios

Ticker	Type	Investment objective	Whole period 8Jan2007-1Mar2011 Treynor	Rank	Sub period 1 8Jan2007-27Feb2009 Treynor	Rank	Sub period 2 2Mar2009-1Mar2011 Treynor	Rank
DBP	ETF	Gold and silver futures (DBLCI OYPM ER)	0.737	4	0.479	4	0.979	4
IAU	ETF	Gold physical deposit	1.245	1	1.206	1	1.208	1
GLD	ETF	Gold physical deposit	1.211	2	1.161	2	1.196	2
DGL	ETF	Gold futures (DBLCI OYG ER)	1.043	3	0.913	3	1.162	3
SLV	ETF	Silver physical deposit	0.402	5	-0.002	6	0.944	5
DBS	ETF	Silver futures (DBLCI OYS ER)	0.366	6	-0.019	8	0.925	6
DBB	ETF	Industrial metal futures (DBLCI OYIM ER)	0.011	14	-0.196	14	0.432	15
RJZ	ETN	Industrial metal promissory debt	*		*		0.569	8
SGGDX	Mutual	Gold, equity, physical deposit, futures	0.247	7	0.044	5	0.523	11
TGLDX	Mutual	Gold & pr. metal, equity, physical deposit	0.220	8	-0.111	13	0.856	7
FGDAX	Mutual	Gold & pr. metal, equity, physical deposit , futures	0.146	12	-0.028	10	0.458	14
IGDAX	Mutual	Gold & pr. metal, equity, physical deposit	0.148	11	-0.093	12	0.485	13
USAGX	Mutual	Gold & pr. metal, equity	0.178	9	-0.016	7	0.532	10
EKWAX	Mutual	Precious metal equity and debt securities	0.166	10	-0.023	9	0.491	12
BGEIX	Mutual	Gold & pr. metal, equity	0.142	13	-0.086	11	0.538	9

The most notable dissimilarity between the Sharpe and Traynor rankings is that the gold related ETFs now are ranked considerably higher for sub period 2. The four gold tracking ETFs are ranked at the top for all periods by Treynor. The silver prices increases made the silver ETFs among the top ranked for the Sharpe values and for annualized returns, but the silver price have beta values of 0.65 for sub period 2, while gold only has a beta of 0.18. As such the gold ETFs are rewarded in Treynor rankings by the low systematic risk of the gold price. Even though the two silver ETFs DBS and SLV have similar beta values to the mutual funds for sub period 2, the high silver prices effectively ranks them higher than all the mutual funds. TGLDX which was the highest Sharpe ratio ranked security in sub period 2 out of all securities in the metal selection is reduced to being ranked at 7. Still though, TGLDX is highest ranked for the mutual funds of that period.

All the beta values for the mutual funds are generally higher for all the periods compared to the precious metal ETFs. This is probably due to the precious metal equities which are held by the mutual funds and the fact that the metal ETFs are narrow trackers constricted either to single or very few commodities. This suggests that the metal ETFs, all with low beta values, should be preferred over the mutual fund counterparts in diversification of the portfolio.

Perhaps the most evident tendency so far in the thesis, when comparing commodity ETPs versus commodity mutual funds, is found by the Treynor ranking for the precious metal selection. The precious metal ETFs are higher ranked by Treynor for all the periods compared to the precious metal mutual funds. The only exception is in sub period 2 where the two silver ETFs SLV and DBS are ranked at 6 and 8 while SGGDX and USAGX is ranked at 5 and 7.

3.3 Conclusions chapter 3

Sharpe ratios of this chapter generally indicate similar results to the annualized ranking results of the previous chapter.

In the comparison of broad commodity ETPs versus mutual funds there are few evident indications that holding a long position in mutual funds is a bad alternative for the investor compared to the ETPs of the same category. Reasons for the unexpectedly few tendencies for broad commodity ETPs versus mutual funds could be that the mutual funds are selected from the top of the Morningstar's ranking and that all the broad commodity securities are utilizing similar derivative based strategies.

For the energy selection the narrow tracking derivative based ETPs have lower beta values than the other securities in the selection, something which could be beneficial in diversification of the portfolio. Also, the broad energy equity based ETPs seem to be a preferred choice over the mutual funds for the whole period and sub period 2. However, in the financial crisis period (sub period 1) the results may suggest that the broad energy equity mutual funds could have benefitted from not having the same type of fixed relation to energy equity indices as the broad energy equity ETPs.

In the choice of the mutual fund or the ETN that is tracking DJ-UBS Commodity Index TR the mutual fund is higher ranked by some of the risk adjusted measures. As such the mutual fund for the investor that wants long exposure to that particular index should probably go for the mutual fund over the ETN, not least to the risk of counterparty default of the ETN. This is contrary to the findings for the S&P GSCI TR related securities, where the ETPs still seem to be a preferred choice.

The most evident result seems to be from the metal selection ranking according to Treynor ratios. Mutual funds tend to have higher systematic risk which they are penalized for in the Treynor rankings compared to the precious metal commodity tracking ETFs.

In the ETF versus ETN comparison the results still seem to suggest that the investor should hold the EFT if there is such an alternative in the exposure strategy, similar to the findings in chapter 2. There seem to be no indication of evident outperformance from the ETN versus the ETF. The rankings seem to suggest that there is minimal risk adjusted performance gain in holding ETNs versus ETFs such as in the choice of exposure to the S&P GSCI total return.

In the physically backed ETF rankings, there seem to be an advantage to the optimal yield technology from Deutsche Bank for the broad commodity and the energy selections. This was also found in chapter 2.

Appendixes chapter 3

Table 25: Beta for all securities

Broad commodity security betas			Whole period		Sub period 1		Sub period 2	
Ticker	Type	Investment objective	8Jan2007-1Mar2011 Beta	Rank	8Jan2007-27Feb2009 Beta	Rank	2Mar2009-1Mar2011 Beta	Rank
GSG	ETF	S&P GSCI TR futures	0.727	6	0.621	6	0.942	9
GSP	ETN	S&P GSCI TR (prommisory debt)	0.742	8	0.635	7	0.956	10
DJP	ETN	DJ-UBS CI TR (prommisory debt)	0.578	3	0.499	3	0.735	3
DBC	ETF	DB LCIOYD ER futures	0.622	4	0.541	4	0.789	4
RJI	ETN	Rogers ICI (prommisory debt)	*		*		0.835	5
CRSAX	Mutual	DJ-UBS CI TR related derivatives	0.524	1	0.439	1	0.694	1
SKNRX	Mutual	Commodity derivatives	0.956	9	0.998	9	0.871	6
PCRAX	Mutual	Commodity derivatives	0.547	2	0.465	2	0.706	2
QRAAX	Mutual	Commodity derivatives	0.735	7	0.661	8	0.882	7
RYMEX	Mutual	S&P GSCI TR related derivatives	0.708	5	0.604	5	0.920	8

Energy security betas			Whole period		Sub period 1		Sub period 2	
Ticker	Type	Investment objective	8Jan2007-1Mar2011 Beta	Rank	8Jan2007-27Feb2009 Treynor	Rank	2Mar2009-1Mar2011 Treynor	Rank
DBE	ETF	Energy broad futures	0.726	1	0.604	1	0.975	2
USO	ETF	WTI futures	0.879	3	0.748	3	1.148	4
OIL	ETN	WTI promissory debt	0.899	4	0.756	4	1.190	5
DBO	ETF	WTI futures	0.778	2	0.652	2	1.038	3
UNG	ETF	Natural gas Futures	*		*		0.495	1
FANIX	Mutual	Energy broad equity	1.610	14	1.669	14	1.502	15
IENAX	Mutual	Energy broad equity	1.449	9	1.482	9	1.394	11
IEYAX	Mutual	Energy broad equity	1.353	5	1.344	6	1.381	7
RYEIX	Mutual	Energy broad equity	1.490	11	1.542	11	1.393	10
WEGAX	Mutual	Energy broad equity	1.407	8	1.421	7	1.389	8
PXE	ETF	Energy broad equity	1.468	10	1.501	10	1.408	12
IEO	ETF	Energy broad equity	1.536	12	1.569	12	1.481	14
XOP	ETF	Energy broad equity	1.557	13	1.605	13	1.470	13
PXI	ETF	Energy broad equity	1.385	7	1.425	8	1.308	6
RYE	ETF	Energy broad equity	1.355	6	1.340	5	1.391	9

Metal security betas			Whole period		Sub period 1		Sub period 2	
Ticker	Type	Investment objective	8Jan2007-1Mar2011 Beta	Rank	8Jan2007-27Feb2009 Treynor	Rank	2Mar2009-1Mar2011 Treynor	Rank
DBP	ETF	Gold and silver futures (DBLCI OYPM ER)	0.273	4	0.266	4	0.289	4
IAU	ETF	Gold physical deposit	0.168	1	0.161	1	0.187	2
GLD	ETF	Gold physical deposit	0.173	2	0.167	2	0.188	3
DGL	ETF	Gold futures (DBLCI OYG ER)	0.178	3	0.178	3	0.181	1
SLV	ETF	Silver physical deposit	0.653	5	0.652	5	0.653	5
DBS	ETF	Silver futures (DBLCI OYS ER)	0.661	6	0.663	7	0.653	6
DBB	ETF	Industrial metal futures (DBLCI OYIM ER)	0.801	8	0.660	6	1.079	15
RJZ	ETN	Industrial metal promissory debt	*		*		0.855	12
SGGDX	Mutual	Gold, equity, physical deposit, futures	0.717	7	0.744	8	0.666	7
TGLDX	Mutual	Gold & pr. metal, equity, physical deposit	0.923	9	1.003	9	0.757	8
FGDAX	Mutual	Gold & pr. metal, equity, physical deposit , futures	1.007	10	1.121	10	0.785	9
IGDAX	Mutual	Gold & pr. metal, equity, physical deposit	1.072	13	1.165	12	0.888	13
USAGX	Mutual	Gold & pr. metal, equity	1.133	14	1.255	14	0.896	14
EKWAX	Mutual	Precious metal equity and debt securities	1.040	11	1.140	11	0.845	11
BGEIX	Mutual	Gold & pr. metal, equity	1.051	12	1.171	13	0.815	10

References chapter 3

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Chapter 4: Tracking errors for the commodity ETP

Summary chapter 4

The passive, unleveraged, non-inverse commodity based ETPs seem to be reliable trackers of their benchmarks. There are some exceptions, such as the WTI tracker USO (ETF) and the natural gas front month tracker UNG (ETF). USO and UNG have very high tracking errors probably due to severe contango futures markets.

Keywords: Tracking errors, commodity ETPs.

4.0 Introduction

In this chapter I am assessing the tracking errors to the underlying indices of the broad commodity, the energy commodity and the metal commodity selections of ETPs. Mutual funds that were included in previous chapters are not included here since the mutual funds do not passively track an index the way the commodity ETPs do. The broad energy equity ETFs that were included in previous chapters to improve the energy mutual fund versus ETP comparison are therefore also not included here.

Tracking error is the deviation from the benchmark a specific index ETP is set up to follow. In analyzing if the ETPs actually are tracking their indices I will use two different methods. One that measure tracking errors by OLS regression, while the other measures tracking error by subtracting the return of the benchmark index to the ETP.

It is essential to the credibility of the passive index tracking ETPs of this thesis that they track the benchmark reasonably well. If not the investor could probably just as well look for other alternatives for exposure to the particular asset class an ETP is supposedly tracking.

Another matter that may be interesting in this chapter is to further explore the difference between ETPs and ETNs. ETN’s are generally supposed to have lower tracking errors than ETF’s. This is due to the unsecured promissory debt structure of ETN’s where the return of the benchmark is not physically replicated, and as such it does not have operational cost due to e.g. the roll yield of futures which are corroding the net asset value of ETFs. One should also expect to find that ETNs have lower tracking error, not least because the ETN is vulnerable to default from the issuer as discussed e.g. in chapter 2. If the ETN do not really have a lower tracking error, it is perhaps not any point in investing in an ETN if there is a viable ETF option.

4.1 Data for the analyses of chapter 4

The data for ETP price series are from Yahoo Finance and are the same price series as in the previous chapters except for IAU, GLD and SLV. For IAU and GLD which track the London gold afternoon fixings I am using the open price instead of the adjusted close price. Likewise for SLV which track the London Silver Fix. This is done since there is a shorter time span between the London fixings and the opening of NYSE Arca, compared to the closing time of NYSE Arca. The tracking errors are also smaller when using the opening prices of IAU, GLD and SLV instead of the closing prices, which is natural due to a shorter time period between the price observations of the securities versus the London fixings. Any dividends and splits are accounted for in the open prices of those ETPs.

As discussed in the general considerations on data in section 2.1, page 38, freely available price series from Yahoo may not have the same reliability as data from a commercial provider. The results from this chapter should have a ‘safer’ validity due to two reasons. It is not so complicated to check that splits/dividends are reasonable accounted for in the adjusted close prices for the short lived ETPs which are isolated in this chapter. Also, the benchmark price series used to analyze tracking errors are downloaded from different sources than Yahoo. I assume it is easier to discover errors in the ETP price series from Yahoo or the benchmark price indices if there were something wrong in either one of them. I have found some discrepancies in the case of UNG and USO as discussed under the energy ETP section of this chapter, but those discrepancies could also be due to actually high tracking errors and not price series data errors.

The periodization of the data is the same as in earlier chapters, and is described in the introduction or the heading of every table. Please refer to Appendix A 1 at page 105 for a list of ETP names and the sources for the benchmark indices of this chapter.

4.2 Method

4.2.1 Measuring tracking errors by OLS regression

A standard type of linear ordinary least square (OLS) regression is applied for the first method in analyzing tracking error as:

Equation 13: OLS regression

$$(return\ for\ ETP)_i = \alpha + \beta(return\ for\ \text{the}\ benchmark\ index\ of\ the\ ETP)_i + e_i$$

$$H_0: \alpha = 0\ and\ \beta = 1 \qquad H_A: \alpha \neq 0\ and\ \beta \neq 1$$

The OLS regression is performed over daily, weekly and monthly returns to check for possible deviations to the benchmark when utilizing different return frequencies. Beta should optimally be 1 and alpha should be 0 since the ETPs that are analyzed are passive, unleveraged, non-inverse trackers of a benchmark index. The passive tracker should not normally yield any alpha performance compared to the index, but it is expected that the alpha might be slightly lower than 0 due to e.g. operational and management cost. A standard OLS regression such as the one above should be suitable when measuring unleveraged, non-inverse index trackers like commodity ETPs of chapter 2 and 3. The OLS regression may not be suitable in measuring bull/and bear index trackers, like I have discussed in the background chapter in section 1.8, page 22.

The residuals of the OLS regression from the Durbin-Watson d test show that almost all the return series of the ETPs have autocolleration characteristics over daily, weekly and monthly returns:

Equation 14: Durbin-Watson d test

$$DW = \frac{\sum_{t=2}^{n}(e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2}$$

To address the issue of autocolleration HAC standard errors from OLS regression of the PCGive software are used to increase robustness of t-tests of significance. That is, when DW values imply autocolleration on a 1% or at least a 5% significance level, I am using

HACSE[27]. If the d values signify autocorrelation above 5% I am using the standard errors from the OLS regression.

In the tables from the OLS regressions the symbol ● indicates significant rejection of the null hypothesis on a 5% level, while ●● rejects the null on a 1% level.

4.2.2 Measuring tracking errors by deviation in returns to the benchmark

Equation 15: Tracking error (T.E) as the negative/positive annualized excess return of an ETP over the index

$$T.E. = Geo. annualized\ periodic\ ETP\ return\ - Geo. annualized\ periodic\ benchmark\ return$$

The tracking errors of the equation above are utilizing weekly returns compared to the daily returns of chapter 2. In effect this adds some small differences to the measured annualized geometric returns of this chapter versus chapter 2.

The equation above is a straight forward method which is similar to the one used by Morgan Stanley Smith Barney (MSSB-Research 2011). MSSB has an extensive yearly listing of all the ETFs in the US market, and they update the reporting once a year by adding the tracking error of the previous year. I haven't found the exact equation that MSSB are utilizing, but they seem to list the absolute value of the excess return in the equation above over daily returns. I find it easier and also interesting to read the tracking error when it indicates if the excess return was negative or positive. Also, when MSSB list tracking error they do it on an annual basis, while I am annualizing the tracking errors over the chosen periods for this thesis.

[27] Heteroscedasticity and Autocorrelation Consistent Standard Errors

4.3 Tracking error for the commodity ETPs

4.3.1 Broad commodity ETPs - Tracking error

The table below lists the results from measuring tracking errors by OLS. The ETP is the dependent variable while the index is the independent variable. All the t-values are calculated by HACSE, except for DBC and RJI over monthly returns[28]. RJI is measured over Sub period 2 (2 Mar 2009–1 Mar 2011) since it only has data for that period. All the other data are measured over the whole period (8 Jan 2007-1 Mar 2011)

Table 26: Broad commodity ETPs - tracking error by OLS

			Daily returns			Weekly returns			Monthly returns		
Name	Index	Period	α	β	R^2	α	β	R^2	α	β	R^2
GSG (ETF)	S&P GSCITR	Whole period	-0.00001	0.952	0.845	-0.00013	0.981	0.954	-0.00063	1.003	0.987
			(-0.07)	(-2.03)●		(-0.421)	(-0.614)		(-0.797)	(0.134)	
GSP (ETN)	S&P GSCITR	Whole period	-0.00002	0.988	0.931	-0.00012	1.008	0.985	-0.00060	1.015	0.998
			(-0.26)	(-0.84)		(-0.687)	(0.382)		(-1.858)	(3.035)●●	
DJP (ETF)	DJ-UBS CITR	Whole period	-0.00002	1.013	0.937	-0.00013	1.024	0.987	-0.00070	1.021	0.999
			(-0.49)	(1.17)		(-1.184)	(1.730)		(3.303)●●	(4.452)●●	
DBC (ETF)	DB LCIOYDER	Whole period	0.00007	0.928	0.846	0.00023	0.998	0.962	0.00061	1.001	0.995
			(0.00)	(-3.80)●●		(0.886)	(-0.080)		(0.862)	(0.131)	
RJI (ETN)	Rogers ICI	Sub period 2	0.00001	0.990	0.888	-0.00001	0.987	0.957	0.00050	0.942	0.966
			(0.033)	(-0.341)		(-0.031)	(-0.388)		(0.258)	(-1.530)	

R^2 values are increasing over daily to weekly to monthly returns, which is natural since daily a high return frequency add more noise to the OLS regression than lower measuring frequencies. All the R^2 values are high which should be expected.

When measuring over daily return GSG's beta of 0.952 is rejected at a 5% significance level while DBC's beta of 0.928 is rejected at a 1% significance level. The beta values are not rejected over weekly returns, while over monthly returns betas of GSP and DJP are rejected at a 1% significance level. As such the GSP (ETN) has a greater tracking error to the other S&P GSCI TR tracker GSG (ETF) which not is rejected over monthly returns, something which is a bit surprising. However, the beta values of both GSP (ETN) and GSG (ETF) are very close to each other, and the R^2 values are higher for all measuring frequencies for the ETN, which suggest that S&P GSCI TR has a higher explanatory power to the returns of GSP (ETN) than to GSG (ETF). It seems like the return difference of the whole period between

[28] Please refer to Table 32, page 98, for a complete list of the Durbin Watson values for all the ETPs and the number of return observations of each ETP and its benchmark index. All the indices names and sources for data are listed in Appendix A 1, page 100.

GSP and GSG are so small that it may not matter to an investor who wants to exposure to S&P GSCI TR. Like I've mentioned several times earlier in the thesis it seems like an investor should probably, due to the counterparty risk of an ETN, prefer to use GSG (ETF) over GSP (ETN). The other ETN of the selection is RJI is measured over a shorter period than the other ETPs of the selection. It is a bit surprising that RJI has a lower beta and R^2 values, but RJI should not be directly compared to the others in the table above due to the difference in measuring periods. Nevertheless, in the table below where all the securities are listed over the same periods, show that RJI actually has a relatively high tracking error in terms of differences to returns from the benchmark index. RJI also has the highest return to the investor among the broad commodity index trackers for sub period 2.

For daily returns the alpha values are very small, and although DBC and RJI's alpha value are slightly positive it probably has no economic significance. Strictly interpreted the alpha values are the return of the ETP when the return of the benchmark is zero. Low alpha values are as expected. DJP's alpha level of -0.007 rejects the null at a 1% level, but still the alpha level is very small. There are no spectacular findings in the table above.

The next table measures the tracking error with differences to the benchmark in terms of annualized returns. There are some small differences in the table below compared to annualized returns of Table 4 on page 49 because the latter is measured over daily return data while this one is measured over weekly returns.

Table 27: Broad commodity ETPs - tracking error by annualized return differences to the benchmark

		Whole period			Sub period 1			Sub period 2		
Name	Index	8Jan2007 -1Mar2011			8Jan2007 - 27Feb2009			2Mar2009 - 1Mar2011		
		ETP	Index	T.E.	ETP	Index	T.E.	ETP	Index	T.E.
GSG (ETF)	S&P GSCITR	-0.33 %	0.42 %	-0.75 %	-18.57 %	-18.29 %	-0.28 %	23.65 %	25.13 %	-1.48 %
GSP (ETN)	S&P GSCITR	-0.25 %	0.42 %	-0.68 %	-19.65 %	-18.29 %	-1.36 %	25.61 %	25.13 %	0.48 %
DJP (ETF)	DJ-UBS CITR	2.14 %	2.87 %	-0.73 %	-15.90 %	-14.57 %	-1.33 %	25.67 %	25.42 %	0.25 %
DBC (ETF)	DB LCIOYDER	7.52 %	6.37 %	1.15 %	-6.90 %	-8.80 %	1.90 %	25.38 %	25.35 %	0.02 %
RJI (ETN)	Rogers ICI							32.64 %	33.30 %	-0.66 %

The largest tracking error is found in sub period 2 for GSG (-1.48). This may indicate that the GSP (ETN) which is about 2% higher than GSG (ETF) for the same period actually may be worthwhile in the alternative over which one to choose in exposure to the S&P GSCI TR. In sub period 1 the tracking error is nevertheless actually larger for GSP (ETN) than for GSG (ETF) which is contradictory to what is expected by an ETN over an ETF that track the same index. This may suggests once more that the investor should prefer GSG over GSP due to ETN counterparty risk, and that there is not much difference in those who when it comes to return performance.

The largest tracking error for the whole period and for sub period 1 is found for DBC. The tracking error is positive though, so the tracking error should come as a gratifying message to the investor. DBC is the only ETP among the broad commodity securities that have a positive excess return to the benchmark for all periods. Again it seem like the optimal yield technology of Deutsche Bank is a sensible choice for broad commodity selection.

4.4 **Energy commodity based ETPs – Tracking error by OLS**

The table below lists the results from measuring tracking errors by OLS for the energy related ETPs. All the t-values are calculated by HACSE[29]. UNG is measured over Sub period 2 (2 Mar 2009-1 Mar 2011) since it only has data for that period. All the other ETPs are measured over the whole period (8 Jan 2007-1 Mar 2011):

Table 28: Energy ETPs - tracking error by OLS

			Daily returns			Weekly returns			Monthly returns		
Name	Index	Period	α	β	R^2	α	β	R^2	α	β	R^2
DBE (ETF)	br. energy DB OYE ER	Whole period	0.00005	0.973	0.900	0.00013	0.979	0.979	0.00001	1.003	0.994
			(0.50)	(-2.74)●●		(-0.539)	(-1.438)		(0.011)	(0.316)	
USO (ETF)	WTI spot futures	Whole period	-0.00058	0.767	0.772	-0.00288	0.755	0.806	-0.01267	0.865	0.866
			(-2.09)●	(-4.88)●●		(-2.11)●	(-3.648)●●		(-1.971)	(-2.24)●	
OIL (ETN)	WTI by S&P GSCICO TR	Whole period	-0.00004	0.934	0.914	-0.00022	0.976	0.980	-0.00067	1.020	0.997
			(-2.01)●	(-1.15)		(-0.660)	(-0.888)		(-1.737)	(3.292)●●	
DBO (ETF)	WTI by DBCI OYCO ER	Whole period	0.00005	0.912	0.890	0.00014	0.947	0.978	0.00039	0.993	0.996
			(1.39)	(-2.55)●		(0.468)	(-2.361)●		(0.723)	(-1.249)	
UNG (ETF)	Nat.gas spot futures	Sub period 2	-0.00232	0.630	0.700	-0.0109	0.728	0.770	-0.04673	0.607	0.662
			(-3.627)●●	(-4.413)●●		(-3.66)●●	(-3.022)●●		(-3.663)●●	(-2.770)●	

The energy derivative based ETPs in the table have a greater diversity in the test results compared to the broad commodity selection in the previous section. The tendency of increasing R^2 values when measuring over lower return frequencies are the same except for UNG which has a lower R^2 value over monthly returns than over both daily and weekly. UNG is also significantly different from the null hypothesis of alpha =0 and beta = 1 for all the periods. When it comes to tracking WTI, it seems like the OIL (ETN) have a slight advantage over DBO (ETF) in that DBO has a 5% significantly rejection of the beta null

[29]Please refer to Table 32, page 98, for a complete list of the Durbin Watson values for all the ETPs and the number of return observations of each ETP and its benchmark index. All the indices names and sources for data are listed in Appendix A 1, page 100.

hypothesis over daily and weekly returns. Nevertheless OIL (ETN) also rejects the null hypothesis over monthly returns at 1% level of significance. The two are really not comparable in terms of annualized returns though as shown in the ETP column of the table below. DBO follows Deutsche Bank's optimal yield indices when tracking WTI while OIL tracks WTI by the S&P GSCI Crude Oil Total return Index and DBO.

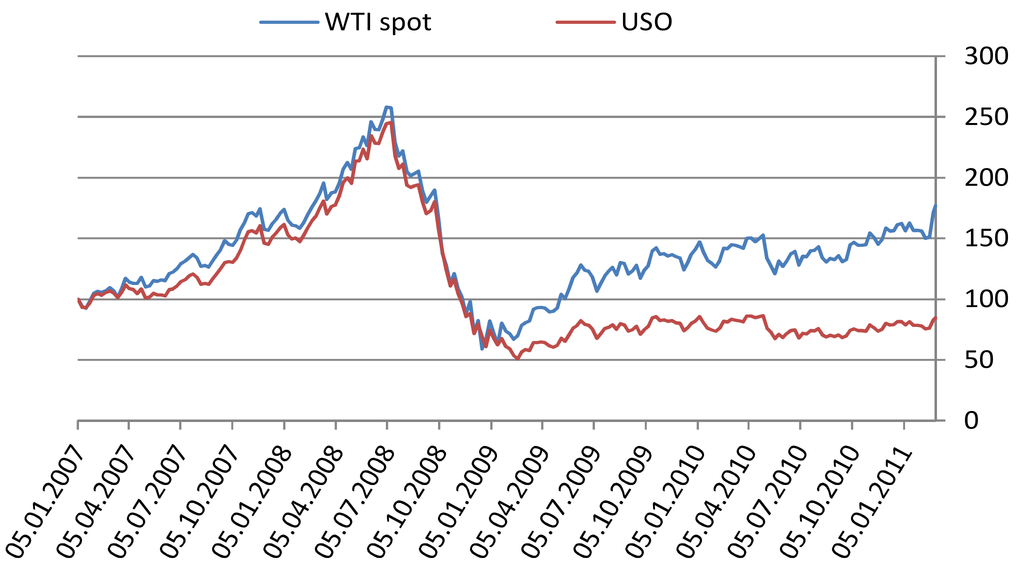
The energy related ETPs has beta values that are relatively close to 1 except for USO and UNG which track front month futures for WTI and natural gas respectively. In the table below the large tracking error of those two ETFs are confirmed

Table 29: Energy commodity ETPs - tracking error by annualized return differences to the benchmark

Name	Index	Whole period 8Jan2007 -1Mar2011			Sub period 1 8Jan2007 - 27Feb2009			Sub period 2 2Mar2009 - 1Mar2011		
		ETP	Index	T.E.	ETP	Index	T.E.	ETP	Index	T.E.
DBE (ETF)	br. energy DB OYE ER	6.53 %	5.93 %	0.60 %	-10.91 %	-12.12 %	1.21 %	28.90 %	29.30 %	-0.40 %
USO (ETF)	WTI spot futures	-3.92 %	14.66 %	-18.58 %	-23.25 %	-10.67 %	-12.58 %	22.10 %	49.64 %	-27.54 %
OIL (ETN)	WTI by S&P GSCICO TR	-6.33 %	-5.50 %	-0.83 %	-27.68 %	-25.74 %	-1.94 %	23.43 %	22.19 %	1.25 %
DBO (ETF)	WTI by DBCI OYCO ER	6.91 %	6.26 %	0.65 %	-11.19 %	-12.10 %	0.91 %	30.31 %	30.09 %	0.21 %
UNG (ETF)	Natural gas spot futures							-45.00 %	-3.97 %	-41.03 %

The investment objective of USO is to track WTI spot as represented by the WTI futures trading on NYMEX. The strong contango market in 2009 seem to have inflicted a very high roll yield for OIL

Figure 12: Severe contango – negative roll yield of USO (based at 100, 5 Jan 2007)



UNG had even higher tracking errors than USO in sub period 2, also due to negative roll yield as far as I can understand. UNGs investment objective is similar to that of USO, in that UNG track the natural gas delivered at the Henry Hub of Louisiana, as measured by front month futures at NYMEX.

The tracking errors of UNG and USO may be extreme and erroneous, and the annual tracking errors according to Morgan Stanley Barney Smith (MSSB-Research 2011) seem to be smaller.

However, there have been several comments on UNG and OIL on various retail investor related internet sites on the issue of their low tracking compared to their expected indices price increases. I will add one here from SeekingAlpha (Johnston 2010) although this probably not is a traditional reference source for an academic paper.

I have attempted to double check the calculations I have done on the data from the US Energy Information Administration. There could e.g. be a measuring error in that when I utilize the historical data, and when the front month futures in the historical data series expires, I switch over to the next front month future. UNG and on the other hand roll to the next futures sometime in the 14 days prior to expiration. UNG and USO are also one of the ETP issuers, unequal to e.g. Deutsche Bank or iPath, that doesn't seem to publish the historical data of the indices they are tracking. If nothing else, it seems like UNG and USO not are tracking the front month futures very well in severe contango markets. At least this is a is point of notice for the investors who wants exposure to the spot prices of WTI and natural gas as measured by the front month which is closest to expiration.

When comparing the WTI tracker ETN (OIL) to the other WTI trackers there is an obvious disparity between OIL and USO, probably to the negative front month roll yield cost incurred by USO. However, when comparing the ETN (OIL) to the other WTI futures tracker ETF (DBO) there is no evident tendency. DBO has smaller tracking errors in absolute terms for all periods than what is the case for OIL, but there are only small differences in the tracking ability.

4.5 Metal commodity based ETPs – Tracking error by OLS

The table below lists the results from measuring tracking errors by OLS for the metal related ETPs. All the t-values are calculated by HACSE[30], except for GLD, DGL and DBS over monthly returns. RJZ is measured over Sub period 2 (2 Mar 2009-1 Mar 2011) since it only has data for that period. All the other ETFs are measured over the whole period of (8 Jan 2007-1 mar 2011)

Table 30: Metal ETPs - tracking error by OLS

			Daily returns			Weekly returns			Monthly returns		
Name	Index	Period	α	β	R^2	α	β	R^2	α	β	R^2
DBP (ETF)	Gold and silver futures (DBLCI OYPM ER)	Whole period	0.00013	0.897	0.730	0.00020	0.976	0.972	0.00063	0.978	0.989
			(1.17)	(-2.49)●		(0.515)	(-1.390)		(0.978)	(-1.043)	
IAU (ETF)	Gold physical deposit	Whole period	0.00007	0.905	0.768	-0.00005	0.992	0.956	0.00014	0.979	0.989
			(0.83)	(-4.19)●●		(-0.231)	(-0.382)		(0.295)	(-1.144)	
GLD (ETF)	Gold physical deposit	Whole period	0.00009	0.884	0.754	0.00002	0.973	0.951	0.00031	0.967	0.986
			(0.97)	(-5.18)●●		(0.076)	(-1.228)		(0.280)	(-1.996)	
DGL (ETF)	Gold futures (DBLCI OYG ER)	Whole period	0.00013	0.878	0.716	0.00029	0.946	0.966	0.00086	0.966	0.994
			(1.28)	(-2.89)●●		(1.559)	(-2.466)●		(1.194)	(-3.014)●●	
SLV (ETF)	Silver physical deposit	Whole period	0.00029	0.746	0.632	0.00017	0.988	0.919	0.00007	0.963	0.977
			(1.15)	(-11.89)●●		(0.930)	(-0.547)		(0.151)	(-2.015)●	
DBS (ETF)	Silver futures (DBLCI OYS ER)	Whole period	0.00017	0.895	0.762	0.00026	0.972	0.976	0.00063	0.991	0.993
			(1.11)	(-2.49)●		(1.374)	(-1.282)		(0.504)	(-0.803)	
DBB (ETF)	Industrial metal futures (DBLCI OYIM ER)	Whole period	0.00006	0.995	0.835	0.00020	1.036	0.947	0.00032	1.014	0.991
			(1.76)	(-2.23)●		(0.566)	(2.012)●		(0.436)	(1.848)●	
RJZ(ETN)	Industrial metal promissory debt	Sub period 2	0.00010	0.957	0.802	0.00002	1.006	0.937	-0.00035	0.980	0.963
			(0.587)	(-1.512)		(0.043)	(0.356)		(-0.256)	(-0.613)	

Especially the precious metal ETFs of the selection seem to have lower beta values when measured over daily returns compared to the broad commodity and the energy selection[31]. Also the R^2 values for the daily returns are relatively small when considering that these ETPs are passive index trackers. R^2 increases over weekly to monthly returns and the indices have very high explanatory power to the returns of the ETPs as expected.

All the daily return beta values for the precious metal ETPs of the whole period are rejected at least at a 5% level. Reasons for this could be measuring errors. For example to the gold and silver London fixing prices for IAU, GLD and SLV although I have tried to account for that by using an adjusted opening price as explained under the method section 4.1, page 92. Also the precious metal futures trackers have similarly low beta values over daily returns, so there could also be other reasons, such as volatile intraday price movements in the highly liquid

[30] Please refer to Table 32, page 98, for a complete list of the Durbin Watson values for all the ETPs and the number of return observations of each ETP and its benchmark index. All the indices names and sources for data are listed in Appendix A 1, page 100..

[31] Except for the two energy ETFs with suspiciously large tracking errors (USO and UNG).

precious metal market, or that daily returns adds more noise to the OLS regression. All the alpha values of the table above are very low as expected, and none of them are rejected at the chosen significance levels for any of the measuring frequencies.

The metal selection ETPs all seem to be tracking the indices quite well when measured over weekly and monthly returns. Only DGL, the gold futures tracker, and DBB, the industrial metal tracker, have beta values that are rejected at a significance level of 5% over weekly returns. Similar over monthly returns, DGL's beta is rejected at a 1% level while DBB's beta still only is rejected at a 5% level. Over monthly returns also the beta of the silver physical deposit ETF SLV is significantly rejected, but only at a 5% level. Beta values for all the precious metal ETFs are all slightly lower than 1 for weekly and monthly returns. There are greater disparities in the broad commodities and energy selection, where some beta values are also slightly over 1. One could speculate in that the precious metal ETPs tend to lag a bit behind the indices, e.g. in that the ETP price tend to move upward a little bit slower if the precious metal indices increases and vice versa. I haven't checked that hypothesis by trying to lag ETP prices by a day or so to the indices, but there might be a possible opening for further exploration in that area.

In measuring tracking errors by excess returns the results have evident tendencies similar to when measuring with OLS regressions.

Table 31: Metal commodity ETPs - tracking error by annualized return differences to the benchmark

		Whole period			Sub period 1			Sub period 2		
Name	Index	8Jan2007 -1Mar2011			8Jan2007 - 27Feb2009			2Mar2009 - 1Mar2011		
		ETP	Index	T.E.	ETP	Index	T.E.	ETP	Index	T.E.
DBP(ETF)	Gold and silver futures (DBLCI OYPM ER)	21.63 %	20.93 %	0.70 %	15.59 %	13.68 %	1.91 %	28.42 %	29.17 %	-0.76 %
IAU(ETF)	Gold physical deposit	22.48 %	22.48 %	-0.01 %	22.19 %	23.00 %	-0.81 %	22.78 %	21.93 %	0.85 %
GLD(ETF)	Gold physical deposit	22.44 %	22.48 %	-0.05 %	22.18 %	23.00 %	-0.82 %	22.71 %	21.93 %	0.78 %
DGL(ETF)	Gold futures (DBLCI OYG ER)	20.14 %	19.40 %	0.73 %	19.12 %	17.18 %	1.94 %	21.23 %	21.82 %	-0.59 %
SLV(ETF)	Silver physical deposit	27.77 %	26.94 %	0.83 %	2.63 %	1.84 %	0.78 %	61.42 %	60.57 %	0.85 %
DBS(ETF)	Silver futures (DBLCI OYS ER)	25.70 %	24.77 %	0.93 %	0.10 %	-1.03 %	1.13 %	60.26 %	59.75 %	0.51 %
DBB(ETF)	Industrial metal futures (DBLCI OYIM ER)	2.54 %	1.85 %	0.69 %	-26.66 %	-28.33 %	1.67 %	46.60 %	48.15 %	-1.56 %
RJZ(ETN)	Industrial metal promissory debt							48.59 %	48.34 %	0.25 %

All the metal selection tracking errors are lower than 2 percent for all the tree periods. When sub period 1 and 2 which has very different market mood characteristics are combined and tracking errors are measured over the whole periods, the annualized return tracking errors are all closer than 0.7% to the index. All in all the metal ETPs are very reliable index trackers according to the periods analyzed above. The industrial metal ETN (RJZ) is tracking slightly better for sub period 2 than the industrial metal futures holding ETF (DBB).

4.6 Conclusions chapter 4

In the periods analyzed in this chapter the index tracking ETPs in general seem to be reliable trackers of their benchmark. It is only passive, unleveraged, non-inverse commodity based ETPs that are analyzed. There are some exceptions in the ETP selections, such as the WTI front month futures tracker USO (ETF) and the natural gas front month tracker UNG (ETF). USO and UNG have very high tracking errors according to the results. There seem to be a challenge for front month ETF trackers when there are severe contango markets, and the next front month future which is rolled over to is higher priced than the expiring futures. However, the tracking errors of UNG and USO are suspiciously high, and there might be erroneous assumptions in the way I have calculated tracking error for those two ETPs. Tracking errors for UNG and USO from Morgan Stanley Smith Barney Research seems to be contradicting to the results of this thesis, but there also seem to be support for my results from individuals on retail investor related websites that report and describe high tracking errors.

There is not any evident higher tracking ability for the ETN than the ETF when measuring with market price series for those securities. This is somewhat unexpected since the ETN in nature promise the return of the underlying indices. A promissory index return from an ETN such as GSP or OIL might be more advantageous to authorized participants which can trade directly with the ETN at net asset value, than for retail investors who are trading the ETN at market prices. The tracking error analyses seem to suggest that the ETN might in some cases even have greater tracking errors than ETF counterparts that track the equal or similar commodities.

In the choice of ETFs that track energy and broad commodities there seem to be indications that the optimal yield technology when rolling futures, as provided by Deutsche Bank, are a good choice for the investor. However, when it comes to precious metals, the optimal yield technology seems for some of the periods analyzed to be slightly outperformed by physical deposit ETFs.

Appendixes chapter 4

Table 32: Durbin-Watson values from OLS tracking error analyses

		Daily	(n=)	Weekly	(n=)	Monthly	(n=)
DBC	Whole period	2.82(●●)	1036	2.78(●●)	217	2.22	49
GSG	Whole period	2.85(●●)	1045	3.22(●●)	217	2.97(●●)	49
GSP	Whole period	3.07(●●)	1045	2.88(●●)	217	2.77(●●)	49
DJP	Whole period	3.03(●●)	1045	2.83(●●)	217	2.66(●)	49
RJI	Sub period 2	2.97(●●)	505	2.89(●●)	105	2.49	24
DBE	Whole period	2.85(●●)	1037	2.74(●●)	217	2.60(●)	49
USO	Whole period	2.36(●●)	1045	2.43(●●)	217	1.29(●●)	49
OIL	Whole period	3.04(●●)	1045	3.11(●●)	217	3.01(●●)	49
DBO	Whole period	2.95(●●)	1045	2.77(●●)	217	2.92(●●)	49
UNG	Sub period 2	2.26(●●)	501	2.44(●)	105	1.26(●)	24
DBB	Whole period	2.90(●●)	1037	2.97(●●)	217	2.74(●●)	49
DBP	Whole period	3.05(●●)	1037	3.06(●●)	217	2.61(●)	49
IAU	Whole period	2.80(●●)	1020	2.90(●●)	217	2.77(●●)	49
GLD	Whole period	2.94(●●)	1020	2.93(●●)	217	2.49	49
DGL	Whole period	3.08(●●)	1037	2.91(●●)	217	2.24	49
SLV	Whole period	2.88(●●)	1028	2.98(●●)	217	2.92(●●)	49
DBS	Whole period	3.10(●●)	1037	2.81(●●)	217	2.44	49
RJZ	Sub period 2	2.80(●●)	505	2.44(●●)	105	2.84(●)	24

References chapter 4

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MSSB-Research. (2011). *Morgan Stanley Smith Barney Research - 2011 review of US listed ETFs*. Available at: http://www.vanguardinformation.com/pdf/mssbreport.pdf (accessed: 04.04.2011).

General appendixes for the thesis

Appendix A 1: List of commodity derivative and deposit based ETPs

BROAD COMMODITIES

Name	Ticker	Type	Website
PowerShares DB Commodity Index Tracking Fund	DBC	ETF	http://www.dbfunds.db.com/dbc/index.aspx
DBIQ Optimum Yield Diversified Commodity Index Excess Return™		Index	https://index.db.com/dbiqweb2/index/dblci_dbc_benchmark_index
iShares S&P GSCI Commodity-Indexed Trust	GSG	ETF	http://us.ishares.com/product_info/fund/overview/GSG.htm
S&P GSCI Total Return Index		Index	Downloaded from iShares GSG website (the link above)
iPath S&P GSCI Total Return Index	GSP	ETN	http://www.ipathetn.com/GSP-overview.jsp
S&P GSCI Total Return Index		Index	Downloaded from iPath's GSP website (the link above)
iPath Dow Jones-UBS Commodity Index Total Return	DJP	ETN	http://www.ipathetn.com/DJP-overview.jsp
Dow Jones-UBS Commodity Index Total Return		Index	http://www.djindexes.com
Elements Rogers International Commodity Index Total Return	RJI	ETN	https://www.elementsetn.com/RICI-Total-Return-ETN.aspx
Rogers International Commodity Index (RICI)		Index	http://www.rogersrawmaterials.com/dailyupdate.asp

ENERGY

Name	Ticker	Type	Website
PowerShares DB Energy Fund	DBE	ETF	http://www.dbfunds.db.com/dbe/index.aspx
DBIQ Optimum Yield Energy Index Excess Return		Index	https://index.db.com/dbiqweb2/index/dblci-oy_energy
United States Oil Fund	USO	ETF	http://www.unitedstatesoilfund.com/
WTI spot. Cushing Oklahoma		Index	http://www.eia.doe.gov/dnav/pet/pet_pri_spt_s1_d.htm
iPath S&P GSCI Crude Oil Total Return Index	OIL	ETN	http://www.ipathetn.com/OIL-overview.jsp
S&P GSCI Crude Oil Total Return Index		Index	Downloaded from iPath's OIL website (the link above)
PowerShared DB Oil Fund	DBO	ETF	http://dbfunds.db.com/dbo/index.aspx
DBIQ Optimum Yield Crude Oil Index Excess Return		Index	https://index.db.com/dbiqweb2/index/dblci-oy_cl_wti_sweet_light
United States Natural Gas Fund	UNG	ETF	http://www.unitedstatesnaturalgasfund.com/
Natural Gas Near Month. Henry Hub, Louisiana (*)		Index	http://www.eia.doe.gov/dnav/ng/ng_pri_fut_s1_d.htm

METAL

Name	Ticker	Type	Website
PowerShares DB Precious Metals Fund	DBP	ETF	http://www.dbfunds.db.com/dbp/index.aspx
DBIQ Optimum Yield Precious Metals Index Excess Return		Index	https://index.db.com/index/dblci-oy_precious_metals
iShares Gold Trust	IAU	ETF	http://us.ishares.com/product_info/fund/overview/IAU.htm
Gold London Afternoon Fix (GOLDLNPM)		Index	http://www.bundesbank.de/statistik/statistik.php
SPDR Gold Shares	GLD	ETF	http://www.spdrgoldshares.com/sites/us/shares/
London Gold Afternoon Fix (GOLDLNPM)		Index	http://www.bundesbank.de/statistik/statistik.php
PowerShares DB Gold Fund	DGL	ETF	http://dbfunds.db.com/dgl/index.aspx
DBIQ Optimum Yield Gold Index Excess Return		Index	https://index.db.com/dbiqweb2/index/dblci-oy_gc_gold
iShares Silver Trust	SLV	ETF	http://us.ishares.com/product_info/fund/overview/SLV.htm
London Silver Fix (SLVRLN)		Index	http://www.lbma.org.uk/pages/index.cfm
PowerShares DB Silver Fund	DBS	ETF	http://dbfunds.db.com/dbs/index.aspx
DBIQ Optimum Yield Silver Index Excess Return		Index	https://index.db.com/index/dblci-oy_si_silver
PowerShares DB Base Metals Fund	DBB	ETF	http://www.dbfunds.db.com/dbb/index.aspx
DBIQ Optimum Yield Industrial Metals Index Excess Return		Index	https://index.db.com/dbiqweb2/index/dblci-oy_industrial_metals
ELEMENTS Rogers International Commodity Metal	RJZ	ETN	https://www.elementsetn.com/RICI-Metals-ETN.aspx
Rogers International Commodity Index - Metals Sub Index (RICIM)		Index	http://www.rogersrawmaterials.com/dailyupdate.asp

AGRICULTURE

Name	Ticker	Type	Website
PowerShares DB Agriculture Fund	DBA	ETF	http://www.dbfunds.db.com/dba/index.aspx
DBIQ Diversified Agriculture Index Excess Return		Index	https://index.db.com/dbiqweb2/index/dblci_dba_benchmark_index
iPath Dow Jones-UBS Grains Subindex Total Return	JJG	ETN	http://www.ipathetn.com/JJG-overview.jsp?investorType=pro
Dow Jones-UBS Grains Subindex Total Return		Index	http://www.djindexes.com

Appendix A 2: List of commodity related mutual funds

BROAD COMMOIDTY Name	Ticker	Type	Frontload /min.investment	Website
Credit Suisse Commodity Return (Class A) Profile: Related to Dow Jones-UBS Commodity TR Index	CRSAX	Mutual	3.00 % $US 2500	https://www.credit-suisse.com/us/real_assets/en/credit_suisse_commodity_return_strategy_fund.jsp
DWS Enhanced Commodity (Class A) Profile: Commodity derivatives	SKNRX	Mutual	5.75 % $US 1000	https://www.dws-investments.com/EN/products/dws-commodity-securities-fund.jsp?fund-key=3610
PIMCO Commodity Real Return Fund (Class A) Profile: Commodity derivatives	PCRAX	Mutual	5.50 % $US 1000	http://investments.pimco.com/Products/pages/287.aspx?ShareClassCode=A
Oppenheimer Commodity Strategy Total Return (Class A) Profile: Commodity market instruments	QRAAX	Mutual	5.75 % $US 1000	https://www.oppenheimerfunds.com/fund/investors/overview/CommodityStrategyTotalReturnFund
Rydex Commodities (Class A) Profile: Derivatives related to S&P GSCI Total Return Index	RYMEX	Mutual	4.75 % $US 2500	http://www.rydex-sgi.com/products/mutual_funds/info/overview.rails?cusip=78356A301

ENERGY Name	Ticker	Type	Frontload /min.investment	Website
Fidelity Advisor Energy (Class I) Profile: Related to energy sector securities	FANIX	Mutual	0.00 % $US 2500	https://advisor.fidelity.com/advisor/portal/performance?deeplink=yes&pageUniqueName=afc.performance&sasid=247&dplid=2&tabPositionRequired=Yes
Invesco Energy (Class A) Profile: Related to energy sector securities	IENAX	Mutual	5.50 % $US 1000	https://www.invesco.com/portal/site/us/products/mutualFunds/fundOverview?fundId=21050
Ivy Energy (Class A) Profile: Related to energy sector securities	IEYAX	Mutual	5.75 % $US 500	http://www.ivyfunds.com/fund-information/fund-detail.aspx?fund-code=694
Rydex Energy (Class I) Profile: Related to energy sector securities	RYEIX	Mutual	0.00 % $US 2500	http://www.rydex-sgi.com/products/mutual_funds/info/overview.rails?cusip=783554751
Waddell & Reed Energy (Class A) Profile: Related to energy sector securities	WEGAX	Mutual	5.75 % $US 500	http://www.waddell.com/mutual-funds/fund-detail/W-R-Advisors-Funds/Energy/A/687/

METAL Name	Ticker	Type	Frontload /min.investment	Website
First Eagle Gold (Class A) Profile: Gold, gold related securities and issuers principally engaged in the gold industry	BGEIX	Mutual	0.00 % $US 2500	https://www.americancentury.com/funds/fund_facts.jsp?fund=980
Tocqueville Gold Profile: Gold and gold related securities	TGLDX	Mutual	0.00 % $US 1000	http://www.tocquevillefunds.com/gf_overview.html
Fidelity Advisor Gold Fund (Class A) Profile: Mainly gold related securites. Also includes other precious metals companies	FGDAX	Mutual	0.00 % $US 2500	https://advisor.fidelity.com/advisor/portal/performance?deeplink=yes&pageUniqueName=afc.performance&sasid=1784&dplid=2
Invesco Gold & Precious Metals (Class A) Profile: Securities of gold and precious metal companies	IGDAX	Mutual	5.50 % $US 1000	http://www.invesco.com/portal/site/us/products/mutualFunds/fundOverview?fundId=21051
USAA Precious Metals and Minerals Profile: Securities of companies principally engaged in gold exploration, mining and other precious metals and minerals.	USAGX	Mutual	0.00 % $US 3000	https://www.usaa.com/inet/imco_mutualfund/ImMutualFunds?FundGroup=EQ&SearchRanking=2&SearchLinkPhrase=USAGX
Wells Fargo Advantage Precious Metals Fund (Class A) Profile: Securities of gold and precious metal companies	EKWAX	Mutual	0.00 % $US 1000	http://www.wellsfargoadvantagefunds.com/wfweb/wf/funds/profiles/profile.jsp?fundNo=0654
American Century Global Gold (Class I) Profile: Securities of gold and precious metal companies	BGEIX	Mutual	0.00 % $US 2500	https://www.americancentury.com/funds/fund_facts.jsp?fund=980

Appendix A 3: List of broad energy equity based ETPs

Name	Ticker	Type	Website
PowerShares Dynamic Energy Exploration & Production Portfolio Profile: Equity of the Energy Exploration & Production Intellidex Index	PXE	ETF	http://www.invescopowershares.com/products/overview.aspx?ticker=PXE
Dow Jones U.S. Oil & Gas Exploration & Production Index Fund Profile: Equity of the DJ US Select Oil Exploration & Production Index	IEO	ETF	http://us.ishares.com/product_info/fund/overview/IEO.htm
SPDR S&P Oil & Gas Exploration & Production Profile: Equity of the S&P Oil & Gas Exploration & Production Select Industry	XOP	ETF	https://www.spdrs.com/product/fund.seam?ticker=xop
PowerShares Dynamic Energy Sector Portfolio Profile: Dynamic Energy Sector Intellidex Index	PXI	ETF	http://www.invescopowershares.com/products/overview.aspx?ticker=PXI
Rydex S&P 500 Equal Weight Energy ETF Profile: Equity of the 500 Equal Weight Index Energy	RYE	ETF	http://www.rydex-sgi.com/products/etfs/products/overview.rails?rydex_symbol=RYE