

**TRACKING ABILITY OF METAL EXCHANGE TRADED
FUNDS (ETFs)**

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Abstract (250 words)

Exchange Traded Funds (ETFs) are investment funds traded in stock exchanges that have recently been introduced and have been growing significantly over the last few years. Despite the vast number of research studies on this topic, there has been a certain lack of attention directed to Commodity ETFs and their suitability as an alternative investment in commodities. In order to understand their viability as an investment and their capacity in tracking their benchmarks, this study analyzes a sample of 27 metal ETFs, traded on the NYSE Arca.

The focus of this thesis is the weekly tracking ability of ETFs, evaluated through a linear regression, tracking error tests and performance analysis indicators. Then, it is also tested the potential mispricing to understand if the ETFs are traded at their “fair prices” or if their price tend to deviate from their net asset values (NAV).

The linear regression and the tracking error results show that most ETFs have negative alphas, although not statistically significant. In addition, they also show strong correlations and low deviations from the benchmarks, where the physically-backed have the smallest values. Regarding the performance, it is not possible to elect the better strategy, due to the mixed results obtained. According to the mispricing analysis, most of the ETFs are traded at premium, where all the physically-backed are traded with a price higher than their NAV.

Key words: Exchange Traded Funds, Commodities, Tracking ability, Tracking Error

JEL Classification System G10 and G11

Resumo

Exchange Traded Funds (ETFs) são fundos de investimento transaccionados em bolsa que foram criados recentemente e têm vindo a crescer bastante nos últimos anos. Apesar do extenso número de investigações sobre este assunto, existem poucos dedicados ao estudo de *Commodity ETFs* e à sua aptidão como investimento alternativo em *commodities*. Assim, de forma a conhecer a sua viabilidade como investimento e a sua capacidade em replicar o *benchmark*, foi analisado uma amostra de 27 *ETFs* de metais, transaccionados na *NYSE Arca*.

O foco desta tese é a capacidade de replicação semanal dos *ETFs*, avaliados através de regressão linear, testes de *tracking error* e indicadores de análise de performance. Depois, é ainda testado o *mispricing* potencial, a fim de perceber se os *ETFs* são transaccionados pelo seu “preço justo”, ou se os seus preços tendem a se desviarem do seu *NAV*.

Os resultados da regressão linear e do *tracking error* mostram que a maioria dos *ETFs* têm alfas negativos, contudo são todos estatisticamente não diferentes de zero. Além disso, apresentam correlações fortes e baixos desvios em relação aos seus *benchmarks*, onde os físicos têm os valores mais baixos. Em relação à performance, não é possível eleger a melhor estratégia, visto terem sido obtidos resultados mistos. Ainda, de acordo com a análise de *mispricing* a maioria dos *ETFs* são transaccionados a prémio, onde todos os físicos são transaccionados a um preço superior ao seu *NAV*.

Palavras-chave: Exchange Traded Funds, Commodities, Tracking ability, Tracking Error

Sistema de Classificação JEL: G10 and G11

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Sumário Executivo

Nas últimas décadas, a evolução dos mercados financeiros foi marcada pelo aparecimento de novos produtos financeiros, nomeadamente os derivados que vieram oferecer todo um novo conjunto de opções aos investidores que, anteriormente, não estavam disponíveis. Os *Exchange Traded Funds* estão neste grupo de novos produtos derivados, visto serem contractos que derivam o seu valor de acordo com a performance de um determinado activo subjacente. No fim dos anos 80, o aparecimento deste novo veículo financeiro veio disponibilizar aos investidores uma alternativa para diversificarem as suas carteiras, na medida em que possibilitou a exploração de certas classes de activo que anteriormente não era possível, devido aos seus elevados custos ou impraticabilidades físicas. Assim, os claros benefícios do uso de *ETFs*, nomeadamente os reduzidos custos, fizeram deste instrumento financeiro um produto muito popular, tendo sofrido um crescimento bastante significativo a partir do ano 2000, na mesma altura em que, coincidentemente, surgiram os *Commodity ETFs*.

O universo de *ETFs* é composto por diversas classes de activos e o seu mercado é dominado, com grande maioria, por instrumentos focados em *Equity*, quer em volume de negócio, quer em número de produtos. No entanto, os *ETFs* de Obrigações têm vindo a crescer em número, sendo o mesmo verdade para os *ETFs* de *Commodities*, embora numa menor escala.

O facto de os *Commodity ETFs* terem um peso quase insignificante, quando vistos no panorama geral do mercado de *ETFs*, é uma das razões prováveis para a reduzida existência de estudos sobre esta classe, comparando com as restantes classes mais tradicionais, como os *Index ETFs*. Por esta razão, torna-se oportuno a realização de um estudo com o fim de explorar e concluir se existe, efectivamente, a capacidade dos *Commodity ETFs* replicarem eficazmente os respectivos *benchmarks*, como se propõem.

No que diz respeito à organização, este estudo está estruturado da seguinte forma: A Secção 1 faz uma apresentação dos *ETFs*, que está dividida em seis partes: na primeira, começamos por uma introdução do conceito de *ETF*, onde é explicada a natureza deste veículo financeiro; Na segunda parte, é feita uma enumeração dos benefícios e riscos inerentes à utilização dos *ETFs*; Na terceira é apresentado um pequeno resumo da história e evolução do mercado dos *ETFs*, desde a sua introdução no final da década de 80. Na quarta parte é feita uma explicação do processo de *creation/redemption* dos *ETFs*.

Seguidamente, na quinta parte é exposta uma visão geral do mercado de *commodities* e uma análise à sua natureza. Finalmente, na sexta parte são apresentados os objectivos e motivações para a realização do presente estudo. Na secção 2, é feita uma revisão da literatura de trabalhos relacionados, onde é sumarizado um conjunto de estudos similares, a fim de actualizar o leitor com a corrente literária nesta área. Na Secção 3 apresentamos a descrição dos dados recolhidos e analisados. A Secção 4 descreve a metodologia utilizada para analisar a amostra, assim como a sua interpretação; os métodos usados foram a regressão linear; indicadores de *tracking error* e *tracking efficiency* que demonstram a capacidade do *ETF* em replicar o seu *benchmark*; indicadores de performance; uma ferramenta de *mispricing*, a fim de perceber se os *ETFs* são negociados a prémio ou a desconto, relativamente ao seu *Net Asset Value*; e, ainda, é feito o estudo da correlação entre *commodities* e acções e obrigações. Na Secção 5 são apresentados e analisados os resultados obtidos na secção 4. Na secção 6 é feita uma pequena discussão das conclusões obtidas na sequência do estudo. Nas Secções 7 e 8 estão presentes os artigos e obras que suportaram a realização deste estudo. E, finalmente, na secção 9 estão os anexos, que não sendo essenciais para o objectivo do trabalho, são importantes para uma melhor compreensão deste.

1. Introduction

1.1. Exchange Traded Fund Concept

An Exchange Traded-Fund, in simple terms, is a financial security that tracks a benchmark and that is traded like a common stock on an exchange market. This benchmark can be anything from an index, a basket of assets or even a single commodity. An ETF can be traded at any hour throughout the day and its prices alter as it is bought and sold. So, basically, it is an investment fund traded with the properties of a stock.

In fact, ETFs are nothing more than shares of a fund, constituted by a basket of assets, with the objective of tracking the yield and return of the respective benchmark, which means that it does not intent to outperform it, but to replicate its performance.

The reason to invest in such instrument is to gain exposure to a different range of assets to be able to diversify a portfolio and, besides that, its flexibility grants you the ability to short sell, buy on margin and purchase exactly the quantity that is desired.

1.2. Benefits and Risks

Besides having the same trading features of a stock, the most evident and attractive benefit of an ETF is its relative low cost, when compared to a mutual fund. Since the goal is to follow an index, it is subject to low administrative costs, opposed to actively managed portfolios. One other main advantage is the diversification that an investor can obtain by adding ETFs to his portfolio. This instrument brought the opportunity to gain exposure to some type of assets, which otherwise would be really expensive and impractical. That is the case of commodities, since the investor can enjoy the exposure, but does not need to pay the full price and does not need neither to own the underlying asset. In this sense, the vast variety of available ETFs allows the investor to diversify a portfolio and follow an asset allocation strategy¹. Finally, the hybrid structure of the ETFs makes it more tax-efficient, when comparing to mutual funds. Firstly, considering the majority of ETFs are passively managed, there is low asset turnover, thus low capital gains subject to taxation, whereas the mutual fund manager is constantly re-balancing the portfolio, having a lot of transactions with capital gains, which have to be taxed. Furthermore, the redemption process also generates more tax-efficiency to the ETF fund. As it will be explained further

¹ Asset Allocation Strategy – investment strategy that aims to balance risk and return, by allocating the portfolio assets accordingly to an individual's goals, risk tolerance and investment time frame.

in this study, the redemption of an ETF is made through an in-kind transaction, which means the Authorized Participant² will redeem the shares to the ETF sponsor and get in return the underlying assets, without having any money involved, hence no capital gains are made.

On the other hand, not everything is perfect with ETFs and there are some risks that all investors should be aware. Firstly, like any common stock, an ETF shareholder needs to take into account the market risk, since they are not protected against volatility and market fluctuations. Moreover, although the market price of an ETF should reflect the NAV³ of the assets held by the ETF, sometimes that does not occur and it becomes mispriced, so, the investor should always research the newest information about the NAV of the assets before acquiring the ETF. Another possible risk is the illiquidity of a certain ETF. If there are few transactions of that specific security, it will result in a large bid-offer spread, thus leading to higher costs. Finally, there is the tracking error risk, which means that the ETF is not replicating exactly the benchmark that it is trying to track. When an index is market capitalization weighted⁴, the fund tracking this index must be constantly rebalancing its securities or it will not have an exact replication. Besides that, fees and taxes are also causes of tracking error.

1.3. History and Evolution

The first variation of ETF was created in 1990 and was traded in the Toronto Stock Exchange (TSE), in Canada. It was inserted in the Toronto Index Participation Fund (TIP 35) and it aimed to track the 35 largest stocks in the exchange. But it was not until 1993 that this type of instrument became truly popularized, when it first appeared in the United States as the Standard & Poor's 500 Depository Receipts (SPDRs), common "*spiders*". This one was traded in the American Stock Exchange (AMEX) and it tracked the biggest American index, the S&P 500. From then on, the ETFs had a substantial growth due to its innovative characteristics. The Asian market followed the trend and, in 1999, created their

² Authorized Participant can be a market maker, specialist or any large institutional investor.

³ NAV – Net Asset Value of a company is the value of its underlying assets minus its total liabilities. In the context of mutual funds and ETFs, NAV per share is calculated everyday based on the closing market prices of the securities in the fund's portfolio. Since ETFs trade like stocks, their shares trade at market value, which can be sold at a premium or at a discount, depending on if it is traded above or below the NAV.

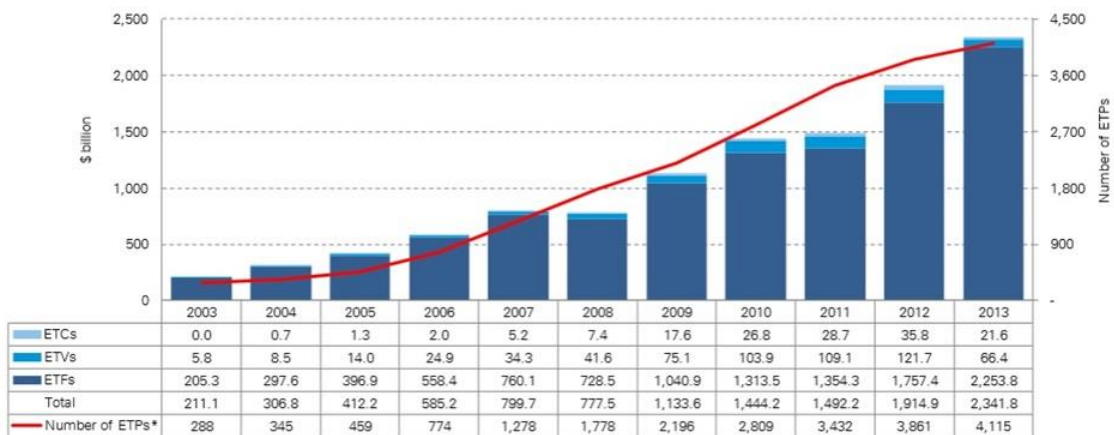
⁴ Capitalization-Weighted Index – A stock market index weighted by the market capitalization of each stock in the index. This means that larger companies will account for a greater portion of the index. Since market capitalization is market price times shares outstanding, fluctuations in the prices of the securities causes the composition of these indexes to change constantly.

own ETF designated by Hong Kong Tracker Fund. Finally, Europe made its debut in the ETF market with the Euro STOXX 50, in 2001. Presently, almost every stock exchange trades some kind of ETFs.

Commodity-ETFs are a subcategory in the ETF sector and, as the name suggests, these funds focus the investment in commodities such as agriculture goods, natural resources and metals. The first gold ETF appeared in 2003 on the Australian Securities Exchange (ASX) and was named Gold Bullion Securities. Three years later, appeared the iShares Silver Trust on the NYSE, first silver ETF.

In order to better understand the evolution of the ETF market, Figure 1 illustrates the Global ETP⁵ asset growth from 2003 to 2013, by scaling the value of the Assets Under Management on the left and the number of ETPs on the right.

Figure 1 – Global ETPs Asset Growth



Source: Deutsche Bank, Bloomberg Finance LP, Reuters.

As we see, the ETF market became extremely popularized after 2005, having an exponential growth, year after year, of the number of products available to investors, reaching, roughly, 4,000 different ETFs to choose from. Regarding the evolution in value, we can assert a steady growth through the years, with the exception of 2008, which coincides with the global financial crisis. In ten years, the ETF market grew immensely starting in 2003 with around \$200 billion, reaching around \$2,200 billion by 2013.

⁵ Exchange Traded Product (ETP) – Type of securities that are derivatively-priced and trades intra-day on a securities exchange. This category includes Exchange Traded Funds (ETFs), Exchange Traded Vehicles (ETVs), Exchange Traded Notes (ETNs) and Exchange Traded Commodities (ETCs).

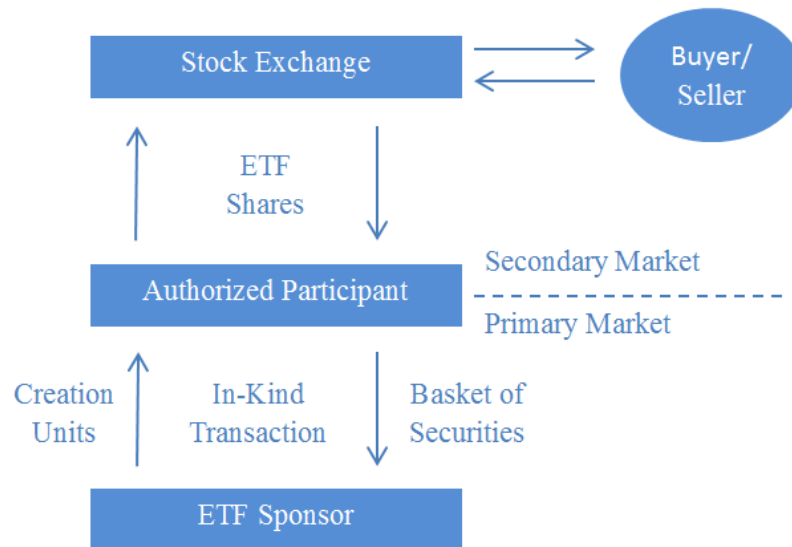
1.4. Exchange Traded Fund Creation and Redemption Mechanics

It is important to understand the creation/redemption process of an ETF to better understand how it gains exposure to the market and how it can be cheaper, more transparent and more tax-efficient than a traditional mutual fund.

Therefore, all the process of creating and redeeming ETF units takes place out of the public view and without the investor interaction. In this sense, there are two major players in this mechanism: the Authorized Participant (AP) and the ETF fund, or sponsor. The creation starts when the fund's manager files a contract with the AP who is responsible for acquiring the selected securities that the ETF Company wants to hold. Then, the AP delivers the block of shares to the sponsor and, in exchange, the sponsor gives a block of equally valued ETF shares, called a creation unit. These creation units are, usually, formed by blocks of 50,000 shares. The ETF shares are valued based on the NAV of the underlying assets, so both the creation and redemption process occur in a one-to-one, fair basis.

On the contrary, in order to redeem an ETF the opposite process occurs. That is, the AP will gather the specified number of ETF shares on the secondary market and deliver it to the Fund, in order to obtain the portfolio of underlying assets.

This process is outlined in Figure 2, for better understanding.

Figure 2 – Creation/Redemption of an ETF

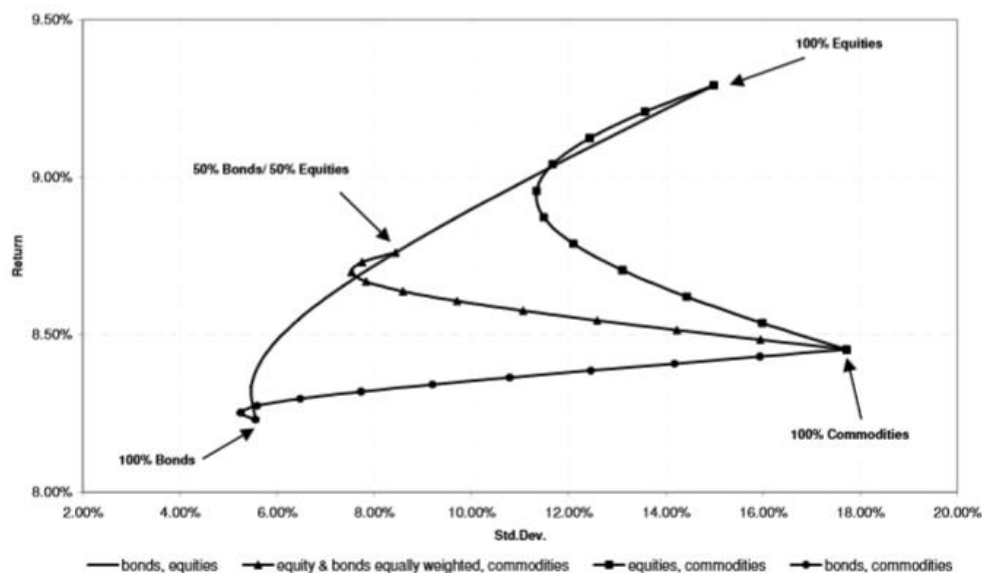
Another role of the AP is to maintain the market price of the ETF shares at, or close to, NAV. Since the ETF shares are traded like a common stock in the market, the shares are selling at a premium or at a discount, according with the demand/supply rule. If the shares are selling at a premium, the AP will buy the underlying assets that compose the ETF at their market price and sell ETF shares, so the prices will gradually converge to their NAV, while making a profit from this arbitrage. The opposite also happens, if the ETF shares are selling at a price below their NAV, the AP buys them and, then, redeems them for the portfolio of the respective ETF, putting the underlying assets back in the market. Bottom line, as the AP profits from this arbitrage, it is also bringing equilibrium to the market, making sure the ETFs are being traded by their fair value.

1.5. Commodities as an asset class of their own

Commodities, by definition, are marketable goods produced to satisfy wants and needs. But, what makes it a particular class of goods is that they are supplied without differentiation across the market, regardless the producer or origin. The commodities are divided by two subcategories: the soft commodities regards products from agriculture and livestock, such as coffee, sugar, wheat or corn; whereas hard commodities are natural resources that need to be mined or extracted, like gold, coal or oil.

There are several reasons to invest in commodities. The most obvious is, based on historical data, having commodities in a portfolio will increase the returns while lowering the risk. So, investors use commodities in their portfolios in order to minimize the risk return relation while enhancing their portfolio diversification. Commodities work as a portfolio diversifier, since it has in most cases a negative correlation with the traditional asset classes, like stocks and bonds, according to Gorton and Rouwenhorst (2004). In this sense, having a percentage of commodities in the portfolio will function as a softener in market downturns. For an investor that follows the asset allocation strategy, it makes most sense to include some exposure to commodities. Looking at Figure 3, we can easily understand the benefits of having commodities in a portfolio, in terms of portfolio diversification, as exposed in Demidova-Menzel (2007).

Figure 3 – Efficient Lines⁶ of Portfolios with and without commodities



Source: Demidova-Menzel, 2007

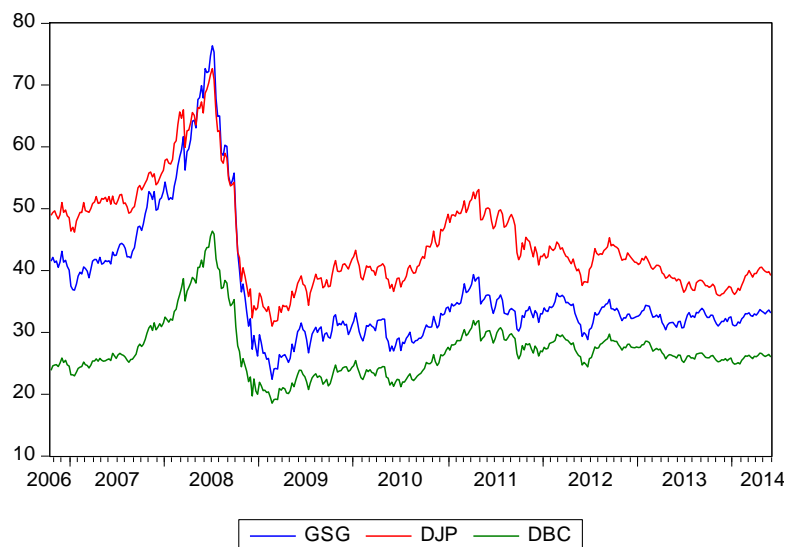
Commodities can be used, also, as a hedging tool against inflation. This particular economic factor is a very significant variable nowadays, as result of the global financial crisis. After all, the current economic conjuncture compelled the western governments to use an expansionary monetary policy, especially in the US and in the EURO zone. Taking this under consideration, it is understandable the preoccupation of the investors in a hike of inflation, which would cause a devaluation of their assets, including their stocks and bonds. In addition, commodities show a highly positive correlation with inflation rates, opposed to

⁶ Efficient line, or Efficient Frontier, is a set of optimal portfolios that offers the highest expected return for a particular.

most assets. This, in the case of an inflation increase, would result in the rise of the commodity prices, making them a good investment just per se.

Furthermore, solely investing in commodities has brought steady positive returns to the investors, as we can see by the yield of Figure 4. In this graph, we can see the time series of the last prices of the ETFs GSCI Commodity-Indexed Trust Fund (GSG), Dow Jones-UBS Commodity Index (DJP) and DB Commodity Index Tracking Fund (DBC), which are three of the most well-known commodity ETFs, with a pool of assets constituted by general commodities. Although they have different prices, they move almost together with similar volatilities. We can observe that this sector was gravely affected by the financial crisis, but since then they are slowly increasing their value at a relative steady rate.

Figure 4 – Last Price of ETFs GSG, DJP and DBC⁷



Finally, the fact that most commodities are uncorrelated with each other is another plus in order to diversify the portfolio, since a crisis in one commodity would not drastically influence other.

Investing in the commodity market used to be difficult to small investors, due to high costs of storing, transportation and insurance. Moreover, the price of storing is linked with interest rates, since it is not possible to earn interest with commodities, contrasting with other financial assets. Fortunately, the introduction of derivatives in the commodity market facilitated the access to this market. With futures, a producer is able to hedge the risk of price fluctuations and a small investor can speculate on the future price of a certain

⁷ Data retrieved from Bloomberg.

commodity, without the need of owning the underlying asset. Besides the futures market, there are also the commodity ETFs as a vehicle to get exposure in this market. The objective of a commodity ETF is to mirror the returns of a basket of commodities, or just a single one and there are three strategies to get exposure to the benchmark: physically-backed, equity-indexed and, the most common, futures-based. The first, as the name implies, consists in funds that physically holds the commodities in vaults. The second strategy, the equity-indexed, are funds that gain exposure to commodities through investments in stocks of companies directly related to the sector. Lastly, the third strategy concerns funds that track the spot prices of commodities through derivatives, being futures the most common. Futures-based commodity ETFs aim to predict, as the name suggests, the future price of a commodity. So, the return for the investor will be constituted by three components: *spot price + roll yield + collateral yield*:

- *Spot Price* – is the variation in the spot price of the underlying asset.
- *Roll Yield* – is return resulting in the closure of a contract near its settlement date and reinvesting the profits in a further dated future contract. This return will be positive if the futures curve is in *Backwardation*⁸ or negative when the futures curve is in *Contango*⁹.
- *Collateral yield* – refers to the interest income from the collateral set aside in the futures contract.

1.6. Objectives of the study

As mentioned before, we have assisted in the last decade in a hike of the growth in number and in volume of available ETFs in the market. This allied to the rising interest in commodities, used in asset allocation strategies, makes this match a subject worth of studying. In this sense, commodity ETFs can be a good alternative to the most common financial vehicles that invest in commodities. Nonetheless, to the present day, there are few studies that examine the performance of ETFs and the ones that exist are mainly focused on stock indexes, while concerning commodity ETFs are scarce, as we see in the following chapter. So, this dissertation studies this relatively new instrument and assesses their

⁸ Backwardation – the shape of the futures price curve has a downward slope.

⁹ Contango - the shape of the futures price curve has a positive slope.

viability and performance, comparatively to the traditional methods. More specifically, this study focus on metal ETFs, traded on the NYSE Arca¹⁰.

The main objective of this study is to make an analysis of the precision and reliability of metal ETFs in tracking the movements of their respective benchmarks, which is exactly their purpose. The results obtained from this study are useful to investors, since they need to know, from the available products in the market, if they will fulfill the requirements desired in the future. What is meant by this is that every investor has a different profile, thus they search different types of securities in order to reach their different objectives, which can be either hedging or speculation.

In light of the above, it is not possible to elect the best ETF or type of strategy used in its composition, since it depends on the objectives and profile of the investor. So, in sections 4 and 5 this study presents several indicators that analyze different aspects of this instrument, where an investor can examine and choose the ETF that suits him the most.

¹⁰ Securities exchange, headquartered in U.S., on which are traded more than 8.000 exchange-listed securities, owned by NYSE Euronext.

2. Literature Review

Exchange Traded Funds started to arouse the academics interest mostly in the end of the nineties and beginning of the twenty first century, as a consequence of the high degree of acceptance among investors towards this instrument. In this sense, the first literature started not only to study the ETFs as a specific instrument, but also began to compare them with traditional mutual funds, stating their benefits and innovations in relation to them.

One of the first writers to discuss the subject was Gastineau (2001), where he enumerates some of the advantages brought by ETFs, such as the low expense ratios and how ETFs manage to avoid significant capital gains contributions. Dellva (2001) refers that the in-kind creation and redemption processes makes ETFs very tax efficient, since the investor no longer supports taxes over capital gains, as opposed to mutual funds. Besides this, he also concludes that ETFs are relatively unattractive for retail investors trading small assets, due to the transaction costs. Fuhr (2001) highlights the innovative features of the ETFs, considering them a viable alternative to future contracts for the investors seeking exposure to different markets. He also reckons that ETFs provide the investors flexibility to use them for numerous applications, which can be useful to both individual and institutional investors. Kostovetsky (2003) examines the origin of cost differences between ETFs and open-end funds and points out that the main differences are due to management fees, shareholder transaction fees, tax efficiency and other qualitative differences. Poterba and Shoven (2002) studies the largest ETF at the time, the SPDR trust, comparing its pre-tax and after-tax returns with the returns on the largest equity index fund, the Vanguard Index 500, having both of them the S&P 500 as benchmark. Their findings show similar performances between them, yet the Vanguard Index 500 showed slightly better results. In addition, Gastineau (2004) finds that pre-tax performance of index ETFs have a bigger tracking error than index mutual funds following the same benchmark. The explanation for this, as he defends, is the lack of aggressiveness for a portion of ETF managers and the process of ETFs creation and redemption, because it limits the ability to follow accurately, immediately and inexpensively the adjustments of the tracking indexes. In their study, Svetina and Wahal (2008) mention that about 83% of all ETFs track indices for which there is no mutual fund equivalents, but when there is, ETFs have a worse performance, although without statistically different returns.

2.1. Tracking Ability

Since tracking error accuracy and cost have an inverse relationship, perfect replication of the benchmark is not achievable and will, ultimately, depend on the composition of an index, the underlying asset liquidity and the replication technique implemented. Some authors report that benchmark always outperforms ETFs, while others support the opposite.

Frino and Gallagher (2001) mention the inevitability of tracking error in index fund performance as a consequence of market frictions. These authors, also, point out the index funds difficulties and demonstrates how S&P 500 index funds outperforms, on average, active funds after expenses over the sample periods. Similarly, in their researches, several authors conclude that tracking errors are caused by factors as index-composition changes, corporate activity, transaction costs, fund cash flows, index volatility, dividends policy and replication strategies (see, e.g. Chiang 1998; Elton, Gruber, Comer, and Li 2002; Frino and Gallagher 2002; and Shin and Soydemir 2010). Besides that, Keim (1999) and Frino et al (2004) identifies that liquidity of the stock and the size of the fund are additional causes of tracking error and are, also, important factors in choosing the replication method.

Frino and Gallagher (2001) find that after expenses, on average, the S&P 500 index funds delivered better performances than active funds over the sample period. On the other hand, Elton, Gruber, Comer and Li (2002) identifies that Standard & Poor's Depository Receipts underperforms by 28.4 basis points its benchmark, the S&P 500 Index. They justified this difference with management fees and the loss of return from dividend reinvestment. Gallagher and Segara (2005) investigate classical ETFs in Australia and conclude that they have returns similar to the underlying benchmark, before costs. In addition, with a sample of 36 Swiss ETFs, Milonas and Rompotis (2006) studies their performance and trading characteristics and identifies that they underperform their benchmark, putting investors exposed to greater risk than the risk of volatility of the indexes. Elia (2011) analyze the traditional and synthetic European ETFs ability to mimic the returns of their respective benchmarks and finds a significant gap between them. Also, the author concludes that ETFs that have a synthetic replication strategy, instead of holding the benchmark underlying assets, show a lower tracking error and higher tax efficiency. On the other hand, synthetic ETFs underperform both the benchmarks and the traditional counterparts.

Johnson, Bioy, Kellet and Davidson (2013) create a measure with the objective of substituting the tracking difference¹¹ and complementing tracking error. This measure was named Morningstar's Estimated Holding Cost (EHC) and consists in measuring the performance of the ETF in tracking its benchmark, while taking into consideration the holding costs and revenues, which differentiates it from tracking difference since it only takes into consideration the difference between two time values.

2.2. Mispricing

Another angle to evaluate tracking error is analyzing whether ETFs are traded at premium or discount, considering the ETF trading price/NAV relation. Several authors defend that pricing deviation can be treated as an additional cost of administering an ETF (see, e.g. Frino and Gallagher 2001 and 2002; Frino, Gallagher, Neubert, and Oetomo 2004; Rompotis 2010).

Despite the differences, Elton et al (2002) research the deviation of trading price from NAV, where he concluded that this gap should be ignored, because of the ability of investors to create and redeem SPDRS at the end of every trading day. Ackert and Tian (2008) studies the pricing of ETFs relative to their benchmark and defends that the mispricing of country ETFs are cause by momentum, illiquidity and size effect.

Ackert and Tian (2000, 2008) research the mispricing in United States ETFs, concluding that it is small. Cherry (2004) discovers that ETFs constantly deviate from their NAV and ETFs, on average, are 17% more volatile than their underlying assets. From this volatility, 70% is explained by proxies for transaction and holding costs, which complicates a successful arbitrage. Elton, Gruber, Comer and Li (2002), Jares and Lavin (2004) and Engle and Sarkar (2006) found high values of mispricing for international ETFs. This is, probably, due to the fact that there is little or no overlap in trading hours with their underlying assets. DeFusco, Ivanov and Karels (2011) find that the pricing deviations of Spiders, Diamonds and Cubes¹² are statistically different from zero. Petajisto (2011) reaffirms that prices of ETFs can deviate significantly from their NAVs, despite of the arbitrage mechanism that allows Authorized Participants to create and redeem shares for the underlying portfolios. He also finds that mispricing is larger in funds holding

¹¹ Tracking Difference is the difference between a security's return and the returns of its benchmark, over a specific period of time.

¹² Spiders, Diamonds and Cubes are names given to ETFs tracking the S&P Indices, the Dow Jones Industrial and the Nasdaq, respectively.

international or illiquid securities, due to the difficulty in determining the NAV of the assets in real time. Delcours and Zhong (2007) studies iShares ETFs and concluded that they trade at economically significant premiums for 10 to 50% of the time, even taking into consideration the transaction costs and time-zone errors. The price returns also shows a relatively high volatility when compared to their NAV returns. In spite of this, they also reached the conclusion that most deviations are not persistent and converge to zero in the short run.

Ackert and Tian (2008) compares closed-end mutual funds with SPDRs and concluded that the latter does not trade at economically significant discounts, as opposite to the first. On the other hand, Mid Cap SPDRs report a larger economically significant discount. Finally, Aber, Li and Can (2009) compares the tracking ability of four iShares ETFs with conventional index mutual funds with the same benchmark using mispricing, daily returns and tracking error and concluded that conventional index funds have a better performance than ETFs.

2.3. Commodity ETFs

As referred before, there is a lack of studies towards Commodities Exchange Traded Funds. Although some are starting to appear, they are mainly theoretical and not so much analytical. Yamori (2011) believes that Commodity ETFs data analysis is still inadequate due to the short time of its existence. He also affirms that not many investors recognize this class of ETFs, because investment companies lack commodities knowledge and are rewarded with relatively small fees.

Apart from this, Maul (2010) compares several ETFs traded in Germany and enumerates the benefits of this asset, particularly the portfolio diversification, hedging against inflation and hedging against foreign exchange risk. Wang and Ahmed (2010) also describe the same benefits. Besides that, they, also, agree that gold ETFs are extremely useful to small and medium investors, however they consider a great lack of knowledge of gold ETFs among them.

3. Data

In order to do this study, a sample of several precious and industrial metal Exchange Traded Funds was selected to analyze. Data is from Bloomberg database, and the final sample is composed by 27 metal ETFs, all traded on the NYSE Arca and in US dollars. The reason to choose only one exchange market is to avoid currency issues, which could bias the final results towards misleading conclusions. After the selection of the sample, it was gathered the time series of the ETF's prices, respective NAVs and corresponding benchmarks. The time series has a weekly frequency and the sample period is from the inception date of each ETF until May 30, 2014¹³. Since every ETF has a different lifetime, the number of observations varies among them.

Table 1 presents the summary statistics for the sample of 27 ETFs, including, between others, their designation and issuer, the respective benchmark, the leverage of the product and their exposure strategy.

The ETFs in this sample are divided into the three strategies, defined before, regarding their exposure to the underlying asset: Physically-backed, Futures-based and Equity Indexed ETFs.

As a preliminary observation, it is possible to apprehend that the first ETFs to exist focused mainly on gold, being the oldest ones the ETFs with the tickers¹⁴ GLD and IAU. These two, are also the ones with the largest market capitalization, being GLD the larger, by far, with \$30.69 billion. We can also see that the equity index ETFs are fairly new when compared to others, only appearing in 2010, with the exception of XME and SLX, which were created in 2006.

Table 1 also shows that leveraged ETFs are the ones with higher Expense Ratios¹⁵. This is due to the operations that these funds have to make on a daily basis, in order to replicate two or three times the benchmark. This is much more difficult and complex to achieve, when comparing to standard funds, and is usually done through debt and derivatives.

¹³ Date of the data collection.

¹⁴ Ticker is a code of characters, normally letters, which represents a particular security listed on an exchange.

¹⁵ Expense Ratio is the annual fees that are charged by funds or ETFs to their shareholders.

Table 1 – ETFs Properties

Stock Exchange	NYSE Arca
Currency	\$ USD

	Issuer	Ticker	ETF Name	Benchmark	Inception Date	Expense Ratio	Leverage	Current Market Cap	Exposure
Broad ETFs	State Street SPDR	XME	SPDR S&P Metals & Mining ETF	S&P Metals & Mining Select Industry Index	19/06/2006	0,35%	Long (1:1)	536,24 M	Equity-Index
	Invesco PowerShares	DBP	PowerShares DB Precious Metals Fund ETF	DBIQ Optimum Yield Precious Metals Index Excess Return	05/01/2007	0,79%	Long (1:1)	169,75 M	Futures-Based
	ETF Securities	GLTR	ETFS Physical Precious Metal Basket Shares	Precious Metals Basket	22/10/2010	0,60%	Long (1:1)	165,37 M	Physically-Backed
	ETF Securities	WITE	ETFS Physical WM Basket Shares ETF	White Metals Basket	03/12/2010	0,60%	Long (1:1)	23,98 M	Physically-Backed
Gold	Direxion	DUST	Direxion Daily Gold Miners Bear 3x Shares ETF	NYSE Arca Gold Miners Index (-300%)	08/12/2010	0,95%	Triple Short(1:-3)	200,32 M	Equity-Index
	Global X	GLDX	Global X Gold Explorers ETF	Solactive Global Gold Explorers Index	04/11/2010	0,65%	Long (1:1)	38,93 M	Equity-Index
	Direxion	NUGT	Direxion Daily Gold Miners Bull 3x Shares ETF	NYSE Arca Gold Miners Index (300%)	08/12/2010	0,95%	Triple Long(1:3)	649,92 M	Equity-Index
	ProShares	GLL	the UltraShort Gold ProShares ETF	Gold bullion (-200%)	01/12/2008	0,95%	Double Short(1:-2)	86,95 M	Futures-Based
	ProShares	UGL	the ProShares Ultra Gold ETF	Gold bullion (200%)	01/12/2008	0,95%	Double Long (1:2)	113,08 M	Futures-Based
	State Street SPDR	GLD	StreetTracks Gold Shares ETF	Gold Bullion	18/11/2004	0,40%	Long (1:1)	30,69 B	Physically-Backed
	iShares	IAU	iShares COMEX Gold Trust ETF	Gold Bullion	21/01/2005	0,25%	Long (1:1)	6,45 B	Physically-Backed
	ETF Securities	SGOL	ETFS Physical Swiss Gold Shares ETF	Gold Bullion	09/09/2009	0,39%	Long (1:1)	1,03 B	Physically-Backed
Other Types of Precious Metals	Global X	SIL	Global X Silver Miners ETF	Solactive Global Silver Miners Index	19/04/2010	0,65%	Long (1:1)	214,89 M	Equity-Index
	Global X	COPX	Global X Copper Miners ETF	Solactive Global Copper Miners Index	19/04/2010	0,65%	Long (1:1)	32,36 M	Equity-Index
	First Trust	PLTM	First Trust ISE Global Platinum Index Fund	ISE Global Platinum Index	11/03/2010	0,70%	Long (1:1)	11,48 M	Equity-Index
	ProShares	AGQ	the ProShares Ultra Silver ETF	Silver bullion (200%)	01/12/2008	0,95%	Double Long (1:2)	382,25 M	Futures-Based
	Invesco PowerShares	DBS	PowerShares DB Silver Fund ETF	DBIQ Optimum Yield Silver Index Excess Return	05/01/2007	0,79%	Long (1:1)	23,41 M	Futures-Based
	ProShares	ZSL	ProShares UltraShort Silver ETF	Silver bullion (-200%)	01/12/2008	0,95%	Double Short(1:-2)	54,80 M	Futures-Based
	iShares	SLV	iShares Silver Trust ETF	Silver Bullion	21/04/2006	0,50%	Long (1:1)	6,10 B	Physically-Backed
	ETF Securities	PPLT	the ETFS Platinum Physical Shares ETF	Platinum Bullion	08/01/2010	0,60%	Long (1:1)	708,72 M	Physically-Backed
	ETF Securities	PALL	the ETFS Palladium Physical Shares ETF	Palladium Bullion	08/01/2010	0,60%	Long (1:1)	492,94 M	Physically-Backed
ETF Securities	SIVR	ETFS Physical Silver Shares ETF	Silver Bullion	24/07/2009	0,30%	Long (1:1)	335,35 M	Physically-Backed	
Base and Industrial Metals	iShares	PICK	iShares MSCI Global Select Metals & Mining Producers Fund	MSCI ACWI Select Metals & Mining Producers Ex Gold & Silver Investable Market Index	31/01/2012	0,39%	Long (1:1)	178,09 M	Equity-Index
	Van Eck	REMX	Market Vectors Rare Earth Strategic Metals ETF	Market Vectors Rare Earth/Strategic Metals Index	28/10/2010	0,57%	Long (1:1)	82,40 M	Equity-Index
	Van Eck	SLX	Market Vectors Steel ETF	NYSE Arca Steel Index	10/10/2006	0,55%	Long (1:1)	109,42 M	Equity-Index
	Global X	LIT	Global X Lithium ETF	Solactive Global Lithium Index	23/07/2010	0,75%	Long (1:1)	57,10 M	Equity-Index
	Invesco PowerShares	DBB	PowerShares DB Base Metals ETF	DBIQ Optimum Yield Industrial Metals Index Excess Return	05/01/2007	0,75%	Long (1:1)	332,52 M	Futures-Based

4. Methodology

This chapter introduces the methodology used in order to evaluate the tracking ability and performance of the ETF's sample. It starts by presenting all the formulas and procedures, as well its meaning and why is it relevant to the study. We start by running a linear regression, followed by the analysis of different methods of tracking error and performance. Finally, we discuss the mispricing of the ETFs.

First of all, it is important to note that all the study is based on the returns of the ETFs, NAVs and of the benchmarks. To obtain these returns, we first have to transform the respective prices using Equations 1, 2 and 3:

$$R_{ETF,t} = \frac{P_{ETF,t} - P_{ETF,t-1}}{P_{ETF,t-1}} \quad (1)$$

$$R_{NAV,t} = \frac{P_{NAV,t} - P_{NAV,t-1}}{P_{NAV,t-1}} \quad (2)$$

$$R_{Bench,t} = \frac{P_{Bench,t} - P_{Bench,t-1}}{P_{Bench,t-1}} \quad (3)$$

Where the R_t is the weekly return of the respective indicator in the end of the trading week t , P_t is the price in the end of the trading week t and P_{t-1} is the price in the end of trading week $t-1$, i.e. the week before.

4.1. Tracking Abilities

In order to conclude about the tracking abilities of an ETF, we use a linear regression, since it is a statistical measure that assesses the strength of the relationship between one dependent variable and a series of other changing variables. Besides this, it is also used to predict or explain the dependent variable outcome.

In this case, we are trying to explain ETFs returns, so this is the dependent variable, while the returns of the benchmark are used to explain the changes in the dependent variable:

$$R_{ETF,t} = \alpha + \beta * R_{Bench,t} + \varepsilon_t \quad (4)$$

Where $R_{ETF,t}$ and $R_{Bench,t}$ are the returns, previously identified and the error term, ε_t , captures the factors that cannot be explained by the regression. Also, the constant α (alpha)

is the intercept of the vertical axis, and the coefficient β (beta) is the relation between the ETF return and the benchmark return.

In order to estimate the regression, we used the OLS¹⁶ method and the following hypotheses were tested:

$$\begin{cases} H_0: \alpha = 0 \\ H_1: \alpha \neq 0 \end{cases} \quad (4.1)$$

$$\begin{cases} H_0: \beta = 0 \\ H_1: \beta \neq 0 \end{cases} \quad (4.2)$$

The null hypothesis is considered true, unless the sample gives convincing evidence that it is false. From the regression, we obtain the p-values of the coefficients which validates, or not, the null hypothesis. We used an interval of confidence of 95%, thus a p-value lower than 0.05 will, automatically, reject the null.

4.1.1. Alpha, Beta, Beta objective, R^2

Through Linear Regression, a straight line is computed that best fits the observations, choosing values for alpha and beta that minimizes the sum of the squared vertical distances between the observations and the regression line. So, in the case that the fund is being well managed, the intercept should be close to zero and the slope should be close to the beta objective, which is the type of leverage that the fund is trying to achieve.

The Coefficient of Determination (R^2) quantifies the goodness of fit of a linear regression model as an estimator of values for the dependent variable, $R_{ETF,t}$. With values between zero and one, it shows which percentage of the changes in the dependent variable is explained by changes in the independent variable, $R_{Bench,t}$. A value of one would result in a perfectly fit and would mean that the model is good to forecast the outcome of the dependent variable. In this context, values of one are not realistic, but we are expecting values close to it.

¹⁶ OLS, or Ordinary Least Squares, is a method used for the estimation of the coefficient parameters in a linear regression model. It minimized the sum of squared vertical distances between the observations and the responses predicted by the linear approximation.

4.2. Tracking Ability and Estimated Holding Cost

As mentioned before, Tracking Error (TE) is one of the types of risk that ETFs are subject to and is one of the most important factors when selecting an ETF. The literature developed several measures to determine the tracking error of funds, which consists in the deviation of the ETFs returns from the benchmark returns. In order to analyze this risk, this study uses the three different measures of Tracking Error presented in Frino and Gallagher (2001), Rompotis (2005) and Gallagher and Segara (2005). Additionally, we also use the Tracking Efficiency measure, Estimated Holding Cost, developed by Morningstar¹⁷.

4.2.1. TE1 - Standard Error of Regression

The first method chosen is the standard error from the regression, which is simply the standard error, obtained when computing the regression for each ETF. This value represents the deviation of the performance of the ETF from the performance of its corresponding benchmark.

4.2.2. TE2 - Average of the Absolute Differences

The second tracking error measure was calculated by introducing the average of absolute differences between the returns of the ETFs and their respective benchmarks.

$$TE2 = \frac{\sum_{t=1}^N |R_d|}{N} \quad (5)$$

Where $|R_d|$ is the absolute return differences and N is the size of the sample.

4.2.3. TE3 – Standard Deviation of Return Differences

This third indicator is measured by the standard deviation of the difference between the fund and the benchmark and its respective average over time.

$$TE3 = \sqrt{\frac{\sum_{t=1}^N [(R_{ETF,t} - R_{Bench,t}) - (\overline{R_{ETF} - R_{Bench}})]^2}{N - 1}} \quad (6)$$

Where $\overline{R_{ETF} - R_{Bench}}$ is the average of the mean excess return between the returns of the ETF and its respective benchmark.

¹⁷ Morningstar is an investment research and investment management firm headquartered in Chicago, Illinois, United States.

4.2.4. SMTE – Semi-Tracking Error

To finish the study about tracking errors, we use the Semi-Tracking Error, which only focuses on the underperformance¹⁸ events of the sample.

$$SMTE = \sqrt{\frac{\sum \text{Min}((R_{ETF,t} - R_{Bench,t}); 0)^2}{N}} \quad (7)$$

4.2.5. Estimated Holding Cost

Morningstar developed the EHC with the purpose of finding a smoother and more consistent measure of an ETF's performance relative to its benchmark after all holding expenses, such as the expense ratio, rebalancing costs, swap fees, between others. It gives an idea of how well the ETF manager is performing in producing income while holding costs down, ignoring the effects of the ETF liquidity in the market. This indicator uses past data of the ETF's NAV in order to predict how a fund will perform against its benchmark in the future. It is possible to understand if a manager is doing a good work finding the lowest cost ways with a small or even negative EHC.

To calculate Morningstar's Estimated Holding Cost, we have calculated twenty sets of return ratios, derived from the newest twenty observations:

$$Ratio_i = \frac{(1 + R_{Nav,i})}{(1 + R_{Bench,i})} \quad i \in N \sim \{1; 20\} \quad (8)$$

Where i represents the period, from 1 to 20, and:

$R_{Nav,i}$ is the one-year trailing total return of the ETF's NAV up to i trading days ago.

$R_{Bench,i}$ is the one year trailing total return of the benchmark up to i trading days ago.

In order to calculate the EHC, we have to compute the geometric average of these twenty ratios and apply the following formula:

$$EHC_j = 100 * (1 - G_j) \quad (9)$$

Where G_j is the geometric mean of the twenty ratios.

¹⁸ For the short ETFs, we've considered the upside risk.

4.3. Performance Analysis

In the following chapter, we analyze the funds in a performance perspective. It is a basic premise of investing that investors are risk averse, so it makes sense to take into consideration the risk of an asset and not solely its returns. This is where the notion of risk-adjusted performance comes in. We introduce several risk-adjusted indicators to evaluate the performance of the ETFs not only by their returns, but also by the risks involved. Therefore, in this chapter, first we look at the returns in an objective way, and then we apply the following risk-adjusted ratios: Sharpe Ratio, Treynor Ratio, Information Ratio and, finally, the Sortino Ratio. This type of performance indicators is opportune to investors that want to obtain some profit and not only hedge it by using tracking securities.

4.3.1. Absolute and Active Returns

First, we start by making a quick and direct review over the absolute and active returns of the sample. The absolute returns are simply the average of the returns of the ETFs and benchmarks, obtained through Equation 1. Then, we compute the active return, which is simply the difference between the returns of the ETF and of its respective benchmark, through the following equation:

$$Active\ Return_t = R_{ETF,t} - R_{Bench,t} \quad (10)$$

4.3.2. Sharpe Ratio, Treynor Ratio, Information Ratio, Sortino Ratio

The Sharpe Ratio was derived in 1966 by William F. Sharpe and since then has been one of the most used risk-adjusted performance indicators. The higher the ratio, the better a fund's return has been considering the risk that it has been taken on. It measures the return of the asset over the risk free rate, standardized by the standard deviation of its returns. Basically, Sharpe Ratio tells us if the returns are due to savvy investment decisions or just a result of taking unnecessary risk. In this case, since we are analyzing an ETF performance over a benchmark, we use the rate of return of the benchmark instead of the risk free rate. Since it uses standard deviation, Sharpe Ratio can be used to compare funds across all fund categories. The formula used is:

$$Sharpe\ Ratio = \frac{\bar{R}_{ETF} - \bar{R}_{Bench}}{\sigma^{ETF}} \quad (11)$$

Where \bar{R}_{ETF} represents the expected ETF percentage return, which was calculated by taking an arithmetic average of the several ETF's historical returns. \bar{R}_{Bench} is the arithmetic average of the benchmark historical returns. And, finally, σ^{ETF} refers to the standard deviation of the ETF percentage return;

Like the Sharpe Ratio, the Treynor Ratio, developed by Jack Treynor, is a relative measure of risk, with the difference that the volatility is now measured by the beta of the benchmark. Following the same logic as before, we use the beta of the benchmark instead of the beta of the market. This ratio is interesting, because it takes into account the systemic risk present of the fund, in the sense that beta reflects the sensitivity of the ETF's price to the fluctuations of its respective benchmark. Again, like the Sharpe Ratio, it is a relative indicator, so the ratio doesn't quantify the value added. Its use is only to rank the ETFs. The formula is the following:

$$Treynor\ Ratio = \frac{\bar{R}_{ETF} - \bar{R}_{Bench}}{\beta_{ETF}} \quad (12)$$

β_{ETF} is the beta of the ETF, achieved by the regression of the ETF's returns on the benchmark's returns, with this formula: $r_t^{ETF} = \alpha_i + \beta_i r_t^{Bench} + \varepsilon_t$ (14);

Unlike the previous indicators, Information Ratio was devised to measure the excess return and risk of a certain security relative to a specific benchmark, and not to a risk free rate, so it was not necessary to adjust the formula to the object of our study. In this sense, the Information Ratio measures the fund ability to generate excess returns relative to a benchmark, considering its tracking error. This ratio is, normally, used as an indicator of the skill of the manager of the fund, in the sense that it measures the active returns divided by the amount of risk that the manager takes relative to the benchmark. The higher the ratio, the greater the risk-adjusted returns. The formula is the following:

$$Information\ Ratio = \frac{\bar{R}_{ETF} - \bar{R}_{Bench}}{TE_{ETF,Bench}} \quad (15)$$

Where $TE_{ETF,Bench}$ refers to the tracking error of the ETF relative to its benchmark;

The final performance indicator discussed in this study is the Sortino Ratio, created by Brian M. Rom. It consists in a variation of the Sharpe Ratio that differentiates the harmful volatility from volatility in general, by using the downside deviation in the denominator,

instead of the standard deviation. This way, the fund is only penalized by the negative active returns, and not by general volatility. A large Sortino Ratio means that there is low risk of large losses. We calculate the ratio according with the formula:

$$\text{Sortino Ratio} = \frac{\bar{R}_{ETF} - \bar{R}_{Bench}}{DR} \quad (16)$$

Where DR refers to Downside Risk and is just another name for the SMTE that we saw in Equation 7.

4.4. Mispricing

As it was mentioned before, all ETFs are traded in a stock exchange, thus their prices are influenced by the market, as a result of the supply/demand rule. This means that the price of an ETF may not be the same as its intrinsic value, denominated by NAV, and can be traded at a premium/discount price¹⁹. In the following chapter, we explore these differences and their amplitudes.

Taking into consideration the study Ackert and Tian (2000), we used the following formula for the misprice analysis:

$$\text{Premium/Discount} = \frac{P_t - NAV_t}{NAV_t} \quad (17)$$

Where P_t is the price of the ETF in the end of the trading day “t” and NAV_t is the Net Asset Value of the same ETF, in the end of trading day “t”. With this formula, we are able to quantify, in percentage, the deviation of the ETF’s price from its NAV.

4.5. Correlation of Commodity ETFs with other asset classes

In a complementary note, it is opportune to analyze if, in fact, the Commodity ETFs are negatively correlated with stocks and bonds, as it was stated by Gorton and Rouwenhorst (2004).

¹⁹ Although the price of the ETF may differ from its NAV, they usually are close due to the arbitrageurs in the market.

In this sense, we examine the correlation of the Commodity ETF GSG prices with the prices of S&P 500 and BUHY²⁰ that represent the benchmark associated with stocks and bonds, respectively, over various investment horizons. The data is presented in following time horizons: monthly, 6 months, 1 year and 5 years. Because asset returns are volatile, the correlation is examined over longer holding periods, since it may reveal patterns in the data that are distorted by short-term variations.

²⁰ BUHY or Bloomberg USD High Yield Corporate Bond Index is a market-value weighted index engineered to measure publicly issued non-investment grade USD fixed-rate, taxable, corporate bonds. To be included in the index a security must have a minimum par amount of 250MM.

5. Empirical Results

In this chapter, it is presented the results obtained from the several tests performed, according to chapter 4, and we provide a technical interpretation of them.

5.1. Absolute and Active Returns

To begin our analysis of the ETFs performance relative to their benchmark, we start by introducing some simple and straightforward variables, in order to have a broader picture of the market. Table 2 compiles these variables.

Table 2 – Absolute and Active Returns

Ticker	Obs	Exposure	β_{obj}	Wins	%	Losses	%	ETF Return	Bench Return	Excess Return
XME	412	Equity-Indexed	1	196	47,6%	215	52,2%	0,13%	0,15%	-0,02%
DUST	182	Equity-Indexed	-3	90	49,5%	91	50,0%	0,99%	-0,45%	1,44%
GLDX	187	Equity-Indexed	1	77	41,2%	109	58,3%	-0,74%	-0,67%	-0,07%
NUGT	182	Equity-Indexed	3	82	45,1%	99	54,4%	-1,50%	-0,45%	-1,05%
SIL	215	Equity-Indexed	1	103	47,9%	111	51,6%	0,02%	0,04%	-0,02%
COPX	215	Equity-Indexed	1	110	51,2%	104	48,4%	-0,05%	0,00%	-0,05%
PLTM	221	Equity-Indexed	1	110	49,8%	111	50,2%	-0,30%	-0,71%	0,41%
PICK	122	Equity-Indexed	1	55	45,1%	66	54,1%	-0,19%	-0,15%	-0,04%
REMX	188	Equity-Indexed	1	91	48,4%	96	51,1%	-0,37%	-0,34%	-0,03%
SLX	398	Equity-Indexed	1	221	55,5%	176	44,2%	0,20%	0,20%	0,00%
LIT	202	Equity-Indexed	1	87	43,1%	114	56,4%	-0,03%	0,01%	-0,04%
DBP	387	Futures-Based	1	195	50,4%	191	49,4%	0,18%	0,19%	-0,01%
GLL	287	Futures-Based	-2	121	42,2%	165	57,5%	-0,48%	0,21%	-0,70%
UGL	287	Futures-Based	2	161	56,1%	125	43,6%	0,34%	0,21%	0,12%
AGQ	287	Futures-Based	2	142	49,5%	144	50,2%	0,55%	0,37%	0,19%
DBS	387	Futures-Based	1	194	50,1%	192	49,6%	0,20%	0,21%	-0,02%
ZSL	287	Futures-Based	-2	136	47,4%	150	52,3%	-0,96%	0,46%	-1,42%
DBB	377	Futures-Based	1	179	47,5%	197	52,3%	-0,04%	-0,03%	-0,01%
GLTR	189	Physically-Backed	1	87	46,0%	101	53,4%	-0,01%	0,01%	-0,02%
WITE	183	Physically-Backed	1	90	49,2%	92	50,3%	-0,09%	-0,07%	-0,02%
GLD	483	Physically-Backed	1	238	49,3%	244	50,5%	0,25%	0,26%	-0,01%
IAU	482	Physically-Backed	1	232	48,1%	249	51,7%	0,25%	0,26%	-0,01%
SGOL	247	Physically-Backed	1	123	49,8%	123	49,8%	0,11%	0,12%	-0,01%
SIVR	254	Physically-Backed	1	129	50,8%	124	48,8%	0,23%	0,25%	-0,02%
SLV	423	Physically-Backed	1	218	51,5%	204	48,2%	0,19%	0,24%	-0,04%
PPLT	230	Physically-Backed	1	126	54,8%	103	44,8%	-0,01%	-0,69%	0,67%
PALL	230	Physically-Backed	1	119	51,7%	110	47,8%	0,37%	0,38%	-0,01%

Overall, we can perceive that the excess returns are close to zero, but with the majority of the benchmarks outperforming the ETF returns. It is, also, logical to assume that the ETFs with more percentage of wins²¹ over the benchmark are the ones with best results and more probable to have a positive excess return, as it indeed happens.

²¹ A win occurs when the absolute return of an ETF is higher than the absolute return of its benchmark, during the same period. A loss occurs in the opposite situation.

The most substantial results are achieved by ZSL (-1.42%), GLL (-0.70%) and PPLT (0.67%), being the first two considered given they are short ETFs, whereas the most negative ones are DUST (1.44%) and NUGT (-1.05%). The remaining has residual negative values and probably inconsequential for the investor's objectives. Again, DUST is a short leverage ETF, so its conclusion is different than for the standards. Looking at these results, we cannot conclude in an optimal strategy or type or metal to invest, since we got mixed results through the sample.

5.2. Tracking Abilities

On Table 3, we can see the results of the time-series regression for each ETF.

Table 3 – Linear Regression Results

Ticker	Exposure	β_{obj}	Alfa	P-Value	Beta	P-Value	R-squared
XME	Equity-Indexed	1	0,000	0,311	0,992	0,000	0,995
DUST	Equity-Indexed	-3	-0,002	0,260	-2,748	0,000	0,952
GLDX	Equity-Indexed	1	-0,001	0,286	0,995	0,000	0,977
NUGT	Equity-Indexed	3	-0,003	0,070	2,664	0,000	0,967
SIL	Equity-Indexed	1	0,000	0,504	1,019	0,000	0,991
COPX	Equity-Indexed	1	-0,001	0,301	1,004	0,000	0,978
PLTM	Equity-Indexed	1	-0,001	0,809	0,341	0,000	0,318
PICK	Equity-Indexed	1	0,000	0,669	0,998	0,000	0,871
REMX	Equity-Indexed	1	0,000	0,842	1,036	0,000	0,950
SLX	Equity-Indexed	1	0,000	0,930	1,006	0,000	0,990
LIT	Equity-Indexed	1	0,000	0,308	1,003	0,000	0,973
DBP	Futures-Based	1	0,000	0,877	0,975	0,000	0,974
GLL	Futures-Based	-2	-0,001	0,333	-1,743	0,000	0,843
UGL	Futures-Based	2	0,000	0,718	1,770	0,000	0,859
AGQ	Futures-Based	2	-0,001	0,763	1,719	0,000	0,788
DBS	Futures-Based	1	0,000	0,805	0,972	0,000	0,972
ZSL	Futures-Based	-2	-0,002	0,518	-1,638	0,000	0,700
DBB	Futures-Based	1	0,000	0,867	1,032	0,000	0,958
GLTR	Physically-Backed	1	0,000	0,867	0,928	0,000	0,849
WITE	Physically-Backed	1	0,000	0,807	0,909	0,000	0,835
GLD	Physically-Backed	1	0,000	0,619	0,854	0,000	0,851
IAU	Physically-Backed	1	0,000	0,626	0,859	0,000	0,851
SGOL	Physically-Backed	1	0,000	0,928	0,872	0,000	0,856
SIVR	Physically-Backed	1	0,000	0,913	0,860	0,000	0,778
SLV	Physically-Backed	1	0,000	0,948	0,846	0,000	0,769
PPLT	Physically-Backed	1	0,001	0,531	0,175	0,000	0,178
PALL	Physically-Backed	1	0,000	0,923	0,952	0,000	0,872

As expected, all alpha are not statistically different from zero, which is normal, because it means the ETF's returns are zero when the returns of the benchmark are zero. So, in this sense, the ETFs are replicating well the underlying asset. We can also observe that, although really close to zero, the ETFs that are physically-backed are the ones with more positive results, and some even outperformed the benchmark. The best alpha results belong to the triple and double short ETFs DUST (-0.002) and ZSL (-0.002), having positive

results, since they are betting against the benchmark, so the negative alpha is profitable for them. NUGT (-0.003), a triple long ETF, has the worst alpha.

Regarding the beta, we expect values close to one in the case of the standard ETFs, or close to the respective beta objective, for the leverage ones, as it shows that the ETFs are tracking closely the benchmarks. For starters, we notice that all ETFs have betas statistically different from zero. Afterwards, what stands out the most is the poor job that PPLT (0.175) and PLTM (0.341) are doing in tracking their benchmarks. Their values are drastically low when comparing with all other ETFs in this sample. All the others have beta close to their objective, being the Equity-indexed ETFs the ones with best results, including five ETFs that have beaten the benchmark.

About the Coefficient of Determination, or R-squared, it is known that they have a high correlation with betas. In this sense, the higher the beta, the higher the coefficient will be. As before, the ETFs with the smallest coefficients are PPLT (0.178) and PLTM (0.318). We can observe, again, the weak relation that these ETFs have and their benchmarks. As for the remaining, we have values close to one, which means that the model is correctly fitting the data of both returns.

5.3. Tracking Error and Estimated Holding Cost

In Table 4 are the results from the four tracking error methods applied, where T1 is the standard error of regression, T2 is the average of absolute differences, T3 corresponds to the standard deviation of returns differences, SMTE is the semi-tracking error and, finally, the Morningstar's estimated holding cost.

Table 4 – Tracking Error and EHC Results

Ticker	Exposure	β_{obj}	T1	T2	T3	SMTE	EHC
XME	Equity-Indexed	1	0,004	0,002	0,004	0,024	0,014
DUST	Equity-Indexed	-3	0,028	0,133	0,174	0,800	-0,096
GLDX	Equity-Indexed	1	0,009	0,005	0,009	0,042	0,044
NUGT	Equity-Indexed	3	0,023	0,059	0,079	0,470	0,734
SIL	Equity-Indexed	1	0,005	0,004	0,005	0,030	0,018
COPX	Equity-Indexed	1	0,007	0,004	0,007	0,036	0,003
PLTM	Equity-Indexed	1	0,035	0,013	0,058	0,063	0,017
PICK	Equity-Indexed	1	0,011	0,008	0,011	0,046	0,038
REMX	Equity-Indexed	1	0,010	0,007	0,010	0,052	-0,010
SLX	Equity-Indexed	1	0,006	0,003	0,006	0,026	-0,003
LIT	Equity-Indexed	1	0,006	0,004	0,006	0,030	0,025
DBP	Futures-Based	1	0,005	0,004	0,005	0,035	0,012
GLL	Futures-Based	-2	0,020	0,057	0,074	0,540	-0,438
UGL	Futures-Based	2	0,019	0,020	0,027	0,163	0,210
AGQ	Futures-Based	2	0,044	0,043	0,056	0,348	0,346
DBS	Futures-Based	1	0,008	0,006	0,009	0,056	0,018
ZSL	Futures-Based	-2	0,055	0,102	0,146	0,988	-0,874
DBB	Futures-Based	1	0,008	0,005	0,008	0,050	0,011
GLTR	Physically-Backed	1	0,013	0,009	0,013	0,064	0,006
WITE	Physically-Backed	1	0,015	0,012	0,016	0,083	0,006
GLD	Physically-Backed	1	0,011	0,008	0,011	0,088	0,004
IAU	Physically-Backed	1	0,011	0,008	0,011	0,088	0,003
SGOL	Physically-Backed	1	0,009	0,007	0,010	0,053	0,004
SIVR	Physically-Backed	1	0,022	0,017	0,023	0,141	0,003
SLV	Physically-Backed	1	0,024	0,018	0,025	0,194	0,005
PPLT	Physically-Backed	1	0,026	0,025	0,062	0,138	0,013
PALL	Physically-Backed	1	0,016	0,011	0,016	0,088	0,006

Overall, all the ETFs have tracking errors close to zero, except for DUST and ZSL, which are clearly the worst ones in this topic. Which is no surprise, taking in consideration that leverage ETFs are prone to have higher tracking errors, due to their inherent complexity, as mentioned before.

Considering the three tracking errors, we can notice that T3 has the biggest values, but there is consistency between the methods in ranking the securities. Also, it is notable that futures-based ETFs have the higher ratios and, on the contrary, the physically-backed ones have the lowest.

The downside method follows the same logic, having DUST and ZSL as the least precise in the sample.

We can see that XME and DBP are the most precise ETFs in tracking their benchmark, while DUST and ZSL are the worst in this chapter.

Looking at the EHC, we take different conclusions than before. With measure of tracking efficiency, IAU (0.003) and SLX (-0.003) are the ones closer to zero, thus with smaller tracking error. On the other hand, we can observe significant high values for ZSL (-0.874) and NUGT (0.734), being the ones less precise in following the benchmark. Concerning strategies, it is clear that physically-backed and standard ETFs are the most precise.

5.4. Performance Analysis

Table 5 summarizes the results of the performance ratios for each ETF.

Table 5 – Performance Ratios

Ticker	Exposure	β_{obj}	Sharpe Ratio	Treynor Ratio	Information Ratio	Sortino Ratio
XME	Equity-Indexed	1	0,004	0,000	0,053	0,009
DUST	Equity-Indexed	-3	0,112	0,005	0,083	0,015
GLDX	Equity-Indexed	1	0,011	0,001	0,075	0,016
NUGT	Equity-Indexed	3	0,085	0,004	0,133	0,022
SIL	Equity-Indexed	1	0,004	0,000	0,044	0,008
COPX	Equity-Indexed	1	0,010	0,001	0,071	0,015
PLTM	Equity-Indexed	1	0,097	0,012	0,071	0,065
PICK	Equity-Indexed	1	0,014	0,000	0,039	0,009
REMX	Equity-Indexed	1	0,006	0,000	0,027	0,005
SLX	Equity-Indexed	1	0,000	0,000	0,002	0,001
LIT	Equity-Indexed	1	0,012	0,000	0,072	0,014
DBP	Futures-Based	1	0,003	0,000	0,017	0,002
GLL	Futures-Based	-2	0,142	0,004	0,095	0,016
UGL	Futures-Based	2	0,025	0,001	0,046	0,008
AGQ	Futures-Based	2	0,020	0,001	0,033	0,005
DBS	Futures-Based	1	0,003	0,000	0,019	0,003
ZSL	Futures-Based	-2	0,142	0,009	0,098	0,019
DBB	Futures-Based	1	0,002	0,000	0,010	0,002
GLTR	Physically-Backed	1	0,005	0,000	0,013	0,002
WITE	Physically-Backed	1	0,006	0,000	0,014	0,003
GLD	Physically-Backed	1	0,005	0,000	0,013	0,002
IAU	Physically-Backed	1	0,005	0,000	0,011	0,001
SGOL	Physically-Backed	1	0,004	0,000	0,011	0,002
SIVR	Physically-Backed	1	0,004	0,000	0,008	0,001
SLV	Physically-Backed	1	0,009	0,001	0,017	0,002
PPLT	Physically-Backed	1	0,236	0,039	0,109	0,049
PALL	Physically-Backed	1	0,002	0,000	0,005	0,001

Since I had to adjust the formula's numerator in order to make sense for the purpose of this study, we consider the absolute values of the results, because it would not be fair to compare an ETF that has a positive active return with one that does not and would make us reach to the wrong conclusions. In this sense, the higher the ratio, the better the risk-return performance. As stated before, this type of indicators are useless for a single ETF, they only serve in a relative perspective, i.e. when compared to others.

Again, it is not possible to ascertain which strategy would be the most profitable, due to the mixed results we find.

To have a better comprehension of which ETFs are performing better under these indicators, we selected the two best and worst performers of each ratio:

- Sharpe Ratio : + PPLT(0.236) ZSL(0.142) – SLX (0.000) PALL (0.002)
- Treynor Ratio : + PPLT (0.039) PLTM (0.012) – SLX (0.000) DBB (0.000)
- Information Ratio : + NUGT (0.133) PPLT (0.109) – SLX (0.002) PALL (0.005)
- Sortino Ratio : + PLTM (0.065) PPLT (0.049) – SLX (0.001) PALL (0.001).

5.5. Mispricing

In table 6 we can observe if the ETFs in the sample are traded at a Premium or at a Discount.

In an overall assessment, looking at table 6, we can conclude that, in average, ETFs are being traded at a Premium, especially the ones who are physically-backed. The ETFs that are Equity-indexed are the ones traded closely to their fair value, having, in general, small mispricing percentages. On the other hand, the Futures-based ETFs have the biggest oscillations in the sample, having the biggest standard deviations as a consequence.

As expected for the complexity of their replication, the leverage ETFs are the ones with the biggest amplitudes in their prices, when comparing with the respective NAV, with the exception of DUST (3.80%) and NUGT (3.67%), which, taking into consideration that they have leverages 3x their benchmark, are doing a good job keeping their prices close to their fair value.

Table 6 – Mispricing Results

Ticker	Exposure	β_{obj}	Avg Mispricing	Std. Deviation	Min	Max	Amplitude
XME	Equity-Indexed	1	-0,01%	0,29%	-1,78%	2,38%	4,15%
DUST	Equity-Indexed	-3	-0,02%	0,44%	-1,62%	2,18%	3,80%
GLDX	Equity-Indexed	1	0,38%	0,53%	-1,28%	2,54%	3,82%
NUGT	Equity-Indexed	3	-0,02%	0,40%	-1,90%	1,77%	3,67%
SIL	Equity-Indexed	1	0,12%	0,42%	-2,13%	1,14%	3,27%
COPX	Equity-Indexed	1	0,05%	0,55%	-1,25%	1,50%	2,75%
PLTM	Equity-Indexed	1	0,06%	0,84%	-3,13%	2,86%	5,99%
PICK	Equity-Indexed	1	0,61%	0,89%	-2,87%	3,78%	6,65%
REMX	Equity-Indexed	1	-0,16%	0,67%	-2,07%	2,17%	4,24%
SLX	Equity-Indexed	1	-0,05%	0,38%	-4,32%	2,15%	6,47%
LIT	Equity-Indexed	1	-0,31%	0,52%	-2,59%	1,40%	3,99%
DBP	Futures-Based	1	0,49%	1,12%	-2,59%	5,32%	7,91%
GLL	Futures-Based	-2	-0,32%	1,43%	-6,67%	6,19%	12,86%
UGL	Futures-Based	2	0,33%	1,46%	-6,25%	7,09%	13,33%
AGQ	Futures-Based	2	0,63%	3,96%	-35,65%	11,56%	47,21%
DBS	Futures-Based	1	0,70%	1,69%	-6,18%	7,73%	13,91%
ZSL	Futures-Based	-2	-0,74%	3,42%	-11,66%	12,70%	24,37%
DBB	Futures-Based	1	0,85%	2,20%	-4,31%	7,60%	11,90%
GLTR	Physically-Backed	1	0,17%	0,96%	1,00%	3,39%	7,62%
WITE	Physically-Backed	1	0,20%	1,17%	-5,18%	3,40%	8,58%
GLD	Physically-Backed	1	0,17%	0,82%	-6,15%	3,98%	10,13%
IAU	Physically-Backed	1	0,13%	0,51%	-3,02%	3,54%	6,56%
SGOL	Physically-Backed	1	0,14%	0,68%	-3,08%	3,36%	6,44%
SIVR	Physically-Backed	1	0,34%	1,69%	-6,47%	5,81%	12,28%
SLV	Physically-Backed	1	0,30%	1,93%	-14,66%	10,05%	24,70%
PPLT	Physically-Backed	1	0,16%	0,74%	-2,79%	2,54%	5,33%
PALL	Physically-Backed	1	0,18%	1,11%	-4,55%	3,66%	8,21%

5.6. Correlation of Commodity ETFs with other asset classes

Table 7 shows the correlation between commodity ETF GSG with S&P 500 and BUHY.

Table 7 – Correlation of GSG with S&P 500 and BUHY

	SP500	BUHY
1 month	0,030382	0,407771
6 months	0,648356	0,740839
1 year	0,202229	0,302193
5 years	0,336311	0,212514

Source: Own calculations

First, it is clear that the premise of negative correlation does not hold for the present business cycle. In fact, looking at the 6 months period we notice that commodities are strongly correlated with stocks and bonds. On the other hand, the correlation tends to decrease when the time span is longer. In conclusion, it is still safe to assume that commodities are an important tool in diversifying a portfolio, but it is not as effective as in past times.

6. Discussion and Conclusions

After all the tests and interpretation of their results, it is possible to draw the final conclusions, in this final chapter of the study. Overall, we can safely say that most ETFs present in this sample are efficiently tracking their respective benchmarks, although, depending on the objective of the investor, there are some strategies that are better than the others.

Looking at the Betas, we notice that, despite the performances of PLTM and PPLT, all of them have good values, even the leveraged ones have very reasonable betas, considering the complexity of their nature. These last ones can be very useful for speculation, if it is the objective of the investor.

If the interest of the investor is the exact mimic of the benchmark, the tracking error is the most representative indicator. In general all of them have consistent values, but in this sense, the physically-backed are the ones with the most reliable values, while future-based have higher values of mismatch relative their benchmarks, probably because of the higher fees of this type of securities, due to rolling-over costs.

In order to obtain some gains, apart from the exposure benefits of commodities, the risk-adjusted indicators are the ones to pay special attention to. In this area, as expected, all ETFs have really small results, since their main objective is to track the benchmark, not outperforming them. Having this in mind, it is not possible to conclude on a specific strategy to apply, due to the mixed evidence that were obtained. Still, if I had to elect a criterion to choose from, I would choose the ETFs that track solely a specific metal, since ZSL and PPLT are the ones with best values and are committed in tracking silver and platinum, respectively, and not a basket of several metals.

Regarding the mispricing, it is interesting to observe that most ETFs are traded at a premium, which could be a result of the low liquidity in this class of assets, mainly visible in the physically-backed securities. On the other hand, the equity-indexed are the most traded at a lower value than their intrinsic value.

Overall, it is difficult to conclude about a single best ETF or the best strategy, because it will depend on the investor objectives and what is optimal for a certain portfolio may not be as good for another.

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8. Annexes

Annex 1 – ETFs descriptions

Class	ETF Name	Ticker	Description
Broad ETFs	SPDR S&P Metals & Mining ETF	XME	The investment seeks to provide investment results that, before fees and expenses, correspond generally to the total return performance of an index derived from the metals and mining segment of a U.S. total market composite index. In seeking to track the performance of the S&P Metals & Mining Select Industry Index (the "index"), the fund employs a sampling strategy. It generally invests substantially all, but at least 80%, of its total assets in the securities comprising the index. The index represents the metals and mining industry group of the S&P Total Market Index ("S&P TMI"). The fund is non-diversified.
	PowerShares DB Precious Metals Fund ETF	DBP	The investment seeks to track the price and yield performance, before fees and expenses, of the Deutsche Bank Liquid Commodity Index - Optimum Yield Precious Metals Excess Return. The index is a rules-based index composed of futures contracts on two of the most important precious metals, gold and silver. The index is intended to reflect the performance of the precious metals sector.
	ETFS Physical Precious Metal Basket Shares	GLTR	ETFS Physical Precious Metals Basket Trust is an exchange-traded fund incorporated in the USA. The Fund's objective is to reflect the performance of the price of gold, silver, platinum, and palladium bullion, less the expenses of the Trust's operations. The Shares are designed for investors who want a cost-effective and convenient way to invest in precious metals.
	ETFS Physical WM Basket Shares ETF	WITE	ETFS White Metals Basket Trust is an exchange-traded fund incorporated in the USA. The Fund's objective is to reflect the performance of the prices of silver, platinum, and palladium bullion, less the expenses of the Trust's operations. The shares are designed for investors who want a cost-effective and convenient way to invest in precious metals.
Gold	Direxion Daily Gold Miners Bear 3x Shares ETF	DUST	The investment seeks daily investment results, before fees and expenses, of 300% of the inverse (or opposite) of the performance of the NYSE Arca Gold Miners Index. The fund, under normal circumstances, creates short positions by investing at least 80% of its assets in financial instruments that, in combination, provide leveraged and unleveraged exposure to the index. The index is a modified market capitalization weighted index comprised of publicly traded companies that operate globally in both developed and emerging markets, and are involved primarily in the mining for gold and silver. The fund is non-diversified.
	Global X Gold Explorers ETF	GLDX	The investment seeks to provide investment results that correspond generally to the price and yield performance, before fees and expenses, of the Solactive Global Gold Explorers Index. The fund invests at least 80% of its total assets in the securities of the underlying index and in American Depositary Receipts ("ADRs") and Global Depositary Receipts ("GDRs") based on the securities in the underlying index. The underlying index is free float adjusted, liquidity tested and market capitalization-weighted index that is designed to measure broad based equity market performance of global companies involved in gold exploration. The fund is non-diversified.
	Direxion Daily Gold Miners Bull 3x Shares ETF	NUGT	The investment seeks daily investment results, before fees and expenses, of 300% of the performance of the NYSE Arca Gold Miners Index. The fund creates long positions by investing at least 80% of assets in the equity securities that comprise the index and/or financial instruments that provide leveraged and unleveraged exposure to the index. The index is a modified market capitalization weighted index comprised of publicly traded companies that operate globally in both developed and emerging markets, and are involved primarily in the mining for gold and silver. The fund is non-diversified.
	the UltraShort Gold ProShares ETF	GLL	The investment seeks to provide daily investment results (before fees and expenses) that correspond to twice (200%) the inverse (opposite) of the daily performance of gold bullion as measured by the U.S. Dollar p.m. fixing price for delivery in London. The fund invests in any one of or combinations of the financial instruments (swap agreement, futures contracts, forward contracts) with respect to the applicable fund's benchmark to the extent determined appropriate by the Sponsor.
	the ProShares Ultra Gold ETF	UGL	The investment seeks to provide daily investment results (before fees and expenses) that correspond to twice (200%) the daily performance of gold bullion as measured by the U.S. Dollar p.m. fixing price for delivery in London. The fund invests principally in any one of or combinations of the financial instruments (swap agreement, futures contracts, forward contracts, option contracts) with respect to the applicable fund's benchmark to the extent determined appropriate by the Sponsor.
	StreetTracks Gold Shares ETF	GLD	The investment seeks to replicate the performance, net of expenses, of the price of gold bullion. The trust holds gold, and is expected to issue baskets in exchange for deposits of gold, and to distribute gold in connection with redemption of baskets. The gold held by the trust will only be sold on an as-needed basis to pay trust expenses, in the event the trust terminates and liquidates its assets, or as otherwise required by law or regulation.
	iShares COMEX Gold Trust ETF	IAU	The Trust seeks to reflect generally the performance of the price of gold. The Trust seeks to reflect such performance before payment of the Trust's expenses and liabilities. The Trust is not actively managed. It does not engage in any activities designed to obtain a profit from, or to ameliorate losses caused by, changes in the price of gold. The Trust receives gold deposited with it in exchange for the creation of Baskets of Shares, sells gold as necessary to cover the Trust expenses and other liabilities and delivers gold in exchange for Baskets of Shares surrendered to it for redemption.
	ETFS Physical Swiss Gold Shares ETF	SGOL	The investment seeks to reflect the performance of the price of gold bullion, less the Trust's expenses. The Shares are intended to constitute a simple and cost-effective means of making an investment similar to an investment in gold. An investment in physical gold requires expensive and sometimes complicated arrangements in connection with the assay, transportation, warehousing and insurance of the metal. Although the Shares will not be the exact equivalent of an investment in gold, they provide investors with an alternative that allows a level of participation in the gold market through the securities market.

Other Types of Precious Metals	Global X Silver Miners ETF	SIL	The investment seeks to provide investment results that correspond generally to the price and yield performance, before fees and expenses, of the Solactive Global Silver Miners Index. The fund invests at least 80% of its total assets in the securities of the underlying index and in American Depositary Receipts ("ADRs") and Global Depositary Receipts ("GDRs") based on the securities in the underlying index. The underlying index is designed to measure broad based equity market performance of global companies involved in the silver mining industry. The fund is non-diversified.
	Global X Copper Miners ETF	COPX	The investment seeks to provide investment results that correspond generally to the price and yield performance, before fees and expenses, of the Solactive Global Copper Miners Index. The fund invests at least 80% of its total assets in the securities of the underlying index and in American Depositary Receipts ("ADRs") and Global Depositary Receipts ("GDRs") based on the securities in the underlying index. The underlying index is designed to measure broad based equity market performance of global companies involved in the copper mining industry. The fund is non-diversified.
	First Trust ISE Global Platinum Index Fund	PLTM	The investment seeks investment results that correspond generally to the price and yield (before the fund's fees and expenses) of an equity index called the ISE Global Platinum(TM) Index. The fund will normally invest at least 90% of its net assets (plus the amount of any borrowings for investment purposes) in securities or in depositary receipts representing securities in the index. The index is designed to provide a benchmark for investors interested in tracking public companies that are active in platinum group metals ("PGM") mining based on revenue analysis of those companies. The fund is non-diversified.
	the ProShares Ultra Silver ETF	AGQ	ProShares Ultra Silver is an exchange-traded fund incorporated in the USA. The Fund will seek daily investment results that correspond to twice (200%) the daily performance, whether positive or negative, of its corresponding benchmark. The Fund tracks the daily performance of silver bullion as measured by the U.S. Dollar fixing price for delivery in London.
	PowerShares DB Silver Fund ETF	DBS	The investment seeks to track the price and yield performance, before fees and expenses, of the Deutsche Bank Liquid Commodity Index - Optimum Yield Silver Excess Return. The index is a rules-based index composed of futures contracts on silver and is intended to reflect the performance of silver.
	ProShares UltraShort Silver ETF	ZSL	The investment seeks to provide daily investment results (before fees and expenses) that correspond to twice (200%) the inverse (opposite) of the daily performance of silver bullion as measured by the U.S. Dollar fixing price for delivery in London. The fund invests in any one of or combinations of the financial instruments (swap agreement, futures contracts, forward contracts, option contracts) with respect to the applicable fund's benchmark to the extent determined appropriate by the Sponsor.
	iShares Silver Trust ETF	SLV	The Trust seeks to reflect generally the performance of the price of silver. The Trust seeks to reflect such performance before payment of the Trust's expenses and liabilities. The Trust is not actively managed. It does not engage in any activities designed to obtain a profit from, or to ameliorate losses caused by, changes in the price of silver. The Trust receives silver deposited with it in exchange for the creation of Baskets of Shares, sells silver as necessary to cover the Trust expenses and other liabilities and delivers silver in exchange for Baskets of Shares surrendered to it for redemption.
	the ETFs Platinum Physical Shares ETF	PPLT	The investment seeks to reflect the performance of the price of physical platinum, less the expenses of the Trust's operations. The fund designed for investors who want a cost-effective and convenient way to invest in platinum with minimal credit risk. Advantages of investing in the Shares include Ease and Flexibility of Investment, Expenses, Minimal Credit Risk.
	the ETFs Palladium Physical Shares ETF	PALL	The investment seeks to reflect the performance of the price of physical palladium, less the expenses of the Trust's operations. The fund is designed for investors who want a cost-effective and convenient way to invest in palladium with minimal credit risk. Advantages of investing in the Shares include: Ease and Flexibility of Investment, Expenses, Minimal Credit Risk.
ETFs Physical Silver Shares ETF	SIVR	ETFs Physical Silver Shares is an exchange-traded fund incorporated in the USA. The Fund's objective is to reflect the performance of the price of silver bullion, less the expenses of the Trust's operations. The Shares are designed for investors who want a cost-effective and convenient way to invest in silver. The security only holds LBMA Good Delivery bars.	
Base and Industrial Metals	iShares MSCI Global Select Metals & Mining Producers Fund	PICK	The investment seeks to track the investment results of an index composed of global equities of companies primarily engaged in mining, extraction or production of diversified metals, excluding gold and silver. The fund seeks to track the investment results of the MSCI ACWI Select Metals & Mining Producers ex Gold & Silver Investable Market Index (IMI) (the "underlying index"). It generally invests at least 80% of its assets in securities of the underlying index or in depositary receipts representing securities in the underlying index. The fund is non-diversified.
	Market Vectors Rare Earth Strategic Metals ETF	REMX	The investment seeks to replicate as closely as possible, before fees and expenses, the price and yield performance of the Market Vectors Global Rare Earth/Strategic Metals Index. The fund normally invests at least 80% of its total assets in securities that comprise the fund's benchmark index. The Rare Earth/Strategic Metals Index is comprised of companies primarily engaged in a variety of activities that are related to the producing, refining and recycling of rare earth and strategic metals and minerals. The fund is non-diversified.
	Market Vectors Steel ETF	SLX	The investment seeks to replicate as closely as possible, before fees and expenses, the price and yield performance of the NYSE Arca Steel Index. The fund normally invests at least 80% of its total assets in common stocks and depositary receipts of companies involved in the steel sector. Such companies may include small- and medium-capitalization companies and foreign issuers. As of December 31, 2013, the Steel Index included 27 securities of companies with a market capitalization range of between approximately \$317 million and \$79.7 billion and a weighted average market capitalization of \$25.9 billion. It is non-diversified.
	Global X Lithium ETF	LIT	The investment seeks to provide investment results that correspond generally to the price and yield performance, before fees and expenses, of the Solactive Global Lithium Index. The fund invests at least 80% of its total assets in the securities of the underlying index and in American Depositary Receipts ("ADRs") and Global Depositary Receipts ("GDRs") based on the securities in the underlying index. The underlying index is designed to measure broad based equity market performance of global companies involved in the lithium industry. The fund is non-diversified.
	PowerShares DB Base Metals ETF	DBB	The investment seeks to track the price and yield performance, before fees and expenses, of the Deutsche Bank Liquid Commodity Index - Optimum Yield Industrial Metals Excess Return. The index is a rules-based index composed of futures contracts on some of the most liquid and widely used base metals - aluminum, zinc and copper (grade A). The index is intended to reflect the performance of the industrial metals sector.