THE TRACKING, PROFITABILITY AND INFLATION RISK HEDGING PERFORMANCES OF GOLD ETFS IN THE UK DURING 2004 – 2014

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Abstract

Gold ETFs are relatively new instruments that were introduced only recently. Consequently, there are many things that are not known about them. Such things include whether the gold ETFs track physical gold prices, and returns, well in the UK, whether the introduction of the gold ETFs in the UK affected the gold mutual funds in the country and whether the gold ETFs hedged, or can hedge inflation. We find that tracking performance of every gold ETF categories is different. Further, individual tracking performance of every gold ETF differs despite of having similar underlying asset. The best individual gold ETF in tracking is a gold ETF that uses physical gold as its underlying asset. Not only it has the smallest tracking error compared to other gold ETFs, its tracking error is also smaller compared to gold mutual funds. In terms of substitutability, we didn't find any evidence to conclude that gold ETFs are substitutes for gold mutual funds, based on event study and regression analysis. Finally, the hedging capability of gold ETFs against inflation rates in the UK is found to be better than the hedging capability of inflation-linked bond ETFs, although both types of ETF track the inflation rates well.

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CHAPTER 1

INTRODUCTION

1.1 Background

The inception of gold ETF in the UK began in 2004, a year after the world's first gold ETF was introduced in Australia. The main objective of the gold ETF is to offer investors an opportunity to invest, or to be exposed to the ups and downs of physical gold prices. It also offers lower cost than physical gold investment, especially in the unit price, transaction cost and storage cost. From only two gold ETF products offered in 2004, the number has risen to 18 in 2013. The fund size has also risen from around £19 billion in 2004 to around £43 billion in 2013 (Morningstar, 2014). Not only can this trend be seen in the UK, but also in other countries, such as in the US, Australia and other European countries. In the US, for example, the number of gold ETF products has risen from less than 10 in 2003 to more than 80 in 2011 (New York Stock Exchange, 2014). The market capitalisation has also risen from less than USD5 billion to USD500 billion in the same period (Baur, 2013a).

Gold ETF is one kind of ETF which can be regarded as a financial innovation, according to Tufano (2003). It securitises gold by issuing 'gold shares'. In other words, owning a gold ETF is not owning physical gold, but owning a paper representation of the physical gold. This is because the gold is not in your possession and there are restrictions between you, as a gold ETF buyer and the gold, as the underlying asset. That is the basis of gold ETF. As time goes

by, we have seen other types of gold ETF appear in the market, such as synthetic gold ETF, inverse gold ETF, leveraged gold ETF and sector equity gold ETF. The first kind of gold ETF is physical gold ETF which invests in physical gold and its return is based on physical gold return although not identical. Synthetic gold ETF invests in financial instruments, especially derivative products, but tries to mimic the return of physical gold investment. Inverse gold ETF and leveraged gold ETF also invest in financial instruments. However, inverse gold ETF promises a return that would be contrary to the return direction of physical gold investment while leveraged gold ETF promises a return that would double the return of physical gold investment. Sector equity gold ETF, however, invests in stocks of gold mining companies.

The birth of these products can be seen as being stimulated by the great reception of gold ETF by the investors. They share a common objective, which is to expose themselves to the physical gold performance. This is in line with Miller (1988) who suggests a financial innovation (gold ETF which invests in physical gold) should stimulate further financial innovation.

Nevertheless, financial innovation can also be a result of complexity creation by certain parties in order to grab easy money from unaware investors (Allen, 2012). According to Miller (1988), the best financial innovation is one that is '*significant*' and '*successful*'. 'Significant' here is defined as permanent in existence while 'successful' is merely doing what it is supposed to do successfully. In the case of gold ETF, based on the current situation, we can say that it does not show any sign of becoming extinct or fading away from the finance arena. Instead, based on the number of products and fund size, it is still expanding. However, as Miller (1988) has put it, "*size is part of the story, but not all of it*". Investors might demand new alternative

financial instruments from financial intermediaries if gold ETF fail to deliver what it is supposed to deliver, i.e. exposure to the physical gold prices. This is where this study positioned its significance, by examining the performance of gold ETF in tracking the physical gold prices.

Previous reports suggest that many investors in the UK are interested in gold ETFs (Garcia-Zarate, 2011) and that the size of the market for the instruments has grown since they were introduced in 2004 (London Stock Exchange, 2014). However, there is not much information in the literature about how well gold ETFs track gold prices, and/or about the comparative performance of the different types of gold ETFs against each other in tracking gold prices. This opinion has also been shared by O'Connor et al. (2016), among others. By providing the performance of gold ETFs based on their tracking error, it will serve at least as a guide to the investors and future studies. Therefore, this serve as our motivation in conducting the first study.

Before gold ETFs were introduced in the UK in 2004, investors who wanted to have exposure to the risk and rewards of ownership of gold without investing directly in gold could do so by investing in gold mutual funds. Since gold ETFs are also meant to give investors exposure to the risk and return of ownership of gold, their introduction could have made a negative impact on the returns and volume of transactions in gold mutual funds markets, if investors in the markets consider gold ETFs as substitutes for gold mutual funds. Alternatively, the introduction of gold ETFs could have made a positive impact on the markets for gold mutual funds, if investors in the markets see gold ETFs as complements of gold mutual funds. Very little is known about whether investors consider gold ETFs to be substitutes or complements of gold mutual funds because there is not much information on this issue in the literature. Thus,

an examination should be done based on justification that how do investors perceived the gold ETFs compared to the gold mutual funds. That is, the importance of gold mutual funds after the arrival of gold ETFs, and this importance can be measured from their returns and volume. As we know, both returns and volume serve as two important factors to the investors in distinguishing one investment against another. Hence, this justification serve as our motivation to perform the second study.

Also, even there is a lot of information about the inflation hedging characteristics of gold, there is not much information in the literature about the inflation hedging ability of gold ETFs anywhere in the world. Further, instead of gold, there is another instrument that has been widely used to catch up with the inflation rate; inflation-linked bond. Quite similarly to gold, investors can also be exposed to the inflation-linked bond's market by investing in one type of ETF. The ETF is called inflation-linked bond ETF. Therefore, based on the logic that if gold ETFs and inflation-linked bond ETFs expose investors to the gold and inflation-linked bond investment, respectively, they should provide the hedging characteristics of the gold and inflation-linked bond to the investors. However, there is no evidence to this date of writing provided from previous studies to support this argument, and this situation serve as the motivation to pursue the third study.

The focus of the thesis is not on gold, but on gold ETFs, and the reason why the thesis focuses on gold ETFs is that they are relatively new instruments that were introduced only recently. Consequently, there are many things that are not known about them, which need to be researched. Such things include whether the ETFs track physical gold prices, and returns, well in the UK, as they were reported to do in other countries, whether the introduction of the

gold ETFs in the UK affected the gold mutual funds in the country and/or whether the gold ETFs hedged, or can hedge, inflation better than inflation-linked bond ETFs in the UK. The motivation for the thesis is that there was very little information on these issues in the literature before the research reported in the thesis was undertaken, despite the potential usefulness of the information on the issues to investors, regulators and some other parties. The purpose of the thesis is to generate the information and bridge the gaps relating to them in the literature.

Investors in gold ETFs, gold mutual funds, physical gold and other relevant instruments or investment vehicles, should be interested in the thesis because they will find the results reported in it is useful for determining whether the return and risk of gold ETFs are better, worse or the same as those of physical gold, gold mutual funds or other relevant instruments or investment vehicles. Thus, the information will be useful to the investors for deciding whether they should invest in the gold ETFs, or physical gold, or some other instruments or investment vehicles.

1.2 Theory and Evidence on the Use of Gold ETF

Gold ETF is a simple way to achieve profits from the ups and downs of physical gold prices without acquiring the physical gold directly (Guedj et al., 2011). This is based on the logic that gold ETF should track physical gold, in terms of returns, fairly well although not perfectly. In the US, research has been conducted that tries to examine the tracking performance of gold ETF (Murphy and Wright, 2012; Ivanov, 2011; Narend and Thenmozhi, 2013). Although the results are mixed, all of the tracking error figures recorded by them are very small, which is only significant when we consider at least four decimal places. To date, no study has analysed gold

ETF in the UK, to the best of our knowledge. Furthermore, those studies on the US market do not consider all of the available gold ETF in that market. Hence, overall, the studies can be understood as not complete enough. In addition, the examination of the tracking capability of the UK gold ETFs is essential in proceeding to the other research studies. This is because the UK gold ETFs performance in tracking the physical gold returns plays a significant part in whether they can be used as substitutes for gold mutual funds or as an inflation hedging.

The introduction of gold ETF in the UK market is perhaps not only as a consequence of marketing strategy planned by financial intermediaries to attract money from investors as mentioned by Massa (2000). Hortacsu and Syverson (2004) underlined that product differentiation plays an important role in the assumed homogeneous product industry. The most important underlying theory that might explain the co-existence of gold ETF and gold mutual funds in the UK market is suggested by Svetina (2010). He argues that the introduction of newly created ETF should aim at tracking the still untracked market sector or as a result of investor demand. Hence, the newly introduced ETF should receive a warm welcome from investors and this should be signalled from the amount of investment that flocked to gold ETF. This theory has been tested by Barnhart and Rosenstein (2010) in the US market between closed-end fund and ETF. They used event study analysis and found that closed-end fund and mutual funds are substitutions for each other. This finding is consistent with Agapova (2010 and 2011).

Regarding the capability of gold ETF, it has only been shown that gold can be used to hedge against inflation rate (Anand and Madhogaria, 2012; Narayan et al., 2010), but there is no such evidence on gold ETF. As a comparison in examining the inflation hedging capability of gold ETFs, inflation-linked bond ETFs which track the performance of inflation-link bond

are used. This is because inflation-linked bonds do track the inflation rate well (Swinkels, 2012) and it has also been shown in previous literatures that inflation-linked bond ETFs track the inflation-linked bonds well, although not perfectly (Fulkerson et al., 2014). However, inflation-linked bond ETFs capabilities to hedge against inflation risk are yet to be determined.

Many previous studies that compared the performance of different type of ETFs and their underlying assets didn't clearly mention the motivation for doing so. It seems like they were doing researches for academic purposes, not from the investors point of view. However, it is worth to mention that there were two occasions in which sparks the interest in ETF study, not only for academic purposes but also for the investor's interest. These two occasions not only involved investors and ETF issuers but also the government. Although on both occasions there were only inverse and leveraged ETFs as the main subjects, they (both occasions) have publicised the whole ETF (Shum et al., 2016).

The polemic of leveraged ETFs and market volatility has sparked arguments between many parties and led the Senate Committee of the US to form an investigation. The first occasion is the public inquiry that was held on 19 October 2011 by the Committee on Banking, Housing, and Urban Affairs on Securities, Insurance, and Investment that was set up by the Senate (U.S. Government Publishing Office, 2011). The inquiry ended with recommendations to improve the regulation and law regarding ETF. Those recommendations arose because all leveraged ETFs, not only in the US but also in the other part of the world, including UK are synthetic ETFs, and this may affect the market's stability and contrasting to the rules and regulations of the market itself (Shum et al., 2016 and Ramaswamy, 2011). That is, the problem with the synthetic underlying assets as they may not be as robust as original underlying assets.

To make the matter worse, there were cases involving inverse and leveraged ETF, especially regarding how it works, thus led to the second occasion. That is, the Financial Industry Regulatory Authority (FINRA) in the US penalised Citigroup, Morgan Stanley, UBS and Wells Fargo in May 2012 regarding their ETFs. The verdict is they were not producing adequate supervision while they were doing the transactions of inverse and leveraged ETFs, and they recommended the inverse and leveraged ETFs not on a reasonable basis, that is, failed to explain adequate information to the investors (Jiang and Peterburgsky, 2017; Shum et al., 2016). The amount of the penalty is $9.1 million.

Further, the leveraged ETFs has also received many negative reviews from columnists of well-known newspapers, including the New York Times, CNN Money and Wall Street Journal (see Sorkin (2011), Farrell (2011), Lauricella et al. (2012) and Light (2012)). All of them unanimously agree that leveraged ETF is a volatile instrument and only suitable to higher level investors. These insights from general papers have not only tarnished the image of leveraged ETF but also publicise the whole ETF. However, there are also contrasting opinions regarding the downside of the leveraged ETF based on the justification that the leveraged ETF plays only a small part, which is less than one percent based on market valuation of the overall ETF market. Hence, it would never make the market collapse and its downside should never be exaggerated (Shum et al., 2016).

In relation to this study, there is no study on gold ETF that is written before as comprehensive as this study. Further, gold ETFs are also offered in the form of synthetic ETF, inverse ETF and leveraged ETF. Thus, this study contribute to the existing literatures on gold ETF in that sense and motivates further research on gold ETF investment.

1.3 Aim and Objectives

A large number of UK investors increasingly turn to gold ETFs to participate in investment in physical gold (Flood, 2011). Because there is no research yet in the UK that has been devoted to identifying the motive behind this, we can only suggest that this is probably because of the performance of the gold ETFs. That is, most probably, their tracking errors that have attracted the investors, as ETFs are created to track.

Although there are empirical studies examining the tracking performance of gold ETF, none have been done in the UK market. In addition, due to the institutional characteristics, the ETF market exchange in one country is different than in other countries as pointed out by Milonas and Rompotis (2010). Furthermore, tax regulation in different countries also acts as a barrier to the local investors (Petroff, 2011). In addition, past research studies only consider a few gold ETF products which can be deemed as not enough to conclude the entire market of gold ETF. Hence, this study aims to fill this gap.

To realise this aim, our study recognises the key objectives as follows:

Study One: To determine whether physical gold ETFs track gold prices well in the UK.

Study Two: To examine whether the introduction of gold ETFs will affect gold mutual funds in the UK.

Study Three: To examine the inflation hedging capabilities of physical gold ETFs and inflation-linked bond ETFs.

The aim and objectives of this study are inspired by the connection between gold ETF and physical gold prices and returns.

To support this hypothesis, the following research questions will be answered:

- Do physical gold ETFs track the return of physical gold prices well in the UK?
- Does the introduction of gold ETFs affect the returns and trading volume of gold mutual funds in the UK?
- Are physical gold ETFs and inflation-linked bond ETFs capable of hedging inflation risk in the UK?

The empirical studies use data from Thomson Reuters Datastream, the Bank of England website, the Office for National Statistics website etc.

1.4 Contribution of the Thesis

This thesis contributes to the investment area by carrying out empirical studies that investigate whether the hypotheses hold in the UK context. To be more precise, these studies analyse a number of issues that have remained largely untouched by previous empirical studies. The main contributions of this thesis are as follows:

- This research has demonstrated that there is a gap in the empirical literature since most of the empirical research on gold ETF has been conducted using samples outside of the

UK, for example in the US. The samples only consist of a few gold ETF and not the entire gold ETF in that country. Specifically, we introduced an added support to the theoretical suggestion that gold ETF is a financial innovation that simplifies the investment in physical gold in the UK. We found that overall, the performance of gold ETF in the UK based on risk and return when compared to physical gold investment only differs by a very small amount. It can be said that gold ETFs in the UK tracked the physical gold well, although not perfectly.

- The most important contribution concerns whether gold ETF is just another financial instrument created to lure investors without any added value compared to the financial instruments that are already in the market. Gold ETF does differ from the gold mutual funds already available. We found that the introduction of gold ETFs in the UK market does not affect the investment in gold mutual funds. In fact, although the inception of the gold ETFs attracts a large amount of investment, we found no significant impact on gold mutual funds investment. This is perhaps because gold ETF offers different value to the investors.
- The other contribution of this study lies in the fact that it is the first study to thoroughly examine the role of gold ETF as an inflation risk hedger in the UK. We also checked the ability of inflation-linked bond ETF in inflation hedging. To the best of our knowledge, this is the first study to focus on this issue. We found that gold ETF is superior to inflation-linked bond ETF in hedging against inflation.

1.5 Structure of the Thesis

The remaining part of this thesis is structured as follows. Chapter 2 discusses the connection between gold market in the UK and other global gold markets, and the factors that influence

the gold prices. This is imperative as these same factors will influence the pricing of gold ETFs. Chapters 3, 4 and 5 are the empirical chapters. Chapter 3 attempts to examine the tracking capability of gold ETF in relative to other instruments in the UK. For that, we use 4 widely-used tracking error methods. We believe that using the UK market as our study market will contribute to the body of knowledge, even if we used a methodology that has been used before.

Chapter 4 examines the co-existence of gold ETF and gold mutual funds in the UK. It investigates whether the introduction of gold ETF lured away the investment from gold mutual funds. In other words, it tries to identify whether gold ETF and gold mutual funds are substitutes for each other.

Chapter 5 assesses the inflation-hedging capability of gold ETFs. This is to determine whether this characteristic that has been found to be in the physical gold prices exists in the proxy of physical gold prices, which is gold ETF.

Finally, Chapter 6 summarises the key findings, conclusions and suggestions made in the thesis.

CHAPTER 2

GOLD MARKETS AND FACTORS INFLUENCING GOLD PRICES

2.1 Introduction

The birth of gold ETF is without any doubt is as a result of gold investment. Gold investment happens around the globe as one of the gold transaction purposes and gold transactions happen in every part of the world. Although most of gold transactions are done over the counter, there are seven places where gold markets are located and they are usually been used by previous researchers as references to the gold pricing (O'Connor et al., 2015). They are London, which the gold market there usually referred to as LBMA or London Fixing, New York (COMEX), Shanghai (Shanghai Exchanges), Tokyo (TOCOM), India (MCX), Dubai (Dubai Gold & Commodities Exchange) and Istanbul (Borsa Istanbul AS). The pricing of gold in these gold markets is said to be influenced by many factors and these factors, alongside the connection between these gold markets, have drawn attentions from many researchers. Not only that, the gold pricing in these markets are undoubtedly have a strong connection to gold ETFs as gold ETFs are created to mimic the ups and downs of the gold prices.

Because of that, the purpose of this chapter is to explain and understand the factors that influence the physical gold prices. This is done as the thesis determines to what extent the gold ETF's return mimics the gold return, hence determines whether gold ETF can becomes substitute for gold. Therefore, it is essential to explain what drives the gold prices as these same factors influence the pricing of gold ETF. In addition, the objectives of this chapter also include

checking whether there is any linkages between the prices of gold and gold ETFs across the various countries that constitute the global market. The connections, if they exist between these asset markets, need to be explained and acknowledged as they could be part of the factors that influence the gold ETFs pricing in the UK.

2.2 Gold Markets around the Globe and Their Connections

As mentioned earlier, there are seven markets that can be considered as gold markets in the world today (O'Connor et al., 2015). From those seven markets, the London Bullion Market Association (LBMA), London, United Kingdom can be considered as the main market based on turnover, followed by New York (O'Connor et al., 2015). Ferry (2016) added that the 'main market' for physical gold in the world is the LBMA and the 'market' itself is over-the-counter with the participants are only consist of five bullion banks. The number of participants or the participant itself may change from time to time. The banks agreed upon the daily prices of physical gold among themselves and their agreed prices are taken as benchmarks for physical gold prices globally. The price benchmarks are widely known as the London Fix.

The other main market for gold is the Commodity Exchange, Inc (COMEX) which operates in New York, United States of America. COMEX trades metals which include gold and silver. The trading is based on the gold futures and the closing prices of the futures are considered as benchmarks for gold spot prices. The dominance of LBMA and COMEX are highlighted by Lucey et al. (2013). That is, they regard LBMA and COMEX as the global biggest spot and futures markets for gold. The reason to that is, the LBMA, followed by

COMEX, usually leads other gold market in gold pricing. This is also supported by the findings by Murray (2011).

According to Murray (2011) the two largest centres for gold trading in the world are the LBMA and COMEX futures, as 86% and 10% of the world's gold trading happens there, respectively. Not only that, Lucey et al. (2013) states that both markets influence other gold markets in terms of price discovery although no specific association in the sense of macroeconomic and politics can be found. They conclude that the LBMA is probably the dominant gold market by taking into account the existence of significant time variation. Further, Lucey et al. (2014) examine the returns and volatilities of four gold markets (London, New York, Tokyo and Shanghai), in searching for gold prices dominance. They provide an evidence that LBMA and COMEX are dominant in influencing other market's returns and volatilities.

The search for gold's market dominance is not new. In terms of gold market status and ranking, Laulajainen (1990) investigates three of them which are located in New York, London and Hong Kong. The daily prices from a 24 hour trading were analysed from each of them by using a VAR model. The findings show that the gold prices from New York do affects the gold prices in London and Hong Kong, which conclude that the New York gold market is the dominant to the other two. However, the study only used PM Fixings (London Fixing that happens in the afternoon) and didn't consider AM Fixing (London Fixing that happens in the morning) at all. This can lead to the reliability problem of the data as the PM Fixings overlaps with the New York trading.

The relationship between TOCOM and COMEX gold markets has also been studied, specifically by Xu and Fung (2005). By analysing the data of gold prices from 1994 and 2001, they found that the gold prices returns in the US led the Japanese gold prices returns and the association between those two is symmetric, especially when volatilities are taken into account. The reliability of the findings is superior to the findings by Laulajainen (1990) as the prices from those two markets do not overlap.

The findings from a more recent study by Jena et al. (2017) indicates that gold prices around markets worldwide do interact with each other. That is, the LBMA and COMEX lead other gold markets to a certain amount of time. Hence, they concluded that LBMA and COMEX serve as factors in determining the gold prices worldwide. Further, Yurdakul and Sefa (2017) deployed Engle-Granger and ARCH analysis and found that the LBMA gold prices as the only and most important factor to the gold prices worldwide.

As a conclusion, based on previous findings, the main gold market in the world which is LBMA is not being influenced by other markets. This is because the determination of the gold prices in the UK is done by market makers which are bullion banks and that process is only unique in the UK. It doesn't involve other markets and the purpose of the process is to determine the gold prices in the UK. As has been argued by Ferry (2016), if the London Fixing is influenced by other gold markets such as COMEX, then the London Fixing itself is pointless and if that is the case, all of the market makers would have realised. That is, they would just simply take the COMEX gold pricing as their reference instead of having their own.

2.3 Factors Influencing Gold Prices

As been mentioned by Ferry (2016), one of the main factor that influences the gold pricing is the price of gold futures. This evidence can be seen in the COMEX and COMEX itself is referred to as one of the main market for gold. Hence, gold futures market serves as a place for price discovery for gold. In fact, gold futures is the main factor that drives the ups and down of gold in 1980 to 1982 as investigated by Mills (2004). As gold futures prices serve as the 'future' prices for gold, it is very common that the market makers and other people who involve in gold transaction use the gold futures prices as their reference in their bid and ask process (Hunsader et al., 2012, among others). Not only in COMEX, gold futures prices are also found to lead the gold prices in India, according to Pavabutr and Chaihetphon (2010). The reason for that is the same to what happens in COMEX.

In the case of UK, although there are few researches done to connect between the gold prices and gold futures prices, the connection is inconclusive. The main reason is the LBMA. It determines the gold prices here and any other factor would be a less important than the LBMA (Harvey, 2013). For example, Caminschi and Heaney (2014) investigate the connection between gold futures in COMEX and LBMA. They found that the prices of gold futures in COMEX responds to the London Fixing process, although that process is done privately between the LBMA members which are bullion banks. A robust explanation to such reaction from the gold futures in COMEX is not given by them, especially on how this can happen in the first place. On the other hand, it confirms the other studies which designate LBMA as the main dominant gold market in the world.

Other than gold futures, as similar to other commodities, the factor that determine the price of gold in different markets is the demand and supply of the gold itself. O'Connor et al. (2015) point out that gold demand mostly derives from investment and jewellery. The most significant gold demand in investment is in gold ETF (Baur, 2013a) while other gold investment such as coin and bullion have much smaller impact to the gold demand. Jewellery in the other hand, plays a consistent role in gold demand, although its amount varies from year to year. Other sources of gold demand come from production industries such as electronics and medicals. The effect of demand factor is also found to be nearly similar, that is negatively affecting the gold prices in the US, Japan, Germany, France, Italy, and the UK, as reported by Batchelor and Gulley (1995). Further, Starr and Tran (2008) found that in developed economies which include the US and the UK, gold demand increases when the per capita GDP increases. They assume that this is because gold is regarded as a discretionary expenditure in those countries, in which people buy gold when they have more money to spend. In other words, gold is considered as luxury items instead of necessities, unlike in certain countries where gold has a close tie to their traditional belief and way of life. Therefore, the connection between gold demand and gold prices is more obvious in the country with developed economy.

Mozes and Cooks (2013) however, conclude that the demand of gold does not strongly influence the gold prices. This is based on their analysis through the 1992 to 2012 period which finds that the pattern of gold demand and gold prices differ and not similar in trends. In summary, there are times when the connection between gold demand and gold prices is strong, weak and there are times when there is no connection at all can be found between them. Hence, the former cannot be accredited to explain the latter, vice versa.

From the supply side, Feldstein (1980) claims that the gold sale by the central banks would affect the gold prices negatively and he offers a long explanation for his claim. In 1999, the Bank of England sold large amount of its gold holdings. The impact was the decreased of gold prices at that time and this is one of the evidences that support Feldstein (1980) claim. Also, previous investigation by Salant and Henderson (1978) found that gold sales announcement by central banks does affect gold prices in negative manner. Their research however, has been heavily criticised by O'Connor et al. (2015) as the methodology used is not reliable and valid in real world practice. It is unfortunate that as in 1999 gold ETF is still not available in the market or else we could have examined the impact of the gold sale by the Bank of England to the gold ETF in the UK.

Other than gold sale by the central banks, the supply of gold also comes from gold mining (O'Connor, et al., 2015). Bertus and Stanhouse (2001) discuss the relationship between gold supply from the gold mining operations and gold prices. From their study, the relationship is sophisticated to be identified as it is hard to differentiate between the new gold investment (ETF, bullion and coin) and the newly mined gold. Because of that, the connection between newly mined gold, gold demand and gold prices is ambiguous. In other words, the exact amount of newly mined gold that was released to the market, being circulated to the economy and was offered to the investors is not known. Of course, one cannot tell whether his or her investment in gold ETF for example, consists of newly mined gold or not. The same goes with gold bullion and coin. Gold is gold and its price does not differ based on whether it is newly mined or not. Perhaps a different and reliable methodology, with certain limitations should be developed and used to tackle the issue.

On the other hand, Erb and Harvey (2013), Borenstein and Farrell (2007) and Blose and Shieh (1995) found no evidence of relationship between gold mining (supply) and gold prices, especially in developed economies. Data from other countries such as developing economies were not considered as they are scarce and unclear. In certain countries, the amount of gold mined is secretive and not available to the public. Nevertheless, Selvanathan and Selvanathan (1999) and Rockerbie (1999) found that the increase of gold prices would result in the increase of gold supply from the mining activity and not the other way around. The effect of gold prices however, takes many years to be detected in the gold supply.

It is interesting to discuss the relationship between gold mining and gold prices. Rather, a couple of general questions should be asked and discussed before any investigation is carried out; Do the gold mining companies increase their output because of gold prices?; In the condition of bearish gold market, do the gold mining companies decrease their output or close their mining activity until the gold prices become bullish? Yet, the response from the gold mining companies to these questions have never been reported in any academic articles, just to avoid any speculative intention.

Apart from demand and supply, interest rate has also been heavily associated with gold prices by previous researchers. The logic behind that is if the interest rate is decreased, gold prices will go up as investors will choose other type of investment such as gold. Because of high demand, gold prices will go up and offer higher returns than interest rate. In other words, gold is an opportunity cost for interest rate. This is not entirely true though.

For instance, Diba and Grossman (1984) conclude that interest rate do act as an opportunity cost for gold. Their study uses data in the US in the late 1970 s to early 1980s. They found that interest rates and gold prices do interact with each other, implicating that interest rate serve as a factor to gold and vice versa. However, that is not the case based on the findings by Lawrence (2003). By using a longer time span for the data, he found that the returns on gold is not significantly correlate with interest rates, inflation rates and GDP. On the other hand, returns from other investments based on other assets such as aluminium and zinc, and financial assets such as stock market indices and T-Bill do significantly correlate with interest rates, inflation rates and GDP. His findings is supported by Silva (2014). Other findings by Levin et al. (2006), Baur (2011) and Batten et al. (2014) are mixed, in which they found that the relationship between gold prices and interest rates varies according to the timing and time span of the data. The explanation is that other variables might have intervened or moderated the relationship between gold prices and interest rates during different times. Therefore, a purely and clear relationship between them cannot be established.

Inflation rate is also found to be having a relationship with gold prices. For instance, Silva (2014) concludes that inflation in the US is positively correlated to gold prices by using data in the 1970s and 1980s. This confirms the findings by Taylor (1998) who uses time series analyses such as cointegration and other long run tests to the data from 1914 to 1996. The inflation rate is represented by the Consumer Price Index (CPI) in the US. Levin et al. (1994) and Levin et al. (2006) investigate and separate the relationship between inflation rate and gold prices to long run and short run. They found that the long run relationship is more obvious than the short run relationship between the inflation rate and the gold prices. Analysis of the inflation rate and gold prices by using structural breaks to eliminate the effect of hyperinflation era

during 1970s in the US was done by Worthington and Pahlavani (2007). They found that gold prices can be used to hedge against inflation during the 1940s to 2000s era. Bampinas and Panagiotidis (2015) confirm that this is also the case in the UK.

Feldstein (1980), Fortune (1987) and Batten et al. (2014) demonstrate that the relationship between gold prices and inflation rate occurs because they both are related to the interest rates. As an evidence, gold prices and Consumer Price Index (CPI) do relate to each other according to their investigations but the relationship becomes weaker during 1980s to 1990s. The relationship however, improved during early 2000s, as pointed out by Batten et al. (2014). After a thorough examination, it is found that the reason for that is interest rates. That is, as interest rates decreased, the inflation rate increases as more money can be borrowed and circulated in the economy. Interest rates, as they suggest, is an opportunity cost for gold prices, vice versa. Hence, interest rate affects inflation rate and gold prices concurrently. This explanation however, can be challenged as that is not the case based on findings by Lawrence (2003), Levin et al. (2006), Baur (2011) and Silva (2014).

Inflation rate might have a 'unique' relationship or might impact gold prices due to many reasons, based on previous researches. The first one is gold has long been regarded as a 'global currency', especially during the gold standards era (O'Connor et al., 2015, among others). That is, many currencies have been linked to gold (Pukthuanthong and Roll, 2011) and as currencies react to inflation, there is a strong intuition that gold itself might react to inflation. Not only that, according to many previous researchers, for example Worthington and Pahlavani (2007), gold is accepted worldwide as it is a real, tangible and has its own widely complimented

intrinsic value. Because of that, Fisher (1930) suggests that gold can be utilised as a wealth shelter against inflation rate. Thus, that suggestion serves as the second reason. Gold is also limited in amount and its production is also limited. Unlike fiat money, gold cannot be simply printed and circulated in the economy. Hence, the third reason is gold financial ability or purchasing power, cannot simply be decreased because of inflation and this is why gold is considered as a hedge against inflation (Van Hoang et al., 2016). Therefore, people will choose gold in the time of inflation and its demand will drive its prices up.

The fourth reason is gold has been found to be responding quicker to news than consumer prices (Mahdavi and Zhou, 1997, among others). That of course is a sign that gold could lead inflation in the economy (Laurent, 1994; Garner, 1995; Ranson and Wainright, 2005), as if there are changes in inflation then there has already been changes to the gold prices. The fifth reason is gold is being used as one of the materials in production sector such as electronics, dentistry, medical, advance technology and aviation (Lawrence, 2003). Therefore, if inflation increases, prices of products from these sectors would also increase. This might decrease the demand of these products, hence the demand of gold. Also, if the gold prices increase, the prices of these products would also increase and this can lead to inflation (Van Hoang, et al., 2016). In the event of higher inflation, interest rates would be raised to appeal the investors or borrowers (Feldstein, 1980). As this happens, investors who are looking for a higher compensation would leave gold investment and buy notes or bonds (where interest rates is part of the deal). As a result, the required rate of return from gold investment or holdings would also be raised to ‘counteract’ the increased interest rates and the exodus of the investors. That is the sixth reason.

Apart from these reasons, Fortune (1987), Levin et al. (1994) and Levin and Wright (2006) suggest a simpler explanation regarding the connection between inflation and gold prices. That is, if inflation increases, the costs related to gold exploration, mining, producing, processing and transportation would also increase, hence increasing the gold prices.

The next factor that is usually being associated with gold prices is the US Dollar currency. This argument stems from the fact that gold transaction usually involves US Dollar (O'Connor et al., 2015). Therefore, when the US Dollar depreciate against other currencies, gold becomes cheaper to other countries and demand will increase, as well as gold prices. In other words, US Dollar and gold prices are said to have negative relationship between them. Many previous literatures found such evidence to support this argument (Tully and Lacey, 2007; Sari et al., 2010, among others). Nevertheless, there are also researchers who find that this is not necessarily true. For example, Sjaastad and Scacciavillani (1996) argue that it is the European countries that controlled the global gold market based on their currencies and this is supported from their analysis of the effect of global currencies to the gold prices.

On the other hand, Sjaastad (2008) conclude that currencies from the countries in which gold investment activity happens intensively do have significant effect on gold prices and top of that currencies hierarchy is the US Dollar. On the other note, Pukthuanthong and Roll (2011) suggest that the connection between the US Dollar and gold prices can only be found and proved in statistics but in real world, that is not the case. They show that the gold prices can be linked with any currencies that is depreciating, not only limited to US Dollar. The gold prices – US Dollar connection is actually based on 'popular' belief. Their argument is supported by

O'Connor and Lucey (2012) by using different methodology. Therefore, these findings from these two articles have successfully show that the connection between the US Dollar and gold prices is not beyond any reasonable doubt.

Gold is also influenced by investor's behaviour according to Aggarwal et al. (2014). That is, gold prices react based on the investor's perception regarding future outcome. The reaction varies in amount and direction (positive or negative) of the future path. This is in line with the findings by Smales (2014) and Smales and Yang (2015). Smales (2014) found that gold futures returns is highly effected by bad news, especially to the traders with net position. In addition, Smales and Yang (2015) found that gold prices decreased when good news are announced regarding macroeconomic condition. The good news are found to be statistically significant in explaining gold trading volume, volatility and returns. But then good news not only influencing gold prices. They are found to be influencing many others such as stock prices, firm's prospect and performance (Milgrom, 1981). Also, they are found to affect stocks, crude oil, interest rate, foreign exchange (Kurov and Stan, 2018) and others, which are also being heavily linked with gold prices. That is, the gold prices-investor behaviour connection is easy to be stated and it's anyone's guess, but to provide solid evidence is another issue. In other words, the relationship between gold prices and investor's behaviour is not really obvious and clear.

The factors that determine the gold prices are many and complicated to be identified according to Li and Chengmei (2013). This can be seen in many previous literatures in which many researchers have been trying to discover the factors from time to time. To sum up, the foundation of gold price is a very sophisticated economic procedure. Nevertheless, Li and Chengmei (2013) found that gold reserve, energy product, financial market and macroeconomic indicators do have significant relationship with gold prices, but not serve as pure factors. Kumar (2017) found that oil prices Granger caused gold prices while Harris and Shen (2017) identify USD rates as factor which determine gold prices. Gangopadhyay et al. (2016) however, identify USD rates, oil prices and financial markets as the factors driving gold prices. Other than that, Ariovich (1983) found that political tensions affect mostly the gold price in the US than any other market, due to the US Dollar that is being used as 'international currency' and gold price quotes.

As many factors have been used in modelling gold prices and determining what are the factors that drives the gold prices, Baur and Glover (2015) suggest that many previous literatures actually have failed to identify the correct factors. Instead, they only come out with what is categorised as '*factors that could be used for speculative purpose by certain investors*' and not factors that actually guide the gold prices. The main reason for that is overspecification, a problem which can be found not only in gold literatures but also in other areas as well.

2.4 Discussion and Conclusion

The relationship between gold market in the UK and gold market in the US can be determined by comparing the gold prices from those two markets. From the Gold Price Group (2017), it is found that the price for 1 oz gold is GBP974.10 in the UK and GBP974.86 in the US (prices for 14/11/2017 after currency exchange conversion). The price is pretty much the same. However, if an investor from the UK want to buy 1 oz of gold, he better buys it from the UK market as the exchange rate does fluctuate and he would have to bear other costs such as transportation and insurance. That is, the gold price is not cheaper in other markets compared to the UK. In terms of returns, the daily return for the UK (between 13/11/2017 and 14/11/2017) is 0.18% while it is 0.05% in the US for the same period. This is because the gold price in the UK was cheaper than in the US on 13/11/2017. However, there is no guarantee that this condition is true all the time.

Because of that, many studies have been undertaken to link between the gold prices in the UK to the other gold prices in other markets, not only the US. Majority found that gold prices in the UK and US markets influence other gold markets and there is no possibility of the other way around. Further, Jena et al. (2017), Yurdakul and Sefa (2017) and Ferry (2016) found that the UK gold market is the most dominant gold market in the world, which support the suggestion from Caminschi and Heaney (2014) that it is the LBMA that influences the gold prices in COMEX. The explanation to that is the LBMA itself which consists of market makers in the gold market, not only in the UK but also in the world. They are considered as market makers as they hold the majority of the gold stocks that can be circulated in the market, whether

that gold belongs to them or to their clients (Ferry, 2016). As far as we know, there is no evidence that suggests that the gold prices in the UK is or was influenced by other gold markets.

As Jena et al. (2017), Yurdakul and Sefa (2017), Ferry (2016) and Caminschi and Heaney (2014) suggest, London Fixing process is like an auction market, but it is done privately between the market makers. Thus, what determines the agreed prices is anyone's guess, but for a start we know that it is the market makers. And the agreed prices serve as the gold prices for UK gold market. The need to determine its own gold prices is caused by the complications involving gold transactions. That is, taxes and other related costs, which are trickier when involving two countries like the US and the UK (Petroff, 2011).

Other than gold market, there are factors that are said to be influencing the gold prices. They are gold futures prices, gold demand and supply, interest rate, inflation rate, US Dollar and others. If these factors do influence gold prices, then these same factors will influence the pricing of gold ETFs. However, based on previous findings, it is still inconclusive whether these factors influence gold prices or not. This is in line with Li and Chengmei (2013) and Baur and Glover (2015) suggestion that so far there is not even a single factor that can be regarded as obvious or pure factor that influences the gold prices and researchers are still struggling to find it. As a result, this is also the case for gold ETF.

Researches regarding gold ETF, especially gold ETF markets around the world is limited (O'Connor et al., 2015). This is because gold ETF is a type of financial instrument which is guided by rules and regulations according to the country it is traded, unlike physical gold which its value is accepted all around the world. That is, gold ETF is probably appealing in one country but not in the other country as it is new compared to other financial products and not many countries have gold ETF market. The other explanation is that the usual benchmark or targeted index for gold ETF is gold prices itself. Hence, people who are interested in gold ETF globally may just refer to the global gold markets. Further, so far there is no literature which investigates the connection between global gold ETF markets.

It is also interesting to note the relationships between gold ETF and gold that are found by previous literatures. For example, Naylor et al. (2011) found that by using gold ETF, there is no possibility for an investor to earn abnormal return. That is, it is impossible to achieve more than what can be achieved in the gold market through gold ETF market. The reason is gold ETF is created to mimic and not to over-achieve the gold returns. Hence, they conclude that the returns from gold ETF market is neither similar nor greater than their expected return, which is gold market return, after other costs are considered.

Other than that, Ivanov (2011) found that gold ETF prices do affect the spot price of gold in New York. That is, gold ETF market serve as a market for price discovery for gold futures and gold itself. This is supported by the findings by Baur (2013a) that gold ETF introduction has increase the demand of gold as gold investment is more accessible, especially to the small investors. This happens as many gold ETF use physical gold and gold futures as

their underlying assets. Hence, certain investors turn their heads to the gold ETF market as a reference to the gold pricing. Also, because of the easier access, gold ETF has become more popular in gold investment especially to the small investors and they consider that gold ETF investment as a gold investment (O'Connell, 2007). Not only that, Bernstein (2009) suggests that ETF introduction would affect significantly the trend of its underlying asset and the derivative instruments which also use the same underlying assets. This happens not only in gold ETF but also in other commodities ETF. The effect is that there is a shift in the dominance of price discovery between the ETF market, the underlying asset market and the futures market of that underlying asset, similar to the conclusion by Ivanov (2011) and Baur (2013a). So far, no such investigation is done in the UK market.

CHAPTER 3

THE TRACKING PERFORMANCE AND PROFITABILITY OF GOLD ETFs RELATIVE TO SOME OTHER INSTRUMENTS IN THE UK

3.1 Introduction

In general, gold exchange traded fund (ETF) is an investment instrument that is created to track the ups and downs of gold prices. Other than gold ETF, there are gold mutual fund, said to have a similar objective to gold ETF. These two investment instruments are usually used as substitutions by investors who are looking to profit from gold prices although they are short on capital (Flood, 2011). On the other hand, if the gold market doesn't do well , hopefully by using either gold ETF or gold mutual fund, they will not lose as much as investing in physical gold. Nevertheless, both investment instruments may or may not share similar performance in tracking the ups and downs of gold prices. The similarity or difference between gold ETF and gold mutual fund in the tracking performance can be determined by looking at their tracking errors. Tracking errors are one of the key elements in choosing which tracking investment instruments to buy, beside other factors such as cost, tax and availability.

People are attracted to gold ETF and gold mutual fund because they either have a direct or an indirect connection to gold, and gold has long been considered as a safe shelter for one's wealth and as a shield from inflation and financial distress. Its value is said to have been consistent over decades and centuries.

In describing the special features of gold in finance, especially in worldwide acceptance of its value, according to Baur and Lucey (2010), there is no robust explanation of why people accept gold as a safe shelter in preserving wealth. It is a common belief that gold may act as the safe shelter, maybe because of its role as money in ancient times or maybe because of traditional belief. Baur and Lucey (2010) also found that gold preserves its value when stock prices in certain countries are experiencing a downturn. The investment in gold is also more profitable when compared to other assets. By using gold spot prices from 1970 to 2003, McCown and Zimmerman (2006) found that gold prices have no market exposure (zero-beta), with average return that is slightly higher than Treasury Bills. They also found that gold has an inflation-hedging ability. Their findings served as a great motivation for investors who are looking for a perfect shelter in preserving the value of their money. Treasury Bills have long been considered as a perfect investment as they are capable of enduring risk. The superiority against Treasury Bills is considered as their greatest achievement. In comparing gold prices against money value, Reboredo (2013) used weekly data of gold prices from 7 January 2000 to 21 September 2012 in his study. By using copulas technique, he found that gold can be used as a hedging technique and a safe shelter against US Dollar movements. His finding is consistent with many previous seminal works which support the idea of using gold as a hedge or a safe shelter against the currency price changes. While many studies support the usage of gold to bear against stock market movements, inflation and currency depreciation, it is worth noting that the attractiveness of gold does not only apply to individuals. Central banks were reported to hold passive stockpiles of gold, without taking into account the patterns of gold prices (Aizenman and Inoue, 2013). Once more, this concludes the utility of gold in the financial system because of its vast worldwide recognition. It is also because gold is useful during difficult times, as it cannot be manipulated, unlike currency notes which can be printed if the central bank wants to interfere

with its value. Aizenman and Inoue (2013) further conclude that this supports the idea that gold is a safe haven asset during economic downturn.

The attractiveness of gold has triggered the innovation of gold investment products, such as gold ETF and gold mutual fund. These products usually offer return characteristics that are similar to or nearly similar to gold prices, as to what they are advertised. This substitutional characteristic has attracted investors, as people may substitute characteristics of the goods or services as the substitution effect is decided by preferences for characteristics (Ratchford, 1975) and in this case, the characteristic is the rate of return of gold prices. Gold ETF has reformed the gold market by successfully securitising gold. Nowadays, there are many gold ETFs available worldwide. In the UK, gold ETF is one of the types of ETP (Exchange Trade Products) and is quoted and traded on the London Stock Exchange intradaily on every working day, similar to ordinary shares (Financial Services Authority, 2012; Morningstar, 2014; Financial Conduct Authority, 2016).

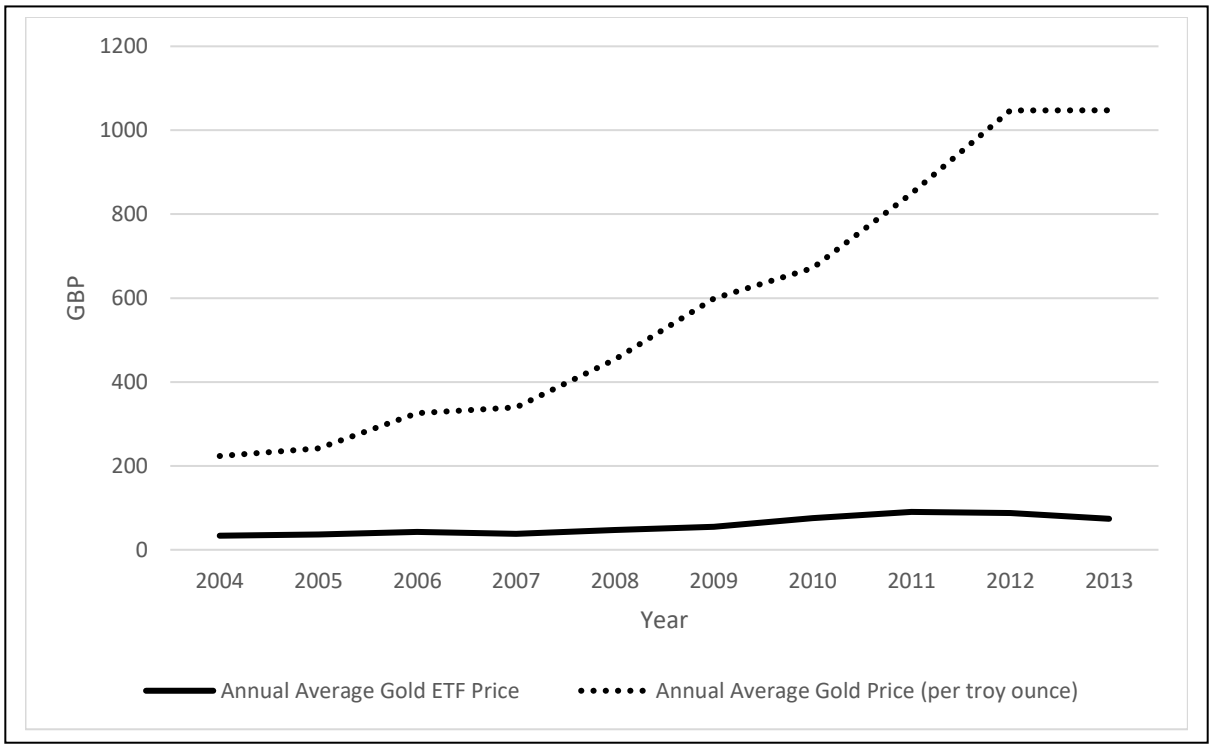
ETF on the London Stock Exchange begins trading in 2000 when an ETF which tracks the FTSE 100 index was launched. Since then, the value of ETF traded has increased from 6 million to 799 million pound sterling in 2006 (Chelley-Steeley and Park, 2011). The same trend can be seen in gold ETF. Gold ETF begins trading on the London Stock exchange in 2004. From only two gold ETF products offered in 2004, the number has risen to 18 in 2013. The fund size has also risen from around £19 billion in 2004 to around £43 billion in 2013 (Morningstar, 2014). In general, the market of gold ETF is more liquid, compared to the market of physical gold, gold mutual funds, gold company stocks and gold futures (Kostovetsky, 2003;

Nedeljkovic, 2005; Christoffersen et al., 2008; Guedj and Huang, 2009 and Baur, 2013a). The annual average volume for gold ETFs on the London Stock Exchange from 2004 to 2013 is around 200 thousand, while the annual average volume for each of the gold ETFs is around 100 thousand (Thomson Reuters, 2014).

One of the explanation on why gold ETFs are popular nowadays is they offer a cheap alternative to the physical gold investment (Zhang, 2015). This can be seen in Chart 3.1 that compares the physical gold prices with gold ETF's price average. The data were taken from Thomson Reuters Datastream (2014) for gold ETFs while for gold prices, they were taken from the Bank of England website (Bank of England, 2014). While the physical gold prices increased in hundreds per troy ounce during the period of 2004 – 2013 with significant difference, the price for gold ETF, on average is still maintained under GBP200 per instrument. This preservation of price is also the advantage of ETF compared to other financial instruments such as mutual funds and futures (Hunsader et al., 2012).

Chart 3.1: Timeline of Gold Price Movement and Average Gold ETF Price.

Gold prices and gold ETF prices are based on annual average from 2004 to 2013. 2004 is the year when gold ETF was introduced on the London Stock Exchange. The data for gold prices were taken from the Bank of England website while the gold ETF prices were taken from Thomson Reuters Datastream. The gold ETFs were offered to the investors at low prices compared to physical gold hence attracting investors.



Regarding the people who is likely to trade gold ETF, according to Zhang (2015) and Shafiee and Topal (2010), people who used to trade physical gold, gold company stocks and gold futures are more likely to trade gold ETF. This is because the trading of physical gold, gold company stocks and gold futures come with their own shortcomings that would let many investors down. For example, the physical gold would include high costs relating to its storage and insurance, the gold company stock would include the other risk such as the management risk of the company and the gold futures contract would include high capital, leverage and margin. However, Zhang (2015) also added that gold ETF may also attract newcomers because

of its cheap price. Milonas and Rompotis (2010) added that ETF doesn't have minimum investment prerequisites hence facilitate the newcomers in the investment process.

Like other investment instruments, ETF also comes with frictions. In the case of gold ETF, according to Gulley and MacDonald (2011), the costs related to buying and selling gold ETF in the secondary market and the fees of the fund's continuing expenses will be reasonable with, or possibly cheaper than, the costs that arise in buying, selling, storing or insuring physical gold in a conventional designated gold bullion account. Gold ETF holders also enjoy lower management costs compared to gold mutual fund as gold mutual fund are actively managed while ETF is passively managed.

However, it is still unclear when it comes to knowing how much or what fraction of gold a share of gold ETF holds, for example in a standard unit of weight measurement. The implication from this is the gold ETF prices would not move as exactly as the physical gold prices. If it is clearly mentioned that a gold ETF represent one troy ounce of gold, then we can expect that the gold ETF prices will follow exactly the prices of one troy ounce of gold. But there is no such announcement (Gulley and MacDonald, 2011). Thus, there exists differences between gold ETF prices and physical gold prices and that differences are known as tracking error.

There are different types of gold ETFs, each with its own underlying assets whose return they aim to achieve for their investors. There are some, called physical gold ETFs, which have physical gold as their underlying assets and aim to mimic the return of physical gold (hereafter, gold) prices. There are some others, called synthetic gold ETFs, which have mainly swaps, securities and/or commodities as their underlying assets and aim to mimic the return of gold prices. There are also some, called leveraged gold ETFs, which aim to double the return of gold prices, while there are others, called inverse gold ETFs, which aim to achieve the opposite of the return of gold prices. Further, there are some, called sector equity gold ETFs, which have only shares of gold related companies as their underlying assets.

All gold ETFs are passively managed. This is one of the characteristics which distinguish them from gold mutual funds (such as gold commodity mutual fund and/or sector equity gold mutual fund) which are actively managed. Gold commodity mutual fund are fund which invest in securities or derivative instruments which provide exposure to the return and risk of gold. They often use the return and risk of gold as their benchmark. Sector equity gold mutual fund invest in shares of domestic and foreign companies which are mainly involved in the mining, exploration and production of gold (Jaffe, 1989).

The inception of gold ETF on the London Stock Exchange happened in 2004 and it is worth mentioning that it was the Australian Stock Exchange where the first trading of gold ETF happened, which was in 2003 (Bloomenthal, 2008). The first gold ETF on the Australian Stock Exchange was a physical gold ETF, in which the investors could experience the performance of gold prices by holding to the gold ETF, through its rate of return, specifically. Since then,

other gold ETFs have emerged, each with its own characteristics and performance in attracting potential investors who are already hungry for gold exposure. The gold ETF transaction activity is done through security exchanges, in which they are bought and sold in a similar way to stocks. Furthermore, they are also priced throughout the day to mirror market fluctuations, hence providing a good monitoring and rebalancing.

The arrangement of this chapter is as follows. The first section introduces the idea of this first study. The second section explains the motivation for pursuing the study. The third section reviews the previous literatures related to this study. The fourth section analyses the previous literatures related to this study. The fifth section describes the gaps that this study tries to fill. The sixth section explains the development of the hypotheses in this study. The seventh and eighth sections describe the sample data and the methodologies used in this study, respectively. The ninth section reports the results from the analyses while the tenth section discusses and concludes the findings of the study.

3.2 Motivation of the Study

ETF is a popular financial instrument that is used mainly as an investment tool. Almost everything that is offered in financial market is being securitised in the form of ETF. The most recent is marijuana ETF, which tracks the performance of 14 stocks of medical marijuana companies in Toronto Stock Exchange (Borzykowski, 2017). In the case of gold ETF, it is created to track the performance of gold prices. Gold prices tracking is desirable because it brings people to experience the performance of gold prices return. Gold prices return is said to be a safe shelter or a hedge against inflation or stock market movements or currency

depreciation. Gold ETF is a newer type of investment product compared to gold mutual fund, gold stocks and gold futures.

The formation of a newer financial instrument may strongly be motivated by arbitrage activity (Dow, 1998 and Rahi and Zigrand, 2009). That is, the new instrument is used as a tool to profit from the discrepancy in different markets. Not only that, Henderson et al. (2011) and Gennaioli et al. (2012) added that beside the arbitrage activity, the motive may also to gain profit from the investors' lack of understanding regarding the performance of the new instrument. In the case of gold ETF, its performance should be measured by its tracking error.

Perhaps if it's not because of its performance, the gold ETF is attractive because of its simplicity compared to other gold products such as gold mutual fund and gold company stocks (Nedeljkovic, 2005; Guedj et al., 2011) and simplicity is an advantage in financial market. That is, it would influence the adverse selection factor (Zhang, 2015). The adverse selection argument brings forward the idea that a security that is information sensitive will be abandoned once security with less information sensitive is inaugurated. In the case of gold ETF, it is considered as a less sensitive security than gold mutual fund and gold company stocks. The reason behind this is the management of gold mutual fund and gold company stocks are more complicated than the management of gold ETF. Gold mutual fund involve active management while gold ETF is not while gold company stocks not only depend on the performance of gold prices but also the management of the gold company itself. Thus, the performance of gold mutual fund and gold company stocks not only show the performance of gold prices but also the management style and ability, the cost structures of the funds and stocks, and other policies

that may be adapted by the gold mutual fund company and gold company (Zhang, 2015). The implication is the introduction of gold ETF will attract the investors that are already have their positions in gold mutual funds and gold company stocks.

But the simplicity of gold ETF compared to gold mutual fund and gold company stocks is well understood and doesn't need to be further examined. It is the other factor that needs to be examined and explained, which is its performance or tracking error. Thus, ETF's tracking error has received much attention from previous researchers such as Kostovetsky (2003), Gallagher and Segara (2004), Cohen and Qadan (2010), Shin and Soydemir (2010), DeFusco et al. (2011), Ivanov (2011), Lu et al. (2012), Meinhardt et al. (2012), Plamondon and Luft (2012) and Narend and Thenmozi (2013), among others.

Oztekin (2016) mentions that there is a rivalry between mutual funds and ETF providers that results in aggressive actions by both teams in attracting investors. This can be seen in moves taken by both providers, especially large institutions in decreasing the costs that should be paid by the investors. Further, Oztekin (2016) elaborates that ETF has grown enormously in numbers for the past 20 years and mentions researches on determining why a few ETFs were chosen by investors instead of many ETFs in the market are still rare. There need to be more researches on that topic as many ETFs share similar backed assets or holdings and intended or track indexes. Therefore, investors should be provided with useful information to choose the best. In choosing the best, the characteristics of the best ETFs should be determined to better suit the investors' need and can also be used for marketing purposes. Not only that, the characteristics can be used as a guideline to develop new funds by the ETFs providers. One of the

characteristics that has been stressed by Oztekin (2016) is the tracking error, which is the difference between the ETFs performance and their respective indexes that they should mimic.

From the point of view of investors, there are two important issues about the gold ETFs referred to above. One of them is the extent to which each type of the ETFs mimics the return and risk of their underlying assets. In principle, all types of the ETFs should mimic the return and risk of their underlying assets in the same market. But from previous literatures, that is not necessarily true.

This study was initiated because there is no comprehensive study regarding gold ETFs performance in mimicking the gold prices in the UK. There are studies which concentrated on the US market but they are not comprehensive studies as they didn't include all of the available gold ETFs or at least majority of the gold ETFs in that market. Furthermore, the US ETF market is different in terms of volume traded, number of products and the prices of the underlying gold prices compared to the UK market.

There are also barriers to the UK investors in investing on the US ETFs such as currency exchange and taxes. It is found that there are similar ETFs that are traded both in the UK and US market. The creation of multiple offerings of similar securities in multiple markets with the existence of arbitrage activities has led to the belief that this situation occurs simply to satisfy the needs of local investors, but markets are also different in terms of institutional characteristics, trading activity and also other associated factors such as return, risk, tracking ability, costs, liquidity, as discussed by Milonas and Rompotis (2010). By comparing ETFs in

the US market and in the Swiss market which offer similar stock indices as their benchmarks, they found that the offerings of the ETFs are not interchangeable as both the markets have different institutional characteristics. They found that tracking errors for the ETFs that mirror their home underlying indices are small compared to others which follow foreign underlying indices. The time of the market operations also contributed to the differences as investors prefer the ETFs that are offered in their local market although the ETFs that are offered in the foreign market with same underlying offers lower expenses and better in performance. The absence of the arbitrage activities, they explained, is caused by currency risk and a shorter time in doing market activities. That is, if an ETF follows a benchmark from foreign country, it has to consider the currency exchange but this is not the case for an ETF which follows a benchmark from its own country. As for the market activities, Milonas and Rompotis (2010) found that there are only two hours when both markets from the two different countries open simultaneously to investors. As a result, anything happened in one market might not fully updated in the other market. The Swiss ETF market is also found to be illiquid when compared to its US counterpart. These factors are also found to discourage US investors from trading in the Swiss ETF market. Furthermore, if an investor considers using currency hedging techniques in achieving arbitrage opportunity between those two markets, it will be more complex than expected and the result is a new transformed financial product that is complicated to sell. This is because currency rate and stock exchange often does not move in a similar or contrasting pattern and there are layers of currency risk regarding the underlying assets and ETF markets. Their results are in line with findings by Engle and Sarkar (2008) (cited in Lu et al. (2012)) who found that local ETFs certainly track the underlying indices with errors that are small and highly transient compared to foreign ETFs. Williams (2016) further support the results with his findings; ETFs do track the underlying indexes well, if the returns from the ETFs are measured by the local currency.

However, when the ETFs use foreign currency quote, the returns experience significant volatility because of the currency movements itself.

Hence, there is a need to examine specifically one market because results from other market is not reliable.

Further, ETF that is based in the US is often tricky to be invested by the UK investors when tax regulations are considered. The tax regime in the US imposes withholding tax and this will tax ETF dividend at a soaring rate, which is usually 30%, if the ETF pays dividend. Of course, when considering returns from the ETF, this should be considered as a high rate (Petroff, 2013). Furthermore, in general, the HMRC enforces a tax regime on ETF similar to that enforced on other funds. Hence, all gains from the funds will be considered as income tax and will not qualify to be held in an ISA. However, if the ETF is given the reporting status, the profit from the ETF can be considered as capital gains tax and generally this is cheaper than income tax. The maths is simple: capital gains tax can be as low as 18% or as high as 28% while income tax can soar up to 50% (HM Revenue & Customs, 2 October 2013). So far, no US ETFs are entitled to a reporting status while most of their UK counterparts are. As a result, many London Stock Exchange ETFs do offer replications of the US ETFs that are perceived as attractive to UK investors. This can be seen from their prospectuses and investment objectives. No research has addressed this issue in the UK. Hence, we expect that our results will be different from previous studies.

Another issue is with the different types of gold ETFs and gold mutual funds described before. There is very little information in the literature about the differences in their abilities to track the return and risk of gold. In fact, according to O'Connor et al. (2015) there only few researches about gold ETF and can be considered as limited in numbers. Such information about gold ETFs and gold mutual funds will be useful to investors for choosing which type of the ETFs to invest in. Apriori, even though all types of the gold ETFs and gold mutual funds are often presented as substitutes for gold (Murphy and Wright, 2010 and Dulaney et al., 2012), there should be significant differences between their returns and risks, relative to corresponding values for gold, because if such differences do not exist, then there may be no economic justification for having the different types of gold ETFs that now exist on the markets.

Therefore, based on these two issues, this research aims to answer and analyse two main ideas:

(1) To determine whether physical gold ETFs track gold prices well in the UK.

(2) To compare the performance of physical gold ETFs tracking with some other instruments in the UK.

3.3 Literature Review

The increase of credit rating in parts of Europe during the end of the first decade of 21st century and the fall of financial institutions has led to an unexpected loss of confidence in debt and equity markets in most parts of the world. This has triggered interest in alternative investments, especially gold and other commodities, and driven their prices higher. This inspiring

performance, especially by gold, during economic distress has sparked interest in investing in gold-related investments such as gold ETF and gold mutual fund. It presents a strong motivation to examine the characteristics of these assets, their usual benchmark (gold prices) and their role in the financial system, in general, and in investment in particular. We begin our literature review with gold and then relate it to gold ETF and gold mutual fund.

3.3.1 Gold and Hedging

In the situations of economic distress, people constantly prefer investing in gold rather than stocks (Anand and Madhogaria, 2012). As discussed earlier, one of the attractiveness of gold is its characteristic as a safe shelter, and safe shelter features inflation or stock market movements or currency depreciation proof. According to Mills (2004), the increasing of gold price began after the collapse of the gold standard. In 1934, the gold price increased from a constant rate of 20.67 USD per ounce to 35.00 USD per ounce and stayed at that rate until 1968.

After the collapse of the Bretton Woods currency system in 1971, the gold price was permitted to be decided by the market. The gold price increased to 37.00 USD per ounce in 1971 and reached 835.00 USD per ounce in 1980. This skyrocketing feature of gold prices can be traced back to the period 1971 to 1974, when people rushed to gold as a reaction to its value which was believed to have been undervalued for a long time by the fixed rate price. It was also because of the nonexistence of new mining and the oil crisis at that time.

The steep characteristic of gold prices can also been seen during the period 1976 to 1980. The causes were believed to be a response to the high inflation rate, the loss of confidence in the dollar and the uneasiness of international politics. The futures market trading in 1980 caused the steep increase to continue with gold prices going beyond 700.00 USD per ounce but this effect was short lived. It declined to roughly 300.00 USD per ounce in 1982. From that time, gold was traded in between the range of 250.00 USD to 500.00 USD per ounce and it was in the region of 300.00 USD during 2002. Mills (2004) further concludes that gold prices are portrayed by short-run persistence and scaling with a split point of 15 days, while gold price daily returns are highly leptokurtic with multi stage only picking up Gaussianity after 235 days. It is fair to say that from his research that gold prices are found to be not independent of other factors.

To investigate the characteristic of gold as a hedge, it is worth examining previous studies that have been conducted specifically to tackle this issue. From our observation, gold has been examined as a hedge against inflation, currency and the stock market as discussed in the next section.

3.3.1.1 Gold Against Inflation

Mahdavi and Zhou (1997) used cointegration test and error correction model and found no indication of cointegrating relationship between the consumer price index and gold prices starting from early 1970 to late 1994. A model of error correction of the inflation rate with the leading indicator of commodity price index was tested and persistently came out with smaller forecast error, measured by root mean square error and mean absolute error, than other models.

Furthermore, the use of commodity price index as a variable in the model was shown to be statistically better than the usage of the price of gold as a variable in the model. The poor performance of the gold price was because of its short-term movements which are too unstable and market specific to be used in forecasting the steady and tiny changes in the consumer price index. Hence, the position of gold as a hedging shelter against inflation has lessened over time. This concludes that the gold price is not a good leading indicator of inflation and not a good guide in determining monetary policy.

Actually, the relationship between gold prices and inflation rate can be traced back to 1994 when Alan Greenspan, the US Federal Reserve ex-chairman, said that the gold price is not a pure indicator but "a very good indicator" of inflation and is used to forecast upcoming inflation (Ullmann, 1994). In a response to that, Blose (2010) examines the issue of the influence of inflation transitions on gold prices. He found that the shocks in Consumer Price Index (CPI) do not influence gold prices. Rather, he found that the bond market is more useful in foreseeing inflation. Hence, inspection of gold prices cannot be used in figuring out the expectation of market inflation. The results came out by using regression models in testing two different hypotheses, which Blose (2010, p.46) stated:

> '*The expected inflation effect hypothesis argues that changes in expected inflation will cause immediate changes in gold prices. The carrying cost hypothesis argues that higher expected inflation will cause higher interest rates (the Fisher effect). The higher interest rates will, in turn, cause a higher cost of carry for gold investment, which will offset any speculative profit from investing in gold over the inflationary period.*

Accordingly, the cost of the carry hypothesis predicts that the price of gold will not change when expected inflation changes.'

By using ARCH, GARCH and EGARCH models on gold prices that were taken from London, in the US Dollar quotation, Capie et al. (2005), however, claim that gold can become an inflation hedge, hence can offer protection against dollar devaluations, although its effectiveness may differ from time to time.

3.3.1.2 Gold Against Currency

By taking the prices of gold in the spot and futures markets, and a set of macroeconomic variables such as exchange rates, stock market index, oil prices, consumer price index, unemployment rate, T-Bill rates and industrial production indices over the 1984–2003 period, Tully and Lucey (2007) used APGARCH (Asymmetric Power Generalised AutoRegressive Conditional Heteroskedasticity) model to investigate the macroeconomic influences on gold prices. They found that based on mean comparison, the US Dollar had the highest influence on gold prices, based on the absolute and statistical influence. The sign of the coefficient is also negative, confirming the negative relationship between gold prices and the US Dollar. There was no significant relationship between the inflation rate and gold prices and no significant relationship between the FTSE 100 price index and gold prices. No variables influenced the variance of gold prices. Hence, over the long period, the return on gold prices was internally influenced. The influence of the US Dollar also occurred around the 1987 equity markets' crisis period but the extent and significance of the US Dollar coefficient lessened. They conclude that the US dollar is the major macroeconomic factor that influences gold prices.

Further, Shafiee and Topal (2010) found that gold prices and oil prices do correlate as high as 85%, but there is no clear evidence to support the significant relationship between gold prices and inflation. To continue the gold price story from Mills (2004), according to Shafiee and Topal (2010), gold prices have increased steadily since 2002 and reached around USD1011.00 per ounce on 17 March 2008. From our observation, starting from that date, gold prices have continued to fluctuate with a steady increase until they reached around USD1895.00 per ounce in September 2011. Gold prices have then continued to fluctuate until now but have never reached USD 1895.00 per ounce again, with a highest price of around USD1777.00 per ounce in February 2012.

Shafiee and Topal (2010) also stated that for the increasing price of gold, whether it is in the short term or the long term, there are explanations for that situation. For the short term, when the worldwide financial markets performed poorly and the economic situation is in a downturn, people will choose gold investment as they believe that gold can act as a safe shelter and provide them with more confidence than other conventional investments of their wealth. They also believed that gold investment is counteracted when the US Dollar declines in value and the inflation rate is high. For the long term, it is widely known that gold excavation production has steadily decreased in recent years. The reasons are that mining costs have increased, exploration has declined and there are complications in finding new deposits, among other factors. Secondly, the investment providers used gold in their investment portfolios to attract investors during unsteady financial market conditions because of the liquidity and marketability of gold during that time. This will make gold prices continue to increase regardless of the situation. Thirdly, the introduction of gold ETF has made investing in gold easier than investing in gold stocks and this has encouraged the demand for gold.

Ciner et al. (2012) found that gold can be considered a secure sanctuary against exchange rates in the UK and US, displaying its monetary asset function. Gold's hedging property against both the Dollar and equities could be more than merely behaving against inflation risk. Hammoudeh et al. (2009) found that there is a negative relationship between the US Dollar and gold prices, as the increase of the latter has made the former depreciate against other major currencies. They suggest this is a result of the exodus in investment or savings made by the people from the US Dollar to gold, as they perceive gold as a safe heaven. Hammoudeh et al. (2009) suggest that monetary authority should use the price of gold as a lead in determining the upcoming direction of the US Dollar movement against other major currencies.

3.3.1.3 Gold Against Stock Market

Li and Chengmei (2013) examine the impact of macroeconomic factors on gold prices. The macroeconomic factors were classified into three groups: i) gold reserve and energy products prices, ii) financial market indices and iii) global market macroeconomic indicators. Gold prices were taken from the spot price for gold traded on the New York Gold Exchange. After doing ADF (Augmented Dickey-Fuller) test and causality test, they constructed a model by applying the FAVAR (Factor Augmented Vector Autoregressive) technique. Then generalised impulse response analysis was done to analyse the effects of the factors on gold prices. As a result, the association between gold reserve and energy product prices and gold spot price was found to be positive, and the association between financial market indices and gold spot price was found to be negative. The relationship between global macroeconomic indicators and gold spot price was also found to be negative. It was also found that the crude oil price and Federal Reserve rate have a powerful influence on the gold price.

Baur and McDermott (2010, p.1889), define hedge and safe haven in connection to the usage of gold in achieving those two characteristics.

> '*A strong (weak) hedge is defined as an asset that is negatively correlated (uncorrelated) with another asset or portfolio on average*.'

> '*A strong (weak) safe haven is defined as an asset that is negatively correlated (uncorrelated) with another asset or portfolio in certain periods only, e.g. in times of falling stock markets*.'

Their article investigates the role of gold in the worldwide financial system by using econometric analyses such as regression, Maximum Likelihood and GARCH. The safe haven characteristic of gold was tested in major and emerging markets, which consist of daily, weekly and monthly stock returns of 53 constituents worldwide, for the period of 30 years. They found that gold can act as a hedge and a safe haven for most of the stock market in Europe and the US. However, gold cannot be used as a hedge and a safe haven in Australia, Japan, Canada and large emerging markets such as Brazil, Russia, India and China. Specifically, gold can act as a sustaining agent as it can lessen losses during tremendous negative surprises in the financial markets and this role can also be seen in most developed markets at the high point of the 1987 financial crisis, but not during the Asian financial crisis. This finding is most solid for daily data and this suggests that the safe haven feature of gold was used to seek protection from short-lived and extreme surprises. It can be said from the findings of Baur and McDermott (2010) that gold played a weak safe haven in emerging markets. This is because losses in emerging markets may cause investors to pull out from their positions in emerging markets for developed markets.

3.3.2 Gold Prices and Gold ETF

It is a common perception that people are attracted to gold ETF because of its connection to gold. Gold investment requires a huge amount of capital as it is a material much in demand in the market. Furthermore, it requires additional cost in handling, safety and storage. This is where gold ETF has surfaced as an alternative to gold. Physically-backed ETFs have become one of the top choices among investors (Brennan, 2012). This includes gold ETF which uses physical gold as its underlying asset. According to Baur (2013a), the debut of gold ETF has influenced the substantial boost of gold prices from 2002 to 2011. He also shows that gold ETFs are certainly more liquid than assets such as gold bars and coins which are used as holding assets. This applies to physical gold ETF and also to synthetic gold ETF. He also provides evidence that the debut of gold ETFs has a high probability in affecting gold prices and the simplicity in trading gold ETFs has improved the volatility of gold. However, gold ETF investors also have to compensate for the risks in gold ETFs which are exhibited by the ups and downs in the price and volatility of gold together with counterparty risk.

According to The Wall Street Journal, as cited in Milonas and Rompotis (2010), a survey of financial advisers conducted by a corporation based in Boston found that ETFs were used by 71% of financial advisers, an increase from just 25% five years before. ETFs typically have incredibly low annual expenses, even lower in general than traditional tracker funds. ETFs are usually less expensive than open-ended investment companies and unit trusts as they do not need an investment manager to be involved. ETFs offer investors a supreme diversification technique as people can invest directly in an overall market rather than picking individual stocks.

People can purchase a small or a large amount of gold ETFs as it does not have minimum investment prerequisites, meaning investors can purchase a single gold ETF or many. Generally speaking, ETFs do not give investors the ability to outperform the market as it supposed to mimic gold prices, minus the associated costs. In contrast, other diversified investments including open-ended investment companies and unit trusts are specifically developed to outperform the broader market, though at times they outperformed it while in other instances they underperformed it. One important difference is that retail investors trade ETF shares on a stock exchange using a broker-dealer, just like they might with any other type of stock. In contrast, mutual fund shares end up not being listed on stock exchanges. Rather, retail investors buy and sell mutual fund shares via various distribution channels, including through a financial adviser, broker-dealer, or straight from a fund company. There are various types of ETFs and some are probably not well suited for individual investors. As an example, ETFs use various techniques to mimic their chosen index, and some of these techniques may generate extra risk for investors. For gold ETFs, they aim to mimic the gold prices, whether directly or indirectly.

When compared with purchasing bullion or coins outright, gold ETFs provide the benefits of lower carrying costs and superior liquidity. If there is a close relationship between gold prices and gold ETF, then gold ETF also offers investors opportunity to arbitrage. For example, if the gold ETF is traded for a way less than to gold price, investors may buy gold ETF and/or sell the gold. The elevated demand for gold ETF should certainly increase its price and sales of gold should lower their prices, reducing a real difference between gold ETF and gold prices. When gold ETF is trading at a higher price to gold, investors may want to sell gold ETF and/or buy gold. Since ETFs trade like stocks, it might be attractive to trade ETFs frequently, particularly when the markets are volatile. Nevertheless, investors can accumulate

substantial costs by frequently transacting ETFs. These costs will consume any potential investment gains. Hence, it is essential to take a disciplined approach in ETF investments.

The added value of gold ETF is that they are simpler in doing transactions. Because of the attraction to gold, people try to invest entirely or proportionally in gold by using products such as gold ETF (Shafiee and Topal, 2010). Generally, gold ETF is an open-ended mutual fund which invests in gold bullion and is traded on stock exchanges just like stocks (Bang, 2009). It is believed that these two features (gold connection and simplicity) have led to the introduction of gold ETF in the Australian Stock Exchange, where the world's first trading of gold ETF happened in 2003 (Bloomenthal, 2008). According to Nedeljkovic (2005), gold ETF attracts investors because of its simplicity and accessibility compared to other products. It also offers cost efficiency, security and high liquidity to investors. Two of the major players in the gold market today are gold mutual funds and ETFs. This can be seen by their large holding of gold. For example, one gold ETF provider, the SPDR Gold Shares ETF, in 2010, stored a quantity gold equivalent to 16% of the US Treasury's gold holding in that year. This gives an idea of the huge number of gold ETF investors, gold ETFs issued and gold ETF transactions in the market (Jagerson and Hansen, 2011).

Besides the gold connection and the simplicity features of gold ETF, investors are also reported to be attracted to their performance. In terms of performance, investors chose gold ETFs as they flatten out the overall returns and are better than stocks (Lauricella, 2009). Hence, gold ETFs are regarded as a long-term investment instrument, a safe shelter and an alternative to gold itself. Few researchers even considered using gold ETF prices as a representative of

gold prices. For example, by employing gold ETF as proxy, Cohen and Qadan (2010) determined that increases in gold prices result in higher fear level with investors still considering the precious metal as an alternative investment in the presence of high uncertainty in the capital market. The main point here is how close the relation of gold and gold ETF can be perceived? Again, this provides a justification to determine the tracking error of gold ETF.

By taking four gold ETFs, Narend and Thenmozi (2013) found tracking errors between gold ETFs and gold spot prices are not statistically significant, while their pricing deviations are significant. From their observation, gold ETF prices were recorded less than gold spot prices. By using Vector Error Correction Model, they found that gold ETF prices influenced gold spot prices. However, the influence expired after two lags. Hence they conclude that this is evidence that the price discovery of gold happened in the gold ETF market, in the case of the US. This finding is supported by Ivanov (2011), who also examined the US market, with addition that it also happened to silver. The conventional place for those assets' price discovery, which is the futures market, has reallocated to the ETF market, he further concluded. He used just one ETF each to represent the gold, silver and oil markets.

Other than the difference between gold ETF prices and gold spot prices, the difference between ETFs in the same sector has also received an interest. Luther and Celik (2007) used 28 ETFs from seven sectors in the US market, which also included the gold sector to compare the intra sector and inter sector returns. By taking early day of the week closing prices, with no adjustment made for dividends, they determined weekly returns and weekly volatility of ETFs from 2000 to 2006. They used Sharpe ratios to compare the reward to variability ratio as the

proxy to performance. The average return of each ETF was compared using ANOVA (Analysis of Variance) and further tested using Fisher's Least Significant Difference (LSD) test if the ANOVA found a significant difference in the sector group.

They also tested whether the ETFs performed any differently to the general market. The general market was represented by mutual funds in that sector and the S&P 500 index. Correlation analysis was conducted at the end to determine the relationship among ETFs by various issuers within the same sector. They found that there are differences in Sharpe ratios between ETFs. However, each of the differences is not statistically significant, hence the ETFs issuer does not perform better than others in all sectors. This concludes that the ETF brand name does not play an important part in investors' selection. The correlation coefficient analysis shows that there is high correlation among ETFs by various ETF issuers within the same sector but there are very low correlation coefficients across-sectors. This implies that there are opportunities for investors to diversify their investments by investing in different sectors. In other words, sector rotation strategy can be applied to the sector ETFs.

Additionally, there are ETFs that invest in equities which are associated with gold companies, such as gold mining, exploration and gold producing companies in order to give investors gold exposure. These are known as sector equity gold ETF. Investors who are seeking gold prices exposure traditionally use this stocks of gold-related companies as a proxy for gold prices. The idea is when the gold price increases, it is because the demand for gold has risen and the gold-related companies will be experiencing profit. Thus, the gold-related companies' stocks or indices will also perform well. As discussed earlier, gold price is believed to be

independent of other market factors and this feature may also apply to the gold-related companies' stock or indices.

This may be true as, on 5 March 2014, investors become concerned about the prospect of their investment in the Canadian stock market because of the confrontation between Russia and Ukraine and the poor US private sector employment rate. The Toronto Stock Exchange was given an unassuming lift as the stock values in the metal sector, especially gold and copper, increased (Morrison, 2014).

Gold company stocks received much attentions from previous researchers. For example, Jaffe (1989) used regression technique and found that by using a portfolio of gold company stocks on the Toronto Stock Exchange and a mutual fund of South African gold mining stocks, gold company stocks do mirror the return on gold prices. Further, according to Blose and Shieh (1995), the value of the gold mining company, represented by the present value of the cash flows from the excavation plus the present value of non-gold-related assets, is shown to be a function of the return on gold prices, production costs, the level of gold raw materials and the proportion of assets held by the firm that are unrelated to gold mining. In addition, Twite (2002) investigated the exposure of gold mining firms' stocks in Australia and concluded that they do have a significant gold price exposure.

Perhaps, because of this strong relationship between gold company stocks and gold prices, the gold company stocks have also been securitised in the form of ETF. However, according to Pleven (2012), in the years prior to 2012, as the world witnessed the increasing gold prices, gold mining companies' stocks did not increased as much. This is because costs in mining operations also increased. In 2011, as gold prices increased by 10%, the Market Vectors Gold Miners ETF (which tracks the NYSE Arca Gold Miners Index (GDM)) decreased by 16%. During late October 2012, however, as gold prices increased by 12%, the Market Vectors Gold Miners ETF increased by 34% as the gold mining companies cut their related costs. This is supported by Gwilym et al. (2011) who found that the reactiveness of gold producing companies' stocks to the prices of gold is not constant and has dropped in recent years as the gold price has progressed.

A more recent study by Zhang (2015) reveals the effect of gold ETF's introduction to the performance of gold company stocks. He found that the introduction has led to the gold company stocks to perform less than their benchmarks. This is because gold ETF is regarded as a replacement to gold stock. Further, the liquidity of gold company stocks became less as gold ETF has taken the trading activities that was previously happened in the gold company stocks market. Because of that, the costs of gold company stocks trading have also increased. The results also suggest that the gold ETF's market and gold company stocks market does have a weak relationship and they don't share similar experience from an event. Further, he suggests that this may be the reason why gold company stocks ETF was introduced. That is, to include both gold company stocks and ETF in one instrument.

However, there is no research yet dedicated on the performance of gold company stock ETF. Morningstar (2014) categorised this type of ETF as sector equity gold ETF.

3.3.3 Gold ETF and Gold Mutual Fund

There are two types of gold mutual fund that are considered in this study; gold commodity mutual fund and sector equity gold mutual fund. Gold commodity mutual fund is mutual fund that invest in securities or derivative instruments which provides exposure to gold prices. Hence, gold prices act as their benchmark in achieving their investment's objective. Sector equity gold mutual fund, however, mainly invests in shares of domestic and foreign companies that are mainly involved in mining, exploration and distribution of gold. They usually benchmark themselves to an index which tracks the performance of gold-related companies' shares. Morningstar (2014), however, categorised these types of mutual fund as gold mutual fund.

Gold mutual fund is different to gold ETF as it is not traded on an exchange like gold ETF. Gold mutual fund is usually bought and sold at its net asset values (NAV) and the expense ratios are usually higher as mutual fund is an actively managed fund while ETF is a passively managed fund.

In general, the objective of the gold mutual funds and gold ETFs is similar; to offer investors a system to hold an investment which exposes them to the ups and downs of the gold prices or an index which is related to the gold prices at low cost. Gold mutual fund accept

deposits from investors and the fund then issue shares of the net asset value of the fund. The fund then use the deposits to buy shares of securities or derivatives instruments or stock of companies that can expose investors to the gold prices. They may also use the deposit to pay back the fund's investors who are cashing in their shares. According to Kostovetsky (2003), the main source of tracking error for mutual funds is bid-ask spreads and other liquidity costs. Whenever there is demand from investors to invest in or divest the funds, there will be costs and this can be more expensive if the funds invest in illiquid assets.

The secondary source is the inflow and outflow of cash in the funds. This is because mutual funds do not invest all of their cash in order to meet the atonement needs from investors and it is not possible to invest all of the investors' deposits straightaway because of the unavailability of the targeted assets. Hence, this creates a period where inflows remain in cash. Dividend policies create the third factor for tracking error. This is because mutual funds have to wait for a particular period before receiving cash dividends (if they invest in dividend paying stocks) and this create a lag between the stocks and the mutual funds. The last source of tracking error is known as rebalancing costs because of the changes in an index or corporate activity. This happens when a company no longer remains in an index, hence this create a problem such as costs associated in buying the replacement company's shares and also a time gap before the mutual fund is capable of selling its shares with the new constituent.

The ETF does not suffer this problem as its movement does not necessarily move the price of its underlying assets, such as company's stock. Hence, it is immune to the liquidity cost. The main qualitative advantage of the ETF, added Kostovetsky (2003), is it can be bought

or sold at any time of a day, as compared to mutual fund which have to wait at the end of the day. Another advantage is that as ETF is traded in an exchange, it allows investors to buy them or margin, sell short, place stop, stop loss and limit orders, just like stocks.

Dellva (2001) describe that the fee war between ETF and mutual fund is caused by fierce competition between those two products; this started as ETF gained in popularity. The comparison between ETF and mutual fund has also attracted many researchers in the field. Dellva (2001) also suggested that ETFs are more profitable than mutual funds, whether over the short-term or medium-term. Blose (1996) studied gold mutual funds in the US market and presented a model in evaluating the theoretical gold price elasticity of the value of mutual funds which invest in gold mining firms. The theoretical gold price elasticity shows that if the mutual fund invest in firms whose assets consist primarily of operating gold mines, the return from the investment in the mutual fund will be at least as great as an investment in gold. He also found that gold mutual funds do have a significant amount of risk which cannot be explained either by market risk or gold price risk. He further concluded that gold mutual fund and gold do not bring equal risks to an investor's portfolio. Gastineau (2004) examined the returns of an ETF and a mutual fund during a period of time. He concluded that the ETF performed worse than the mutual fund. This is because the mutual fund is an active management fund. Gallagher and Segara (2004), however, found that ETF and mutual fund are indifferent in performance. Zanotti and Russo (2005), in the case of the Italian market, found that ETFs' performance was superior to the mutual funds and they associate this with the less liquid and less mature market compared to the US.

The majority of the previous studies, in examining the tracking error and profitability of ETFs, whether gold ETFs or other types of ETFs, use techniques that are also being used to examine other financial instruments, especially mutual funds. For example, Rompotis (2013) distinguished in detail the differences between actively managed funds and passively managed funds. He noted that there are few studies concerning the issues between actively managed funds and passively managed funds. By using data from the American Exchange Funds sector, he investigated the issues of risk adjusted performance and systematic risk between those products.

Further, Rompotis (2013) investigates the characteristics of those products by checking the accumulated return of funds by using Sharpe and Treynor ratios. He also measured the skill of market timing by regression technique which is usually associated to the actively managed funds and to passively managed funds as a control. The methodology used in his paper utilises the methodology that is generally found in mutual funds research articles. To assess the risk adjusted return, he used a formula from Jensen's model and also three factor model by Fama and French. The results indicate that active funds show inferior performance compared to the passive funds and are more volatile. The active funds also do not result in significant alpha according to the performance analysis by the regression techniques. The passive funds, however, fail to achieve any return that can be considered as above the market, but this is expected as that is not their stated objective. Through the investigation of market timing skills by regression analysis, he shows that managers of active funds do not have enough skills to operate the active funds.

Pullen et al. (2014, p.76), in their research on comparing gold bullion, gold stocks, gold mutual fund and gold ETF, define hedge, diversifier and safe haven as:

> '*A strong (weak) hedge is defined as an asset with returns that are negatively correlated (uncorrelated) with returns on another asset or portfolio on average. A diversifier is defined as an asset with returns that are positively (but not perfectly) correlated with returns on another asset or portfolio on average. A strong (weak) safe haven is defined as an asset with returns that are negatively correlated (uncorrelated) with returns on another asset or portfolio in certain periods of market stress or turmoil (e.g., a financial crisis).*'

By using daily data from the US market, they used regression models (specifically Generalised Autoregressive Conditional Heteroscedasticity (GARCH)) to identify whether each of the assets can be categorised as a hedge, diversifier or safe haven. Their result shows that strong hedging capability is found on gold bullion, diversifier capability is found on gold ETFs, gold mutual funds and gold stocks, while safe haven capability is found on gold ETFs and gold bullion. The diversifier capability of gold ETFs and strong hedging of gold bullion is said to be surprising as they argue that gold ETFs and gold bullion have a close linkage. However, given that not all gold ETF have physical gold as their underlying asset and not all of them set their benchmark to the gold spot price, from our point of view, one cannot say that gold ETF and gold bullion have a close linkage. Furthermore, they did not exactly list the name of the gold ETFs that were used in their research.

A more recent study by Sherrill et al. (2017) found that throughout 2004 to 2015, there were many mutual funds that held their positions in ETFs. One of the reason behind that is there is a believe between the mutual fund management companies that ETF tracks their benchmarks more efficient than any other instruments. Thus, to track their benchmarks as well as ETFs, the mutual funds management invest in ETFs. The amount of the mutual funds that acquired ETFs was around thirty percent of the overall mutual funds, with the value of the ETFs that were held by them is around one trillion dollars.

Regarding the differences between gold ETF and gold futures, London Stock Exchange (2013) has provide us with the details. The report clearly states that ETF is not a derivative instrument. Further, gold ETF does not need any daily margin requirement and is not attached to mark-to-market process. Further, there is no contract rolling process, maturity date (constrained lifecycle), delivery process and minimum order size involved in gold ETF trading, unlike gold futures. In short, gold ETF and gold futures are totally different in purpose and management.

3.3.4 Tracking Error

The search for tracking error starts when mutual funds that track stock indexes were offered in the market. One of the influential research in motivating other researchers in that field is by Sharpe (1991), which compares the performance of actively-managed funds and passively-managed funds (Frino and Gallagher, 2001). Since then, other researches emerged, such as by Roll (1992), Pope and Yadav (1994), Chiang (1998), Larsen and Resnick (1998), Keim (1999) and Frino and Gallagher (2001), among others.

Frino and Gallagher (2001) evaluates the tracking performance of actively-managed funds and passively-managed funds. Their comparison is based on the ability of both funds in tracking their benchmarks, which is S&P 500 index. Both funds suffer from tracking errors, which are positive and significant. They found that actively-managed funds, on average, perform worse than passively-managed funds. In addition, actively-managed funds are more costly than passively-managed funds. As a conclusion, they strongly suggest that actively-managed funds is a type of fund that does not have any economic justification to be recommended to the investors, in line with the findings by Sharpe (1991).

In the light of differences between ETF prices and their underlying prices, DeFusco et al. (2011) revealed that the pricing deviations between ETFs and their underlying assets take place due to specific price discovery processes and dividend accumulation and distribution. However, their research only considers ETFs on stock market indices and this might not be true in the case of gold. Gold ETF involves fees that should be paid to the issuer, expenses from selling and buying their assets holdings in mimicking the targeted benchmark and also types of their holding assets which are used in achieving the objectives. All of these factors may lead to price deviation. It is interesting to note, however, that gold ETF prices have been found to influence gold spot prices, at least in the US market.

In the case of gold ETF, the research on tracking error are not many. One of the is by Ivanov (2011). He investigates the connections among gold, silver and oil ETFs, their relevant futures instruments and the underlying commodities from March 2009 to August 2009. The ETFs are S&P Depository Receipts (SPDR) Gold Trust, iShares Silver Trust and the United

States Oil Fund. To the best of his knowledge, as he stated, his study is the first to examine the relationship between gold, silver and oil ETFs in the futures market and their underlying spot prices. By taking the intradaily data of those respective assets, he investigated the existence of unit roots on the prices by using ADF (Augmented Dickey Fuller) test, and further tested them for cointegration with specifying error correction models to complement the ADF test. He found that silver, oil and gold prices are all non-stationary. He used and defined the most straightforward definition of tracking error of the commodities instruments and the underlying assets which is the difference between the return of the spot prices of the commodities and the return of the ETF. Another technique of obtaining the tracking error that was used is the pricing deviation.

The pricing deviation used by him is defined by DeFusco et al. (2011) as the divergence between the underlying assets' return and the ETF's return. By using t-test on the tracking errors of the assets based on former definition of tracking error, the tracking errors are practically statistically equal to zero. However, by using the latter definition, he found that the tracking errors are statistically not equal to zero. He pointed out that the first and second definition actually captures different characteristics, as suggested by DeFusco et al. (2011). The former is just the difference while the latter seized upon how the ETF's managers are successful in bringing together the fraction of the underlying asset and this only applies on index-based ETFs. For commodity ETFs, the latter act as what he stated as '*the accumulated since the ETF inception reduction in fund assets due to fund expenses rather than success of replicating an index*'. Therefore, the latter definition, which used pricing deviation, can be understood as a cost-efficiency amount. He then tested for cointegration between the spot prices of the commodities, futures and ETFs by using Johansen Cointegration Test. The results indicate that

there exist two cointegration relationships among the commodities' prices, futures and ETFs, and these resulted in the identification of the relationships by using VECM (Vector Error Correction Model). The AIC (Akaike Information Criterion) was used in selecting the lag length in the VECM and in the unit root test which was tested earlier. From that, he found that the discovery of prices for gold and silver primarily take place in the ETF market of those assets.

Later, Plamondon and Luft (2012) examine the return divergence of the ETFs that hold physical assets, which are palladium, gold and silver; ETFs that hold commodities futures contracts with underlying assets are Brent crude oil, corn, gasoline, heating oil, West Texas Intermediate oil and natural gas with the return on the spot prices of the assets. By using regression analysis, they found that the ETFs that hold physical assets had beta coefficients that are statistically no different to one. They also recorded high R^2 values, which the authors concluded as signifying that the underlying assets are the primary driver of those ETFs that hold physical assets. On the other hand, the ETFs which hold commodities futures recorded low R^2 values with only one of the ETFs tested recording beta coefficient statistically equivalent to one. By using mean returns comparison test for both types of ETFs, in comparison to the spot prices of the underlying assets, they found that both types of the ETFs gave returns that were statistically identical to the spot prices of the underlying assets. Finally, by using Sharpe Ratios comparison, they found that there were constant differences between the Sharpe Ratios of the ETFs that hold physical assets, ETFs that hold commodities futures and the spot prices of the assets. It is interesting to note that two of the ETFs that hold commodities futures outperformed their respective spot prices, in the case of Sharpe Ratio.

In the case of leveraged and inverse ETF, Lu et al. (2012) used four ETFs that tracked separate indices as a proxy to the indices. Their intention was to examine the tracking error of the leveraged and inverse of the ETFs of the indices. The indices are Dow Jones Industrial Average, S&P 500 index, National Association of Securities Dealers Automated Quotations (NASDAQ) 100 index, and Russell 2000 index. All of the ETFs in their study came from the ProShares family. By using regression of the daily returns of the inverse and leveraged ETFs on the benchmark indices ETFs, they found that only one ETF from each of the leveraged and inverse ETF tracked the indices very well. They repeated their methodology on the returns of the ETFs for different investment time horizons. Their results indicate that for a shorter time of investment (less than or equal to one month), the inverse (-2 times return) and leveraged (2 times return) ETFs produce the returns as they have promised to the investors, which are twice the inverse return of the benchmark indices and double the return of the benchmark indices, respectively. For over the three months investment, the performance of the inverse ETFs is starting to be poor, while for the leveraged ETF, the starting point is one year. Hence, they conclude that the inverse and leveraged ETFs are not suitable for long-term investors.

In a more recent study, Ben-David et al. (2014) found that inverse and leveraged ETF shows larger deviations from their intended index in certain periods. These periods may occur few times in a day because of the rebalancing activities by different inverse and leveraged ETFs. During these periods, the more volatile the intended index, the more volatile the inverse and leveraged ETF will be and this situation does not have anything to do with either compounding activity or management expenses. It only can be explained by the exposure of the inverse and leveraged ETFs to the volatile index.

In the case of international ETFs comparison, Shin and Soydemir (2010) examined the tracking errors of 26 ETFs from the US, Europe, Asia and Australia. By using three different methods in measuring tracking errors, they found that the tracking errors of the ETFs, based on the difference between the ETFs and their underlying index, were statistically not equal to zero and negative in sign. They further tested the difference by employing Jensen's model. They found that risk adjusted returns of all ETF's were statistically lower than the returns of their benchmarks except for two of the ETFs which were not significant when the significant level was lowered to 1%. This indicates that investing in ETFs is not profitable when compared to the benchmark. They also checked the factors which may contribute to the tracking errors and found that exchange rate changes were statistically proven as a source of the tracking errors. From the tests of serial correlation, runs and panel regression, they concluded that ETFs from Asia exhibited more persistence than other ETFs from other countries, hence are less capable in returns information spreading and filtering.

For ETFs traded on New York Stock Exchange (NYSE), Huang and Lin (2011) examine 19 iShare ETFs traded on NYSE Arca and found that ETF investments have greater Sharpe measures than direct investments but that they were not statistically significant. In terms of tracking error on different markets, global emerging markets (GEM) ETFs demonstrate higher amount of tracking error than developed markets ETFs with, on average, GEM ETFs falling short of their own benchmark indices by around 85 basis points per year (Blitz and Huij, 2012).

In the case of European ETFs, Meinhardt et al. (2012) examined ETFs from Frankfurt Stock Exchange to study the impact of ETFs' replication process on tracking errors. In doing so, they measured the tracking errors of fully replicated ETFs and synthetically developed ETFs. In general, they found that all ETFs considered in their study experienced huge tracking errors. From their literature surveys, they found that synthetic ETFs are believed to be better than the fully replicated ETFs when it comes to tracking errors. However, from their findings, the fully replicated and synthetically developed ETFs were indifferent in tracking errors. Specifically, fixed income ETFs that were synthetically developed recorded smaller tracking errors than fully replicated fixed income ETFs. Without considering the replication method, fixed income ETFs were found to have smaller tracking errors than equity ETFs and this result still held when the ETFs were further separated into distributing and appropriating categories. The tracking errors were found to be high despite the consequences of the ETFs' asset classes and profitability. In explaining the existence of the tracking errors, they concluded that tracking errors arise because of the risk, volume and total expense ratio of the ETFs.

3.4 Analysis of the Literature

From literature reviews, it is understood that ETFs are created to overcome an issue but they may cause another issue. Majority of previous researchers agree that ETFs have overcome, at least, the liquidity issue. However, there are evidences that ETFs sometimes failed to track their benchmarks well, in contrast to what they are created to do. Hence, there is no guarantee that they will follow their benchmarks. On the other hand, ETFs sometimes do create misunderstanding and exploitation to the investors, especially to the investors who do not fully understand how the ETF works. For example, what the underlying assets are, what does the

ETF supposed to track and how the ETF going to track the benchmark. Nevertheless, in general, previous researchers found that the creation of ETF has had a significant positive effect, that is, improvement to the investment environment. In the case of gold ETF, this type of ETF has prolong, renew and flourish the investment on gold.

That is, by giving alternatives to be involved in gold investment through the offering of many types of gold ETF; physical gold ETF, synthetic gold ETF, leveraged gold ETF, inverse gold ETF and sector equity gold ETF. Before, investors can only be involved in gold mutual fund and gold company stock.

It is also worth to mention here that physical gold ETF, synthetic gold ETF, leveraged gold ETF and inverse gold ETF mentioned in this study are categorised as gold ETF based on previous researches, for example see Nedeljkovic (2005), Bloomenthal (2008), Lauricella (2009), Baur (2013a), Shafiee and Topal, 2010, Murphy and Wright (2010), Jagerson and Hansen (2011), Bok (2012), Narend and Thenmozi (2013), Zhang (2015) and Caginalp and DeSantis (2017), among others. That is, the definition of gold ETF is a financial instrument that is traded on stock exchange and used by the investors to achieve the ups and downs of gold prices. This is consistent with the definition of commodity ETF according to London Stock Exchange (2013). Not only that, this definition is also given by investment research company such as Morningstar UK (2014) and applies to many markets such as US and Italian markets (iShares Physical Metals plc, 2015). However, based on the later definition by London Stock Exchange (2014), these types of ETF are categorised as ETC (Exchange Traded Commodities). The difference between ETF and ETC according to the London Stock Exchange (2014) is ETF

has to comply to Undertakings for Collective Investments in Transferable Securities (UCITS), which is done to protect the investors more while ETC does not has to comply to UCITS. That is, under UCITS, ETF must be collateralised and it is compulsory, while collateralisation requirement for ETC is not compulsory. However, there are many ETCs that comply to UCITS, including gold ETCs used in this study (London Stock Exchange, 2014). Anyway, both ETF and ETC are still products that track an index, asset or benchmark (London Stock Exchange, 2014) and it is still consistent with the definition of ETF in this study and other previous studies. Further, Morningstar UK (Morningstar, 2014) categorised gold ETCs (the definition by the London Stock Exchange (2014)) in this study as gold ETFs, as it is commonly accepted as. Sector equity gold ETF, however, is categorised as gold ETF by London Stock Exchange (2014), Morningstar (2014) and other previous studies. For the sake of consistency and continuation from previous studies, the term gold ETF will be maintained instead of gold ETC. Also, this study only concerns about the tracking performance of those funds, no matter what their names are.

Regarding the tracking error, as a conclusion from the literature reviews, its definition is the difference or the deviation between the NAV of the ETF and the price of the underlying asset or benchmark. To determine the tracking error, there are many methods can be found from previous researches. It can be derived from a simple method or from a complex method. But at the end of the day, the one that matters is the difference between the returns of the ETF and the returns of the underlying asset. Therefore, the necessity of a complex method can be argued. In other words, there is nothing wrong with a simple method as long as it does its job well; finding the difference between the returns. For reliability and improvement in research reporting, a

research should include both methods in determining the tracking error. Further, not all investors are capable in interpreting the results from a complex method.

The exploration of the type of return that gold ETFs offer can be considered as new and needs to be improved. For example, Murphy and Wright (2010) announced that they were the first in this field to compare between the return of gold bullion as the underlying asset, the leveraged gold ETF and the inverse gold ETF. However, their dataset only consisted ETFs from the ProShares company that are traded on the US market. Hence, their results do not necessarily apply to the UK market. Furthermore, their methodology can be called into question. As they stated, the study used '*a simple two-tailed t-test for significance to determine whether the average daily tracking error for each ETF is significantly different from zero. If the ETFs are successfully achieving their stated objectives, we expect the t-test for significance in the daily tracking error to result in a p-value greater than 0.10*'. No pre-statistical testing examination has been done to the dataset in determining the suitability of the two-tailed *t*-test to be done to the dataset in arriving at the conclusion that the leveraged and inverse gold ETF do mirror their benchmarks.

3.5 Gaps in the Literature

Based on the review of the studies in the previous section, most gold ETFs and gold mutual fund that were tested regarding their performance, profitability and tracking error are in the US market. For comparison between ETFs and mutual funds, in general, most of the types that were considered were based on indices and stocks as their underlying assets. So far, to the best of the author's knowledge, there are no extant studies devoted to gold ETF, gold mutual fund and

sector equity ETF with consideration of their features such as the underlying assets, type of return, type of management and type of benchmark as to what this study try to achieve. In summary, the findings of the previous studies are not concrete enough to come to a conclusion that gold ETF performs well enough in tracking gold prices. It is also fair to say that they were not proven to be superior to gold mutual fund.

Although certain ETFs that were considered by previous studies on the US market are available to UK investors, it is not that simple to the UK investors. The US and UK markets are not interchangeable as they have many specific differences as pointed out by Milonas and Rompotis (2010). Furthermore, the tax provision would complicate this matter as pointed out by Petroff (2013). These two hurdles have been described earlier in this study.

The performance of the physically-backed or full replication ETF is assumed to be inferior when compared to the synthetically-backed ETF as mentioned by Meinhardt et al. (2012). However, they proved that this is not the case with the types of ETF that they examined in the German market. That is, there is a chance that different markets would resulted in different outcomes to the ETFs. Further, there is still no study that considers gold ETF in comparison of this type of feature (physical and synthetic).

Comparison between ETFs and mutual funds has received much attention from previous research studies. Nevertheless, there has been little specific discussion between gold ETFs and gold mutual funds. The majority of the studies considered index or stock ETFs and mutual funds. Although Blose (1996) and Pullen et al. (2014) do offer some insight regarding this

matter, the exact point, which deserved to be tackled, has not been handled well. First, their market of study is the US, where tax has been imposed on UK investors who participated, as described earlier, and second they did not describe their data specifically to the extent as to whether the ETFs or mutual funds are physically or synthetically-backed or use physical gold prices as benchmark or any other index, especially in the case of Pullen et al. (2014). Therefore, the explanation regarding the relationship between gold ETFs, gold mutual funds and gold is considered inadequate. As a result, the contention between whether ETF or mutual fund is better will be reinvestigated on UK data.

The differences in performance and profitability of the gold ETF and sector equity gold ETF has not yet been examined before, to the best of our knowledge. However, sector equity gold ETF is still offered today. Although sector equity gold ETFs benchmark themselves with the indices from the stock market, they are not necessarily equal in performance and profitability to the gold prices. Hence, there exist a gap in the literature in that sense and this study tries to bridge this gap.

This study also considers various type of gold ETFs, different to the previous studies. The reason behind this is different funds were found to be different in performance, although they belong to the same group. By taking mutual funds as examples, Collins (2005) investigated several funds with the S&P 500 index as underlying, concluding that each of the funds performed differently and each have their own preferred investors. This result is supported by Elton, Gruber and Busse (2004) and Haslem, Baker and Smith (2006). Milonas and Rompotis

(2006) found that this also applies to the ETF. Therefore, this study will test the generalisability of their findings.

3.6 Hypotheses Development

The primary purpose of the study presented in this chapter is to examine the tracking performance of gold ETFs relative to some other instruments referring to UK data. If the gold ETFs track the gold prices well, hence we can say that they have done their job well. That is, their tracking errors are significantly not different to 0. However, if there is any significant difference or deviation between the gold ETF's NAV returns and the gold price returns, then we can say that gold ETFs failed to perform and achieve their target. The performance of gold ETFs in that sense will also be compared to other gold instruments that are available in UK. The framework of the study can be seen on Figure 3.1 as the structure is expressed by the figure. The large UK market for ETFs provides an ideal and particularly valuable focus for empirical examination of these instruments.

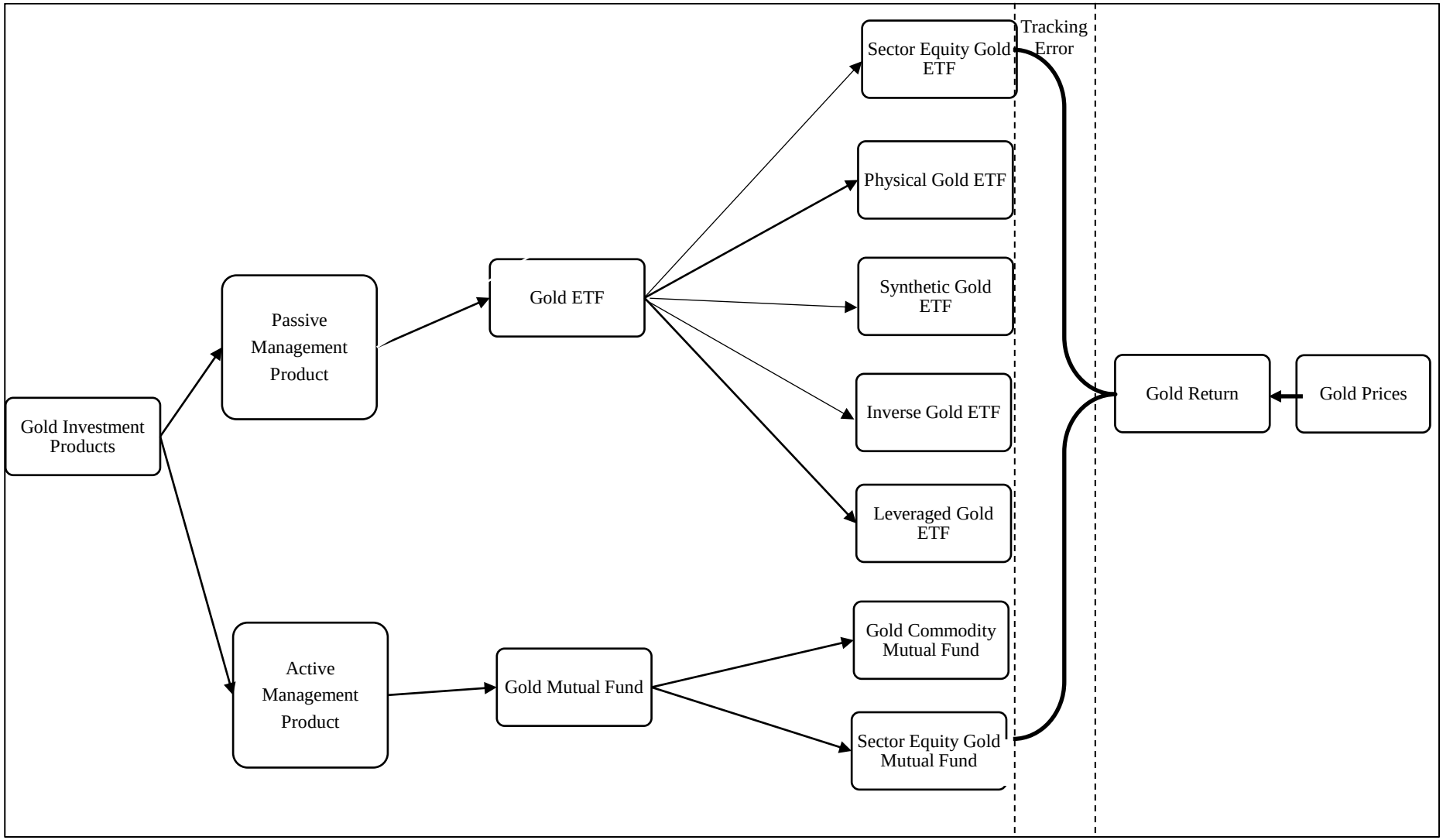
This statement is based on the London Stock Exchange themselves. According to the London Stock Exchange (2014) their exchange is the largest in Europe for on-exchange ETF for 2012 and 2013, with increasing trading and order-book turnover every year. The exchange has also received recognition from other parties, in which it was crowned as the largest exchange of ETF by volume and most proactive ETF exchange, both for European categories in The 9th Annual ETF Global Awards (London Stock Exchange, 2014). In addition, the lack of consensus on the performance of gold ETFs and mutual funds, as well as the limited research on this issue in the UK, provides the inspiration for this study.

Based on Figure 3.1, the financial products that have been identified as applicable and available in this study are sector equity gold ETF, physical gold ETF, synthetic gold ETF, inverse gold ETF, leveraged gold ETF, gold commodity mutual fund and sector equity gold mutual fund. Each of them will be compared based on their tracking errors. That is, how well they track gold prices.

All things being equal, how well the return and risk of a physical gold ETF will track the return and risk of gold will depend mainly on the difference between the return and risk of the underlying assets of the ETF, the management expenses of the ETF and the pricing efficiency of the markets for the ETF and gold. The underlying assets of physical gold ETFs are physical gold (Bloomental, 2008 and Bang, 2009). Therefore, the returns and risks of the ETFs and gold should be the same. However, whilst the investment funds that issued the ETFs will not manage the instruments, because they are traded on stock exchanges like any other share, the funds will incur some transaction costs when buying or selling gold, and pay management expenses, among others. All such costs will reduce the net asset value of the funds that issued the ETFs and, consequently, reduce the return on the ETFs as well and make them to be lower than those of gold.

There are six hypotheses developed for this study, based on evidences from previous literatures. They are physical gold ETF hypothesis, synthetic gold ETF hypothesis, leveraged gold ETF hypothesis, inverse gold ETF hypothesis, sector equity gold ETF hypothesis and gold mutual fund hypothesis.

Figure 3.1: The Framework of the Study. This study tries to determine the tracking performance of gold ETFs and gold mutual funds, in terms of tracking the returns of gold prices. Gold ETFs and gold mutual funds are chosen as according to previous reports they are considered as alternatives to physical gold investment.



3.6.1 Physical Gold ETF Hypothesis

Physical gold ETFs have some advantages over gold. One of them is that they require much less outlay than gold. Another advantage is that their transaction costs, storage/security costs and/or insurance costs, are much less than those of gold. Also, they are relatively more liquid than gold because they are traded on stock exchanges (Brennan, 2012 and Baur, 2013a). These advantages of physical gold ETFs make them to be accessible to a wider variety of investors than those that invest in gold (Nedeljkovic, 2005). More importantly, the advantages could have increased the demand for the ETFs, raised their prices and returns, and compensated for the negative effect of the transaction costs that the investment funds that issued the ETFs would have incurred when they bought or sold gold. This may make the returns, and risk, of the ETFs to be very close to those of gold. This argument is the basis of the following hypothesis that is tested in this study:

H1A: *Physical gold ETF tracks the return of gold well in the UK*.

3.6.2 Synthetic Gold ETF Hypothesis

Unlike physical gold ETFs, synthetic gold ETFs do not invest in gold. Instead, they enter into a swap contract with a counterparty which promises to deliver the return on gold to the investment funds that issued the synthetic ETFs. The intention behind the introduction and use of synthetic gold ETFs is to reduce the costs, hence the tracking error that investors will be exposed to when they invest in gold ETFs (Baur, 2013a). Therefore, the tracking error of synthetic gold ETFs is expected to be less than that of physical gold ETFs. However, the reality may be different from this intention because of the bid-ask spread between the swap prices that

the investment funds that issue synthetic ETFs will be charged by swap dealers and the counterparty risk of the swap dealers (Johnson et al., 2012). All things being equal, both the bid-ask spread of the prices that the investment funds that issue synthetic ETFs will be charged by their swap dealers, and the counterparty risk of the swap dealers, are likely to be positively related to the volatility of the return on gold (Johnson et al., 2012 and Guedj et al., 2011). Therefore, if the return and risk of synthetic gold ETFs will be lower than those of physical gold ETFs, that must be because the swap dealers involved in the issue of the synthetic ETFs are providing a risk-hedging service to the investment funds that issued the ETFs. The swap dealers will be expected to charge a risk-premium for this service. Since such a premium will not be paid for physical gold ETFs, we expect the return and risk of physical gold ETFs to be higher than those of synthetic gold ETFs. This argument leads to the following hypothesis which is tested in this study:

H1B: *Synthetic gold ETF tracks the return of gold better than physical gold ETF*.

3.6.3 Inverse and Leveraged Gold ETF Hypothesis

Inverse and leveraged ETFs are popular among investors nowadays as they are types of ETF that accommodate investors to bet, rather than invest, on the underlying asset or index (Jiang and Peterburgsky, 2017). In terms of performance, they are found to underperform their indices because of what they called as leverage or inverse trap. Leverage or inverse trap is the situation where the returns of the ETF deviates more and more from the returns of the underlying asset from day to day as the deviations are accumulated every day. This happens as inverse and leveraged ETF tries to match the opposite or double the returns of the underlying asset,

respectively. However, the trap can be eliminated if the investors based their return on daily basis rather than months or years.

According to Shum et al. (2016), the introduction of inverse and leveraged ETFs has raised many concern and anxiety among investors and other people in the market, because of its end of day volatility. This volatility occurs because inverse and leveraged ETFs would engage in hedging activities just before the market close. Those activities are essentials as to rebalance the exposure of their assets that are 'synthetically' used to match an index. In details, inverse and leveraged ETFs' management usually have agreement with other parties, such as swap counterparties who agreed to provide the returns that were promised to the inverse or leveraged ETF holders to match the returns of the inverse or leveraged ETFs to the intended index or underlying asset. Not only that, the swap counterparties would also take the risks which associated with the matching process. In the matching process, the swap counterparties would usually hedge their positions to secure their exposure to the entire earnings of the swaps. For example, when the market is bullish, the swap counterparties would buy more securities or portfolio of securities to expand their exposure hence match the intended index. They do this once a day, just before the market close and that is why the inverse and leveraged ETFs only report their NAV once a day before the market close. In the matching process, something might go wrong here and there. Further, the inverse and leveraged ETFs only try to match the intended index at only one point of time and not the entire day. If the price of the inverse and leveraged ETFs have deviated significantly from the intended index during most of the day, this would result in significant price pressure to the inverse and leveraged ETF. Thus, this would also contribute to volatility of the inverse and leveraged ETF. As a result, this implies that the differences between the returns and risk of physical gold ETFs and gold should be less than

those between the return and risk of inverse gold ETFs and gold, and also between the return and risk of leveraged gold ETFs and gold. Consequently, we hypothesise that:

H1C: *Physical gold ETF tracks the return of gold better than inverse gold ETFs in the UK.*

H1D: *Physical gold ETF tracks the return of gold better than leveraged gold ETFs in the UK.*

3.6.4 Sector Equity Gold ETF Hypothesis

Sector equity gold ETFs usually invest in securities of companies which are associated with gold - such as gold mining, exploration and production companies as well as in market instruments, money market funds, debt instruments, interest rate instruments, etc. Morrison (2014) reported that stock market investors flocked to the gold related companies' securities because of the Russia and Ukraine confrontation and the poor employment rate of the US private sector. However, the returns and risk of this type of securities, hence the sector equity gold ETFs may be different from those of gold for a number of reasons. One of them is that the returns and risk of the underlying assets of the ETFs may not have a strong relationship with movements in the price of gold. When gold prices change, the prices of the securities of gold related companies will be expected to change with gold prices, but the prices of the securities of other companies may not change because the factors that drive gold prices and the prices of the securities of gold related companies may be independent of the factors that drive the returns and risk of the securities of other companies (Blose and Shieh, 1995). This may cause a deviation between the return and risk of the ETFs and those of gold.

Another reason why the returns and risk of the sector equity gold ETFs may be different from those of gold is that the returns and risk of the securities of gold related companies may diverge from those of gold because changes in gold prices and changes in operating expenses and profits of gold related companies may occur at different rates. Finally, returns and risk of the ETFs may differ from those of gold because of hedging activities of gold related companies which may prevent changes in the price of gold from having a direct impact on their profit, or loss, and the market prices of their securities. Even though we expect sector equity gold ETFs to track the return and risk of gold, because evidence reported by previous studies shows that gold related companies' stock usually do (Jaffe, 1989; Blose and Shieh, 1995 and Twite, 2002), the reasons stated above imply that, on a comparative basis, physical gold ETFs should track the return and risk of gold better than sector equity gold ETFs. This is the logic behind the following hypothesis which is tested in this study:

H1E: *Physical gold ETF tracks the return of gold better than sector equity gold ETFs in the UK*.

3.6.5 Gold Mutual Fund Hypothesis

Two types of gold mutual funds are considered in this study, namely, gold commodity mutual funds and sector equity gold mutual funds. In general, the objectives of gold mutual funds and gold ETFs are similar – to offer investors a mechanism to have exposures to the return and risk of gold. Gold mutual funds sell their securities to investors to raise funds and use part of the funds raised to buy the securities of gold related companies, or suitable derivatives, in order to have exposure to the return and risk of physical gold. The other part of the funds are usually

held as reserves to use to buy back the securities of the funds from investors who want to sell the securities that they have bought from the funds.

However, there are three important differences between gold mutual funds and gold ETFs. One of them is that, unlike gold ETFs which are traded on stock exchanges, gold mutual funds are not traded on exchanges. Instead, their securities are bought and sold at prices set by the managers of the funds. This makes them to be less liquid than gold ETFs. Another difference between gold mutual funds and gold ETFs is that gold mutual funds are required by law to buy back their securities from investors in the securities whenever the investors wish to sell. Whereas, gold ETFs do not have to buy back their shares because their shares are traded on stock exchanges and any investor who wants to sell the shares of the ETFs will sell them on the stock exchanges rather than sell them back to the ETFs. This requirement may make the underlying assets of gold mutual funds to be not only less liquid but also less profitable than those of gold ETFs. The other important difference between gold mutual funds and gold ETFs is that gold mutual funds are actively managed by their managers. Whereas, all the gold ETFs referred to above are not actively managed. Consequently, the expense ratios of gold mutual funds are usually higher, and their profit ratios usually lower, than those of gold ETFs.

There are also other factors that can cause deviations between the returns and risk of gold mutual funds and those of gold. One of them is the bid-ask spread and other liquidity costs (Kostovetsky, 2003). Whenever there is demand from investors to invest or divest in gold mutual funds, there will be costs and the costs can be more if the funds have invested in illiquid assets. Another factor that can cause a deviation between the returns and risk of gold mutual

funds and those of gold is the inflow and outflow of cash in the funds. When new funds are received from investors in the funds, there is usually some time lag between when the money is received and when it is invested in profitable securities. The time lag often causes some loss to the funds. Also, if mutual funds invest in securities which pay dividends, some time will pass after the dividends are declared before they will be received by the funds. This delay will reduce the amount of time that the dividends will be available to the funds to invest and result in some loss of returns to the funds.

Finally, gold mutual funds may suffer rebalancing costs because of changes in an index or corporate activity. For instance, if a company that a gold mutual fund has invested in drops out of an index and the funds decides to replace the company with another one that is in the index, the costs associated with selling the shares of the company that has dropped out of the index and buying the shares of the replacement company may reduce the profit of the fund and cause a deviation between the returns and risk of the fund and those of gold. Due to these reasons, we expect the returns and risk of gold mutual funds to deviate more from those of gold than those of traditional gold ETFs. The arguments above apply to the two types of gold mutual funds considered in this study. Hence, we hypothesise that:

H1F: *Physical gold ETF tracks the return of gold better than gold mutual funds in the UK*.

3.7 Sample Description

Gold ETFs used in this study are gold ETFs that are active and available in the UK market on 31st December 2013 as this date is the most recent during this study. This also applies to gold mutual funds. The list of gold ETFs that are active at that time were taken from the London Stock Exchange (2014) while the list of gold mutual funds that are active at that time were taken from Morningstar (2014). Thus, there are 27 gold ETFs and 28 gold mutual funds in this study. From that 27 gold ETFs; 12 are physical gold ETFs, 6 are synthetic gold ETFs, one is an inverse gold ETF, one is a leveraged gold ETF and 7 sector equity gold ETF. From that 28 gold mutual funds, 5 are gold commodity mutual funds and 23 are sector equity gold mutual funds. These categorisation is based on their own prospectuses and Morningstar's website (Morningstar, 2014) categorisation. Their prospectuses can also be obtained from Morningstar's website (Morningstar, 2014). Thus, this study consists of 55 financial instruments.

The inception date for each of the gold ETF and each of the gold mutual fund were then checked from the London Stock Exchange (2014) and Morningstar (2014) respectively. The earliest inception date for gold ETFs is 15th April 2004 while for gold mutual funds is 30th December 1994. The latest inception date for gold ETFs is 15th November 2012 while the latest inception date for gold mutual fund is 2nd January 2013. Daily NAV from each of the gold ETFs and gold mutual funds were taken beginning from their inception dates to 31st December 2013. The names, types and inception dates for each of them can be referred to Table 3.1.

Table 3.1: Sample Description.

The list of gold ETFs and gold mutual funds along with their inception dates. There are 27 gold ETFs and 28 gold mutual funds in this study. From that 27 gold ETFs; 12 are physical gold ETFs, 6 are synthetic gold ETFs, one is an inverse gold ETF, one is a leveraged gold ETF and 7 sector equity gold ETF. From that 28 gold mutual funds, 5 are gold commodity mutual funds and 23 are sector equity gold mutual funds. These categorisation is based on their own prospectuses and Morningstar's website (Morningstar, 2014) categorisation.

	Fund Name	Type	Inception Date
1	db Physical Gold	Physical Gold ETF	15/06/2010
2	db Physical Gold G Hedged	Physical Gold ETF	01/04/2011
3	db Physical Gold Hedged	Physical Gold ETF	07/06/2011
4	ETFS GBP Daily Hedged Gold	Synthetic Gold ETF	27/02/2012
5	ETFS Gold Bullion Securities E	Physical Gold ETF	15/04/2004
6	ETFS Gold Bullion Securities	Physical Gold ETF	15/04/2004
7	ETFS Gold	Synthetic Gold ETF	22/09/2006
8	ETFS Gold G	Synthetic Gold ETF	22/09/2006
9	ETFS Physical Gold	Physical Gold ETF	24/04/2007
10	ETFS Physical Gold G	Physical Gold ETF	24/04/2007
11	ETFS Physical Swiss Gold	Physical Gold ETF	16/12/2009
12	iShares Physical Gold	Physical Gold ETF	08/04/2011
13	iShares Physical Gold GBP	Physical Gold ETF	08/04/2011
14	Lyxor ETN Gold	Synthetic Gold ETF	20/03/2009
15	Source Physical Gold P	Physical Gold ETF	26/06/2009
16	Source Physical Gold P G	Physical Gold ETF	26/06/2009
17	SPGS Gold	Synthetic Gold ETF	27/04/2010
18	SPGS Gold G	Synthetic Gold ETF	27/04/2010
19	ETFS Leveraged Gold	Leveraged Gold ETF	11/03/2008
20	ETFS Short Gold	Inverse Gold ETF	22/02/2008
21	ETFX DAXglobal Gold Mining Fund	Sector Equity Gold ETF	11/09/2008
22	ETFX DAXglobal Gold Mining Fund GBP	Sector Equity Gold ETF	11/09/2008
23	iShares S&P Commodity Producers Gold (IE)	Sector Equity Gold ETF	16/09/2011
24	iShares S&P Commodity Producers Gold (IE) GBP	Sector Equity Gold ETF	16/09/2011
25	RBS Market Access NYSE Arca Gold Bugs GBP	Sector Equity Gold ETF	11/01/2007
26	UBS (Irl) ETF plc – Solactive Global Pure Gold Miners A-dis GBP	Sector Equity Gold ETF	15/11/2012
27	UBS (Irl) ETF plc – Solactive Global Pure Gold Miners I-dis	Sector Equity Gold ETF	15/11/2012
28	Baker Steel Alpha Gold Fund A C	Gold Commodity Mutual Fund	02/05/2012
29	Baker Steel Alpha Gold Fund A E	Gold Commodity Mutual Fund	02/05/2012
30	Baker Steel Alpha Gold Fund A G	Gold Commodity Mutual Fund	02/05/2012
31	Baker Steel Alpha Gold Fund A	Gold Commodity Mutual Fund	02/05/2012

(*continued*)

Table 3.1-*Continued*

	Fund Name	Type	Inception Date
32	Baker Steel Alpha Gold Fund SA	Gold Commodity Mutual Fund	21/09/2011
33	BGF World Gold D4	Sector Equity Gold Mutual Fund	11/10/2012
34	BGF World Gold A2	Sector Equity Gold Mutual Fund	30/12/1994
35	BGF World Gold A4	Sector Equity Gold Mutual Fund	19/01/2009
36	BGF World Gold B2	Sector Equity Gold Mutual Fund	01/07/2002
37	BGF World Gold C2	Sector Equity Gold Mutual Fund	01/07/2002
38	BGF World Gold D2	Sector Equity Gold Mutual Fund	19/05/2006
39	BGF World Gold E2	Sector Equity Gold Mutual Fund	11/11/1998
40	BGF World Gold I2	Sector Equity Gold Mutual Fund	20/06/2008
41	BGF World Gold Q2	Sector Equity Gold Mutual Fund	01/09/1998
42	BGF World Gold X2	Sector Equity Gold Mutual Fund	19/03/2009
43	Investec Global Gold A Acc Net G	Sector Equity Gold Mutual Fund	10/04/2006
44	Investec Global Gold A Acc Net U	Sector Equity Gold Mutual Fund	06/04/2006
45	Investec Global Gold Net R GBP Acc	Sector Equity Gold Mutual Fund	02/01/2013
46	Investec Global Gold I Acc Net GBP	Sector Equity Gold Mutual Fund	01/06/2007
47	Investec Global Gold S Acc Net GBP	Sector Equity Gold Mutual Fund	01/06/2007
48	LO Funds – World Gold Expertise IA	Sector Equity Gold Mutual Fund	29/05/2008
49	LO Funds – World Gold Expertise PA	Sector Equity Gold Mutual Fund	07/08/2003
50	LO Funds – World Gold Expertise PD	Sector Equity Gold Mutual Fund	07/08/2003
51	LO Funds – World Gold Expertise RA	Sector Equity Gold Mutual Fund	08/06/2010
52	LO Funds – World Gold Expertise SA	Sector Equity Gold Mutual Fund	07/08/2003
53	SF t1ps Smaller Companies Gold A	Sector Equity Gold Mutual Fund	04/09/2009
54	Smith & Williamson Glbl Gold & Resources	Sector Equity Gold Mutual Fund	03/12/2004
55	Smith & Williamson Glb Gold & Res B	Sector Equity Gold Mutual Fund	06/06/2011

Previous researchers also consider inception date as the starting point for their ETFs and mutual funds data, for example Harper et al. (2006), Can (2009), Murphy and Wright (2010), Shin and Soydemir (2010), Yang et al. (2010), Charupat and Miu (2011), Blitz and Huij (2012) and Drenovak et al. (2012), among others. This is because the performance of each of the ETFs need to be checked from the beginning as tracking is the main purpose on why they were introduced. Also, the best way to invest in gold is by using the buy and hold strategy. That is, from the very beginning to the end (Almudhaf and Alkulaib, 2016). In other words, gold investment should be regarded as a passive investment, not as an active investment and it is similar to ETF in that sense. This explains the date selection criteria of the sample. Regarding the number of gold ETFs and gold mutual funds taken for this study, it is the best practice to include the data as many as possible in the study (De Vaus, 2001). The NAVs data were obtained from Thomson Reuters Datastream (Thomson Reuters, 2014). For comparison purpose, the gold prices data were taken from the Bank of England website (Bank of England, 2014).

Table 3.2 shows summary statistics for gold ETFs and gold mutual funds used in this study. It also reports the summary statistics for gold prices during the period of study. Synthetic gold ETF has highest mean returns and it differs from gold price returns more than other categories. Physical gold ETF has lowest mean return difference compared to other gold ETFs and gold mutual funds. Mean return difference of physical gold ETF, synthetic gold ETF and inverse gold ETF are all positive while mean return difference for leveraged gold ETF, sector equity gold ETF and gold mutual funds are all negative.

Table 3.2: Summary Statistics of Gold ETF and Other Instruments.

The table shows mean, standard deviation and range of return for each gold fund category. Physical gold ETF has lowest mean return difference compared to other gold ETFs and gold mutual funds. Inverse gold ETF, leveraged gold ETF and gold mutual funds has the smallest standard deviation difference relative to gold prices.

	Physical gold ETF	Synthetic gold ETF	Inverse gold ETF	Leveraged gold ETF	Sector Equity Gold ETF	Gold Mutual Funds
Mean Return	0.0002	0.0005	-0.0003	-0.0002	-0.0009	-0.0018
Gold Prices Mean Return	0.0001	0.0000	-0.0005	0.0000	-0.0006	-0.0007
Mean Return Difference	0.0001	0.0005	0.0002	-0.0002	-0.0003	-0.0011
Standard Deviation of Return	0.0043	0.0072	0.0001	0.0002	0.0004	0.0001
Gold Prices Standard Deviation of Return	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001
Standard Deviation of Return Difference	0.0042	0.0071	0.0000	0.0000	0.0003	0.0000
Minimum Return	-0.0003	-0.0008	-0.0003	-0.0002	-0.0039	-0.0029
Maximum Return	0.2523	0.4720	-0.0003	-0.0002	0.0032	-0.0014

It is also found that synthetic gold ETF category has largest standard deviation difference relative to gold prices. On the contrary, inverse gold ETF, leveraged gold ETF and gold mutual funds has the smallest standard deviation difference relative to gold prices. These mean and standard deviation analysis should at least give an idea about the comparison of tracking performance between those categories (DeFusco et al., 2011). Thus, it is expected that synthetic gold ETF would have largest tracking error than any other type of gold funds. However, as no category has lowest mean return difference and lowest standard deviation difference at the same time, we couldn't expect any category to be have the lowest tracking error than other.

3.8 Methodology

The methodology used in this study uses techniques that have been used by previous researchers. This is because the techniques are well known and widely used in finance research studies.

3.8.1 Return

The return of individual gold ETF or gold mutual funds is expressed by

$$NR_{i,t} = \frac{NAV_{i,t} - NAV_{i,t-1}}{NAV_{i,t-1}} \tag{3.1}$$

where $NR_{i,t}$ is the return based on a gold ETF or gold mutual funds *i*'s net asset value (NAV) on day *t*. The NAV was chosen as it is the value of an ETF that should mirror, although not exactly, the value of its underlying asset (Shin and Soydemir, 2010). The return of gold prices is expressed by

$$GR_{i,t} = \frac{GP_{i,t} - GP_{i,t-1}}{GP_{i,t-1}} \tag{3.2}$$

where $GR_{i,t}$ is the return on gold prices on day *t* and $GP_{i,t}$ is gold prices on day *t*. They are essential in calculating the summary statistics and tracking errors for testing the hypotheses.

3.8.2 Inverse and Leveraged Return

In the case of leveraged and inverse ETFs, this study will use Murphy and Wright (2010) in determining the returns. Firstly, because the objectives of inverse and leveraged gold ETFs do not directly follow gold prices, we have to redefine gold prices which they have to track. The

new daily gold prices return is calculated by multiplying the daily gold prices with the direction of the leverage or inverse multiplier which is 2 or -1, respectively. Hence, the return of gold prices that will be used to check the leveraged ETF tracking error is

$$GR_{i,t} = \frac{(2)GP_{i,t} - (2)GP_{i,t-1}}{(2)GP_{i,t-1}} \tag{3.3}$$

and for inverse ETF is

$$GR_{i,t} = \frac{(-1)GP_{i,t} - (-1)GP_{i,t-1}}{(-1)GP_{i,t-1}} \tag{3.4}$$

$GR_{i,t}$ is the return on gold prices on day *t* for the inverse and leveraged ETF and $GP_{i,t}$ is gold prices on day *t*. It can be seen here that the calculation of return of gold prices that is to be compared with the leveraged and inverse gold ETFs is actually similar to the return calculation in the previous part. We use this method in examining the inverse and leveraged gold ETF, as in the hypotheses.

3.8.3 Standard Deviation

The risks of gold ETFs, gold mutual funds and gold prices are defined using the standard deviation of returns as

$$\sigma_{NAVi} = \sqrt{\frac{\sum_{t=1}^{n}\left(NR_{i,t} - \overline{NR_i}\right)^2}{n-1}} \tag{3.5}$$

where $\overline{NR_i}$ is the mean or average return of a gold ETF or gold mutual funds *i*'s NAV. While

$$\sigma_{GR_i} = \sqrt{\frac{\sum_{t=1}^{n}\left(GR_{i,t} - \overline{GR_i}\right)^2}{n-1}} \tag{3.6}$$

is the standard deviation of gold prices where $\overline{GR_i}$ is the mean or average return of gold prices. This calculation is used to determine the dispersion/risk of the fund's NAV return relative to gold prices return.

3.8.4 Diagnostic Tests on Returns

Diagnostic tests include kurtosis and skewness test on the returns of all gold ETFs and gold mutual funds. These tests are essential and pre-requisites for parametric statistical tests as they will determine whether the returns are normally distributed or not. That is, whether the data are feasible for parametric tests. In addition, the returns were also tested for ARCH effects as financial assets over short horizons are likely to exhibit these effects.

3.8.5 Tracking Error 1 (TE1)

The equation to calculate the average daily tracking errors of a gold ETF or gold mutual fund to gold prices is

$$TE_1 = \frac{\sum_{t=1}^{n}\left|NR_{i,t} - GR_{i,t}\right|}{n} \tag{3.7}$$

Here, the TE_1 is the average daily tracking errors based on the absolute difference between the return from NAV of a gold ETF or gold mutual fund *i* and gold prices. If the TE_1 equals zero,

this means that the gold ETF or gold mutual fund tracks gold prices perfectly. This calculation is used to test all the hypotheses regarding tracking performance.

This Tracking Error 1 is based on the simplest definition of tracking error, according to Ivanov (2011). That is, it is simply the difference between the fund's NAV and the gold prices. The definition of tracking error by this calculation is the most understandable definition in general. However, it does not consider the distribution of the tracking error. Hence, if there is any difference between the fund's NAV return and the gold prices return i.e. tracking error exist, it can't determine whether the difference is significant or not. Further, problem may arise in concluding the results to the population by using results obtained from the sample. Nevertheless, this tracking error calculation is still used as it acts as a preliminary to other tracking error calculations (Roll, 1992; Pope and Yadav, 1994; Larsen and Resnick, 1998; Frino and Gallagher, 2001; Rompotis, 2008; Shin and Soydemir, 2010; Ivanov, 2011; Meinhardt et al., 2012). After the Tracking Error 1 is obtained, it will be tested whether it is significantly different from 0 by using *t*-test.

3.8.6 Tracking Error 2 (TE2)

Tracking Error 2 was calculated by using the standard errors from the analysis of regression. By using daily NAV return on each gold ETF or gold mutual fund and gold prices, the equation

$$NR_{i,t} = \alpha_i + \beta_i \cdot GR_{i,t} + \varepsilon_{i,t} \tag{3.8}$$

were estimated for each of the gold ETFs and gold mutual funds. α_i indicates the excess return which the gold ETF or gold mutual fund *i* can earn in excess of gold prices. However, due to

the various expenses associated with the management of ETFs, the α_i is expected to be zero or negative but not positive (Pope and Yadav, 1994; Frino and Gallagher, 2001; Rompotis, 2008; Shin and Soydemir, 2010). The β_i indicates systematic risk and replication strategy of the gold ETF or gold mutual fund, so that the coefficient gets nearer to 1 if the gold ETF or gold mutual fund mimics gold prices well. In this regression analysis, the standard errors from the regressions represent tracking errors (Blitz and Huij, 2012). If a gold ETF or gold mutual fund perfectly mimics gold prices by its return, then the standard deviation of residuals from the regression will be zero. This method is different from the Tracking Error 1 method as it uses ordinary least square to describe the relationship between gold fund's NAV return and gold prices return, hence to determine the tracking error. That is, it looks at the linear relationship between the fund's NAV return and the gold prices return. Further, the *t*-distribution is used to determine whether this linear relationship is significant or not. However, in real, the relationship might not be in linear. Also, there might exist other factors that should be included in the regression equation. Nevertheless, any study on linear relationship should starts with the simplest model first before looking for any complex relationship, in line with Occam's Razor principle, as stressed by Henry (2004).

3.8.7 Tracking Error 3 (TE3)

Tracking Error 3 uses standard deviation of differences between NAV returns of a gold ETF or gold mutual fund and gold prices. The calculation is

$$TE_3 = \sqrt{\frac{\sum_{t=1}^{n}\left(ND_{i,t} - \overline{ND_i}\right)^2}{n-1}} \tag{3.9}$$

where $ND_{i,t}$ is the difference between the NAV return of a gold ETF or gold mutual fund *i* and gold prices on day *t*, and $\overline{ND_i}$ is the mean difference between the NAV return of a gold ETF or gold mutual fund *I* and gold prices in the period of study.

If a gold ETF or gold mutual fund mimics gold prices perfectly and consistently, or, consistently although not perfectly, then this tracking error should be zero. This estimation was further tested by using *t*-tests. This is done to see if there is a statistically significant difference between the daily performance of gold ETF or gold mutual fund and their average performance. If the result of the *t*-tests is statistically insignificant, we can say that the gold ETF or gold mutual fund tracks gold prices consistently. This method is different from the previous tracking error methods as it uses the standard deviation of differences between the fund's NAV return and the gold prices return. In other words, it measures the divergence of the fund's performance (Frino and Gallagher, 2001; Gallagher and Segara, 2006; Milonas and Rompotis, 2006; Shin and Soydemir, 2010). This tracking error is based on the premise that it is almost impossible that a fund would track an index or underlying asset perfectly; in direction and magnitude. Hence, the performance should be based on consistency rather than precision. Further, this tracking error is also used by the ETF issuers in reporting their product's tracking error performance (Meinhardt et al., 2012). As it also uses *t*-test, the underlying assumption is the dispersion of the divergence follows *t*-distribution and any significant divergence can be determined.

As we can see, this measurement of tracking error might suffer from its assumption itself. That is, the assumption of the bell-shaped distribution of the divergence. For that, we need to rely on the diagnostic test as to confirm whether this test is applicable. If its distribution is bell-shaped, then the same probability exists for the divergence to be above or below its mean. However, this might not be the case as returns of both gold funds and gold prices on a day might behave differently from the other day. Nevertheless, this tracking error is still being used as we need a distribution of the divergence to determine any significant difference in the period of study and so far, *t*-distribution is the mostly accepted distribution to be used (DeFusco et al., 2011).

3.8.8 Tracking Error 4 (TE4)

Tracking Error 4 is used to determine whether the prices of gold ETFs or gold mutual funds and gold prices correlate dynamically. It is a type of cointegration and VECM approach. This method is to determine the tracking error in a long-term horizon, as it investigates the commonality of net asset value returns of the gold ETF or gold mutual fund and gold prices in terms of trends. This method also involved stationarity test as a pre-requisite in determining Tracking Error 4. To calculate Tracking Error 4, a model from Drenovak et al. (2012) that was adopted from Alexander (1999), is used:

$$\Delta NAVp_t = \alpha_1 + \sum_{i=1}^{m_1} \beta_{1i} \Delta NAVp_{t-i} + \sum_{i=1}^{m_2} \beta_{2i} \Delta NAVb_{t-i} + \gamma_1 \left(NAVp_{t-1} - NAVb_{t-1} \right) + \varepsilon_{1t} \tag{3.10}$$

$$\Delta NAVb_t = \alpha_2 + \sum_{i=1}^{m_3} \beta_{3i} \Delta NAVp_{t-i} + \sum_{i=1}^{m_4} \beta_{4i} \Delta NAVb_{t-i} + \gamma_2 \left(NAVp_{t-1} - NAVb_{t-1} \right) + \varepsilon_{2t} \tag{3.11}$$

where $NAVp$ is the daily log of net asset values for the gold ETF or gold mutual fund and $NAVb$ is the daily log of gold prices. Δ is the first difference operator. $NAVp$ and $NAVb$ will be checked for stationarity in level and first difference by using Dickey-Fuller – GLS test. This is crucial as it is prerequisite in cointegration analysis. After passing this test, we then proceed to the next stage. That is, using Dickey-Fuller – GLS test to determine the stationarity of the residuals. Johansen Test trace (JT Trace) is then used to check for cointegrating equations between the returns of gold ETF NAV or gold mutual funds NAV and gold prices. The null hypothesis under this test is there is zero cointegrating vector. The number of lags is chosen based on Log Likelihood, Akaike Information Criterion and Schwarz Criteria. That is, based on majority of the criterion. The fund that is more cointegrated with gold prices than others are considered as having better tracking performances (Alexander, 1999), while the coefficients of the autocorrelation of the residuals from the cointegrating equation is the Tracking Error 4 (Drenovak et al., 2012). The lower the Tracking Error 4, the better the tracking performance of the gold ETF or mutual fund. This method is different from other tracking errors as it assumes that the prices are inconstantly correlated.

This definition of tracking error is the most complicated compared to the previous definitions of tracking error. Also, there are pre-requisite tests that should be passed before the value of the tracking error can be determined. If the returns failed any of these pre-requisite tests, then the tracking error value cannot be determined. Hence, comparison couldn't be made. Further, the explanation from this calculation might be hard to be understood to most people, but it is an approach which assume that the tracking errors are not statically correlated, different from the previous tracking errors used in this study. Tracking errors do un-statically correlated,

although there is no hard evidence that they do, entirely (Alexander, 1999; Ivanov, 2011; Drenovak et al., 2012).

There is a dispute of whether the cointegration is about a long-run relationship between the data series as there is an assumption that cointegration test requires a long-run series of data. Hence, the time span of data needs to be long enough, rather than the number of observations. This argument is discussed in many literatures, for example Maddala and Kim (1998), Zhou (2001), Andrews and Kim (2006) and Alexander (2008), among others. Maddala and Kim (2008) conclude that the argument of short-run data is not sufficient in cointegration test is baseless, and they offer several reasons for that. The first reason is that cointegration is a statistical concept and technique. It purely is and it doesn't claim any interpretation outside that scope. That is, it does not have any economic interpretation. Its definition is simple; if two or more series of datasets are nonstationary at level but there exists equilibrium relationship in their time series, then this implies cointegration. Thus, whether the series of those datasets is sufficient or long enough to verify the cointegration between those series of datasets is purely subject to the statistical properties of the series and not on the time span. Further, the question of whether the cointegration found in short-run series of data is logic or interpretable depends on the basis or hypothesis developed before the cointegration analysis is used. In short, cointegration relationship can have a meaning in short-run relationship.

If long-run series of data is needed, then the question of how long they should be would arise. According to Maddala and Kim (1998), the time span of data needed for cointegration analysis depends on the speed of adjustment, and this is why short-run dynamics analysis such as cointegration and VECM is needed; to estimate the speed of adjustment. Further, one cannot say that the long-run data is preferred against the short-run data in cointegration analysis as the long run data also has its own problem. That is, it is more likely to have a few structural changes, and '*under parameter changes, a single cointegrating relationship cannot be considered meaningful*' (Maddala and Kim, 1998). This is less likely to happen in short run data.

As evidence, Zhou (2001) found that increasing the time span of data do increase the power of cointegration test. That is, the Johansen cointegration test is more likely to discover the existence of cointegration when the time span is increased. However, he also found that increasing the number of observations instead of the time span also achieve similar result. Further, Andrews and Kim (2006) have proven that cointegration can be detected over a short-period mathematically, while Alexander (2008) suggest that cointegration exists in financial market in a short-period.

Therefore, in the context of gold ETFs and gold mutual funds, their NAVs must show equilibrium relationship with gold prices in their time series as gold ETFs and gold mutual funds are created to track the gold prices, whether in short-run or in long-run. Hence, the cointegration analysis is needed to examine this relationship based on that logic. Also, the data is sufficient as each of the gold funds and gold prices has more than 300 observations. That is, based on the previous argument by Maddala and Kim (1998) that cointegration test itself does

not has any minimum or maximum limit of the data series (sample period requirement) but it depends on the availability of the data and whether they can be calculated by the Johansen cointegration test itself. In fact, previous researchers also hold to this argument, for example Alexander (1999), Alexander and Dimitriu (2004), Maurer (2008), Ivanov (2011), Drenovak et al., 2012), Chu (2016), Papantonis (2016) and Pastor et al. (2016) among others.

As a conclusion, there are 4 methods used to investigate the existence of tracking error. Each of them uses different approach as they capture tracking error from different angles. Thus, if only one of the methods points that there exists tracking error, then it exists at least at one stage (DeFusco et al., 2011).

3.9 Analyses and Results

This section reports the outcomes from the diagnostic tests and tests for tracking errors.

3.9.1 Diagnostic Tests

Skewness and kurtosis values are often calculated to determine whether the data violates the normality assumption. The normality assumption is essential before proceeding to various statistical analyses such as ordinary least squares and hypothesis testing. George and Mallery (2010) suggest that to determine whether the data is normally distributed or not, the value of each skewness and kurtosis should be less than 2 but greater than -2. However, according to Hair et al. (2010) and Byrne (2010), the value of skewness should be less than 2 but greater than -2, but the kurtosis value should be less than 7 but greater than -7. As a response to Hair

et al. (2010) and Byrne (2010), a more recent publication by Kline (2011) suggests that there is no severe violation of normality if the skewness value is below 3 and the kurtosis value is below 10. This is based on the analysis of newer and larger datasets.

Table 3.3 shows the results of diagnostic tests on the data used in this study. All of the data has skewness value between -2 and 3, while the values of kurtosis are between 0 and 6. Therefore, this suggests that the deviation of the data from normality is not severe and they are feasible for parametric analysis (Kline, 2011).

Table 3.3: Diagnostic Tests for Gold ETFs and Mutual Funds Returns.

The table shows the skewness value, kurtosis value and p-value of ARCH effects test on each gold fund and their categories based on average return. The skewness value, kurtosis value and p-value of ARCH effects test on gold prices is also reported. The results show that the gold funds and gold prices returns do not violate the normality assumption. The ARCH effects are also not severe based on their p-value.

	Fund Name	Skewness Value	Kurtosis Value	ARCH Effects p-value
1	db Physical Gold	0.15	0.10	0.59
2	db Physical Gold G Hedged	0.76	0.90	0.62
3	db Physical Gold Hedged	0.03	0.75	0.18
4	ETFS GBP Daily Hedged Gold	0.53	0.11	0.84
5	ETFS Gold Bullion Securities E	0.08	0.31	0.04*
6	ETFS Gold Bullion Securities	0.32	0.21	0.46
7	ETFS Gold	0.25	0.05	0.03*
8	ETFS Gold G	0.27	0.12	0.19
9	ETFS Physical Gold	0.25	0.12	0.09
10	ETFS Physical Gold G	0.28	0.18	0.32
11	ETFS Physical Swiss Gold	0.11	0.12	0.18
12	iShares Physical Gold	0.27	0.32	0.68
13	iShares Physical Gold G	0.26	0.33	0.71
14	Lyxor ETN Gold	0.33	0.45	0.86
15	Source Physical Gold P	0.01	0.06	0.16
16	Source Physical Gold P G	0.03	0.06	0.49
17	SPGS Gold	0.49	0.41	0.16
18	SPGS Gold G	0.49	0.76	0.49
19	ETFS Leveraged Gold	-1.26	5.61	0.05

(*continued*)

Table 3.3-*Continued*

	Fund Name	Skewness Value	Kurtosis Value	ARCH Effects p-value
20	ETFS Short Gold	-0.48	3.47	0.03*
21	ETFX DAXglobal Gold Mining Fund	2.19	5.23	0.04*
22	ETFX DAXglobal Gold Mining Fund GBP	2.39	5.42	0.00*
23	iShares S&P Commodity Producers Gold (IE)	0.00	2.87	0.47
24	iShares S&P Commodity Producers Gold (IE) GBP	-1.87	3.79	0.10
25	RBS Market Access NYSE Arca Gold Bugs GBP	-0.20	5.04	0.02*
26	UBS (Irl) ETF plc – Solactive Global Pure Gold Miners A-dis GBP	0.33	1.11	0.82
27	UBS (Irl) ETF plc – Solactive Global Pure Gold Miners I-dis	-0.38	3.36	0.75
28	Baker Steel Alpha Gold Fund A C	-0.48	5.41	0.73
29	Baker Steel Alpha Gold Fund A E	-0.50	5.38	0.71
30	Baker Steel Alpha Gold Fund A G	-0.60	5.44	0.74
31	Baker Steel Alpha Gold Fund A	-0.48	5.40	0.75
32	Baker Steel Alpha Gold Fund SA	-0.47	5.26	0.76
33	BGF World Gold D4	-0.57	5.10	0.90
34	BGF World Gold A2	-0.07	5.03	0.96
35	BGF World Gold A4	-0.06	5.02	0.97
36	BGF World Gold B2	-0.07	5.03	0.97
37	BGF World Gold C2	-0.07	5.02	0.96
38	BGF World Gold D2	-0.07	5.03	0.96
39	BGF World Gold E2	-0.07	5.05	0.97
40	BGF World Gold I2	-0.07	5.03	0.96
41	BGF World Gold Q2	-0.06	5.04	0.97
42	BGF World Gold X2	-0.07	5.01	0.96
43	Investec Global Gold A Acc Net G	-0.18	1.83	0.11
44	Investec Global Gold A Acc Net U	-0.09	1.72	0.48
45	Investec Global Gold Net R GBP Acc	-0.27	0.81	0.41
46	Investec Global Gold I Acc Net GBP	-0.36	2.23	0.15
47	Investec Global Gold S Acc Net GBP	-0.24	1.87	0.13
48	LO Funds – World Gold Expertise IA	-0.18	2.65	0.11
49	LO Funds – World Gold Expertise PA	-0.19	2.68	0.11
50	LO Funds – World Gold Expertise PD	-0.17	2.67	0.12
51	LO Funds – World Gold Expertise RA	-0.18	2.66	0.10
52	LO Funds – World Gold Expertise SA	-0.16	2.65	0.11
53	SF t1ps Smaller Companies Gold A	-1.09	5.54	0.98
54	Smith & Williamson Glbl Gold & Resources	-0.36	2.96	0.04*
55	Smith & Williamson Glb Gold & Res B	-0.19	2.25	0.02*
56	Gold Prices	0.21	0.15	0.50
57	Physical Gold ETF Average	0.30	0.22	0.57
58	Synthetic Gold ETF Average	0.41	0.31	0.64
59	Sector Equity Gold ETF Average	1.53	4.48	0.25
60	Gold Mutual Funds Average	-0.44	4.01	0.67

*ARCH effects exist at 0.05 level but not at 0.01 level.

In terms of time series analysis, such as Johansen cointegration, Silvapulle and Podivinsky (2000) suggest that normality is not an issue in order to perform such analysis as long as the data are not severely violating the normality. Cheung and Lai (1993) and Johansen (1995) further stress this suggestion by mentioning that Johansen cointegration analysis is robust to the violation of normality. As all the data do not severely violate the normality, they can be tested for cointegration.

In the case of ARCH effects analysis, it is done to further check whether the data are feasible for Johansen cointegration test and vector error correction model (VECM). The main difference between time series analysis and other statistical tests, such as ordinary least squares and hypothesis testing, is that time series analysis considers the lag values of the dependent variable as the independent variables. However, in other statistical tests the independent variables are taken from other variables, and they are usually exogenous (Robert and David, 2011). ARCH effects test is undertaken to examine whether there is conditional heteroscedasticity or serial correlation of the heteroscedasticity in the data concerned. ARCH effects may result in efficiency loss in the model developed and may cause rejection in tests of serial correlation (Engle, 1982). It is also essential to check for ARCH effects as it may affect the parameters of ARMA model (Weiss, 1984).

To perform the ARCH effects test, the Lagrange Multiplier (LM) procedure, as suggested by Engle (1982), was done. The LM test's null hypothesis is that there are no ARCH effects. Hence, if the significant value is less than the significant level, we reject the null hypothesis of no ARCH effects.

Based on Table 3.3, there are only 7 datasets of fund's returns that suffer from ARCH effects. However, the effects are not severe as they are only significant at 0.05 level. Further, MacDonald and Taylor (1991) point out that Johansen cointegration estimation is robust to heteroscedasticity effects, if the effects are not severe. Not only that, Cheung and Lai (1993), Gonzalo (1994), Lee and Tse (1996), Silvapulle and Podivinsky (2000), Rahbek et al. (2002) and Kurita (2010) also suggest that the Johansen estimation is not affected by ARCH effects. Because of that, one may proceed to VECM estimation without considering the ARCH effects (Batten et al., 2014). Therefore, there is no restriction to advance to Johansen cointegration test and VECM (Tracking Error 4).

In conclusion, from the diagnostic tests results, Tracking Error 1, Tracking Error 2, Tracking Error 3 and Tracking Error 4 methods can be done to the funds' data.

3.9.2 Tracking Errors

Table 3.4 shows the results of tracking errors for gold ETFs and gold mutual funds in this study. As expected, tracking errors exist in all gold ETFs and gold mutual funds. That is, there is no gold funds that track the gold prices perfectly. The results from tracking error analysis also consistent across TE1, TE2 and TE3. There is no Tracking Error 4 for inverse gold ETF, leveraged gold ETF, sector equity gold ETF and gold mutual funds as they are not stationary in level and first difference.

On average, inverse gold ETF has minimum TE1, TE2 and TE3 compared to other gold ETFs and gold mutual funds. However, if we look at individual fund, there is a physical gold ETF that has lowest TE1, TE2, TE3 and TE4. As described earlier, there is only one inverse gold ETF and one leveraged gold ETF offered in the London Stock Exchange during the study period. Hence, we can't measure the performance variability of those two types of gold ETF. Also, on average, synthetic gold ETF has maximum TE1, TE2 and TE3. Synthetic gold ETF also has maximum TE1, TE2 and TE3 individually. It is as expected in the previous section as synthetic gold ETF has the largest mean difference and standard deviation difference based on gold prices compared to other categories.

TE2 and TE3 confirms the result from TE1. That is, by assuming the linear relationship between physical gold ETF and gold prices, the TE2 detect tracking errors from all gold funds while at the same time, by using TE3, there exists inconsistency in tracking the gold prices by the gold funds. The estimation by TE4 found that there exists cointegrating vector in the gold prices and physical gold ETF relationship at 0.05 significant level, hence suggest that both are cointegrated. This means that there exists similar pattern to some extent of physical gold ETF NAV and gold prices. Also, the value of minimum TE2, TE3 and TE4 are bigger than 0 but the differences are still small.

Table 3.4: Gold ETFs and Other Instruments Tracking Errors.

Minimum TE1, TE2, TE3 and TE4 can be seen in one of the physical gold ETFs. Maximum TE1, TE2, TE3 and TE4, however, can be seen in one of the synthetic gold ETFs. There are no TE4 for inverse, leveraged and sector equity gold ETF, and also for gold mutual funds. This is because their returns are not stationary in level and first difference. All TE1, TE2 and TE are different from zero and significant at 0.05 level. TE4 for physical gold ETF and synthetic gold ETF are significant at 0.05 level, suggesting that there exist cointegrating vectors between them and gold prices.

Tracking Error (TE)	Physical gold ETF	Synthetic gold ETF	Inverse gold ETF	Leveraged gold ETF	Sector Equity Gold ETF	Gold Mutual Funds
TE1						
Average	0.0277%*	0.0676%*	0.0081%*	0.0124%*	0.0227%*	0.0114%*
Minimum	0.0048%*	0.0051%*	0.0081%*	0.0124%*	0.0137%*	0.0080%*
Maximum	0.2523%*	0.4879%*	0.0081%*	0.0124%*	0.0571%*	0.0156%*
TE2						
Average	0.4319%*	0.7266%*	0.0116%*	0.0158%*	0.0278%*	0.0147%*
Minimum	0.0067%*	0.0095%*	0.0116%*	0.0158%*	0.0167%*	0.0096%*
Maximum	1.0111%*	1.6788%*	0.0116%*	0.0158%*	0.0487%*	0.0208%*
TE3						
Average	0.4318%*	0.7271%*	0.0121%*	0.0165%*	0.0285%*	0.0151%*
Minimum	0.0070%*	0.0102%*	0.0121%*	0.0165%*	0.0164%*	0.0107%*
Maximum	1.0050%*	1.6749%*	0.0121%*	0.0165%*	0.0487%*	0.0208%*
TE4						
Average	0.0263%*	0.0532%*				
Minimum	0.0250%*	0.0260%*	-	-	-	-
Maximum	0.0290%*	0.0820%*	-	-	-	-

*significant at 0.05

It is also found that TE1, TE2, TE3 and TE4 for synthetic gold ETFs are larger than physical gold ETFs. Hence, physical gold ETFs track gold prices better than synthetic gold ETFs. Also, based on the result, there is a physical gold ETF that has a minimum TE1, TE2, TE3 and TE4 compared to any other gold ETF and gold mutual funds in the UK. Hence, the physical gold ETF tracks gold prices better than inverse gold ETF, leveraged gold ETF, sector equity gold ETF and gold mutual fund.

3.10 Discussion and Conclusion

From the results, it is found that TE1, TE2 and TE3 show consistency in detecting the tracking error. That is, they unanimously show that tracking error exists and they are consistent in ranking the gold funds based on the tracking errors (minimum or maximum). These findings can be considered as an another insight to whether there is a need to use many different tracking errors instead of just one tracking error. This issue arise as there are previous researchers who used many different tracking error methods such as Milonas and Rompotis (2010), Shin and Soydemir (2010), Ivanov (2011) and Drenovak et al. (2012) while there are previous researchers who used just one tracking error method, for example Murphy and Wright (2010) and Narend and Thenmozi (2013).

Regarding on how well physical gold ETFs track the gold prices in the UK, it is found that on average, the error is around 0.0277%, based on TE1. However, instead of looking at the whole physical gold ETF, an investor can choose one physical gold ETF that has the minimum TE1, which is around 0.0048%. These tracking error values (0.0277% and 0.0048%) is still low according to Drenovak et al. (2012) and close according to Ivanov (2011). By using similar TE1 method, Murphy and Wright (2010) found that the minimum tracking error for physical gold ETF in the US is 0.01%. Bok (2012) further expand the data and retested the performance of the physical gold ETF in the US. He found that the minimum tracking error is around 0.02%. Plamondon and Luft (2012) investigate 3 US gold ETFs individually and found that the tracking errors are around 0.007%. Therefore, the tracking error of UK physical gold ETF is still low. In addition, if we consider the currency risk as mentioned by Milonas and Rompotis (2010) and Williams (2016), and the tax imposed to the UK investors who invest in the US ETF market

which can be as high as 50% compared to as high as 28% on UK ETF (HM Revenue & Customs, 2 October 2013), the UK physical gold ETF should be preferable to the UK investors.

The physical gold ETF category has tracking errors which are less than the synthetic gold ETF. This result is in line with the findings by Guedj et al. (2011), Jagerson and Hansen (2011), Plamondon and Luft (2012) and Chu (2016). They explain that ETFs that hold physical assets have lower tracking error than synthetically-backed ETFs. This is because synthetic ETF holds derivative products which remain in different market to the physical or spot market. They stress that most of the time, the two markets are differ in prices although their underlying asset might be similar, such as gold futures prices and gold spot prices. The tracking process might become harder when other derivatives products, such as swaps, are being used to back the ETFs. That is, if physical gold ETF market is struggling to match the gold spot market because of certain factors such as timing and information, then the synthetic gold ETF market has to at least double that difficulty as they need to consider at least one more market, which is the derivative market. That's the common sense behind that. Another explanation is offered by Osterhoff and Kaserer (2016). That is, the liquidity of the underlying assets does significantly influence the ETF's tracking error. In relation to this study, gold spot market and derivatives market do differ in liquidity, as mentioned by Jagerson and Hansen (2011). The explanation for that is as the underlying securities such as derivatives become more liquid, the cost of that underlying securities will increase. Hence, the market participants will try to rebalance the ETFs to their respective underlying securities. The process of rebalancing will trigger other transactions that will either move the NAVs of the ETFs or the price of the underlying securities. Hence, the tracking errors would likely become larger.

Regarding the performance between physical gold ETFs, leveraged gold ETF and inverse gold ETF, it is found that the mean return of physical gold ETFs is highest in TE1, TE2 and TE3. But if we based our findings on individual physical gold ETF, this is not the case. There are 12 individual physical gold ETFs while there is only one from each inverse and leveraged gold ETF category. Hence, individually, physical gold ETF is better than inverse and leveraged gold ETFs but as a group they are not. The difference in performance between group and individual ETF is not new. Previous researchers also found that ETFs do differ individually although they share similar underlying assets (Kostovetsky, 2003; Milonas and Rompotis, 2006; Murphy and Wright, 2010; Ivanov, 2011; Drenovak et al., 2012; Oztekin, 2016; Vandermarliere et al., 2017 among others). The reason behind that is explained by Fulkerson et al. (2014) and Tang and Xu (2014). They suggest that the different in individual performances between ETFs is because of the management of the ETF itself. It is the responsibility of the management to decide which assets they should invest, what they are trying to achieve and how are they going to do that. Hence, because of different approaches, certain funds do perform better than other. Further, gold is hard to mimic as there are many factors that can influences the ups and downs of its prices.

Anyway, the performance of inverse and leveraged ETFs found in this study is in line with other findings. For example, Lu et al. (2012) and Murphy and Wright (2012) found that there are leveraged and inverse ETFs that track their benchmarks well, although not many. Dulaney et al. (2012) mentioned that leveraged and inverse ETFs are more volatile than regular ETFs if the benchmarks that they should track are also volatile. Although it is still being argued as to whether gold prices are volatile or not, Mills (2004) and Shafiee and Topal (2010) suggest that gold prices increase steadily over the years but they are not volatile. The findings in this

study do support the conclusion by Barnhorst and Cocozza (2011), who suggest there are certain leveraged and inverse ETFs that are able to help investors in tracking their desired benchmarks.

Between physical gold ETF and sector equity gold ETF, it is found that on average, the sector equity gold ETF performs better than physical gold ETF. But individually, physical gold ETF performs way better in tracking the gold prices. An explanation for this has been offered by Gwilym et al. (2011), Pleven (2012) and Zhang (2015). Gwilym et al. (2011) found that stocks of gold companies do not increase in tandem with gold prices for years, hence tracking errors of sector equity gold ETF gets larger. Not only that, gold companies also have to bear risks associated with gold such as excavation costs, safety and decreased in production output as pointed out by Pleven (2012). These are factors that affect the gold stocks rather than gold itself. Further, Zhang (2015) suggests that gold company stocks has stronger relationship with the company management than with gold.

For the last hypothesis, which is between the physical gold ETFs and gold mutual funds, it is found that on average gold mutual funds perform better in terms of tracking error. However, based on individual performance, physical gold ETF performs better than gold mutual funds. Thus, we can conclude that being either physical gold ETF or gold mutual fund does not simply differentiate a fund's tracking error performance. This is in line with findings by Pace et al. (2016) who examine the differences between European mutual funds and ETFs in terms of performance. That is, both are indifferent in that sense. However, mutual funds charge investors more in transaction costs as they are an active type of investment. Hence, when choosing between any type of investment, it is essential for investors to choose the cheapest available

type of investment rather than considering the style of the investment. In relation to physical gold ETFs and gold mutual funds performance, there might be other funds factor in determining the tracking performance, as suggested by Blose (1996), Dellva (2001), Kostovetsky (2003) and Zanotti and Rosso (2005). For example, Blose (1996) emphasises that the type of investment chosen by gold mutual funds would also determine the performance of the gold mutual funds relative to their benchmarks. It is found that gold mutual funds used in this study make various types of investment, based on their prospectuses. This may explain why their individual results vary. However, determination of factors affecting gold mutual funds performance is beyond the scope of this study.

As a conclusion, we find that there is a physical gold ETF product that tracks gold prices well. At the same time, we don't find any evidence that physical gold ETF, as a category, tracks gold prices well and better than any other categories of gold ETF and gold mutual fund. However, if we consider individual performance, the physical gold ETF do tracks gold prices well and better than any other instruments. We also found that gold ETFs in the UK differs individually in tracking performance although they share similar characteristic i.e. underlying asset. To the best of our knowledge, this is the first study that is specifically devoted to the gold ETF in the UK.

CHAPTER 4

ARE GOLD ETFs SUBSTITUTES FOR GOLD MUTUAL FUNDS?

4.1 Introduction

The search for the best investment has been the bread and butter in financial research since the very beginning of modern portfolio theory and investment analysis. The seminal work by Markowitz (1952) has become a threshold in choosing the right investment and paved the way for other research studies to be done as return and risk analysis has become an important part of every investment study and most investors' topic of interest. Extensive academic studies and research reports explain a variety of methods and inferences in examining the best investment for wealth maximisation. These include buffing up the analysing method of examining the performance of the investment and financial instruments, mostly on stock returns and other common investment vehicles.

The searching process becomes more encouraging and determined when there are only two types of investment vehicles or financial instruments involved and only one to be selected as better than the other. If one found that both the investment vehicles or financial instruments have certain similar characteristics and profitability, and each has its own admirers because of their segregated market, could it be that one of the investment vehicles or financial instruments is a substitute for the other? Scholes (1972) mentioned that substitution hypothesis can be applied in asset purchasing. While the substitution of

stocks has been stressed by Scholes (1972), the substitution of other financial instruments has been a topic of interest in many other studies. For instance, the substitution between leases and debts has been investigated by Ang and Peterson (1984), Marston and Harris (1988), Lewis and Schallheim (1992), Krishnan and Moyer (1994), Adedeji and Stapleton (1996) and Yan (2006). It is said that the improvement in financial markets with the introduction of new financial products is vital to the market's benefit and prolonged development (Miller, 1986; Ross, 1989; and Tufano, 2003).

In the context of mutual funds and ETF, the response to the financial improvement that led to the availability of the latter in financial markets has been encouraging. ETFs are regarded as possible replacements for mutual funds by many researchers (Calamia et al., 2013; Cheng et al., 2013; Agapova, 2010 and 2011; Aber et al., 2009; Guedj and Huang, 2009; Boney et al., 2006; Doran et al., 2006; and Dellva, 2001). This is possible because ETFs are traded intraday in an exchange, the costs associated with ETFs trading are lower, ETFs are more tax efficient and ETFs offer more flexibility than mutual funds. This is also supported by the market growth the ETFs relative to the mutual funds market.

As the ETFs are traded on an exchange daily, they are considered as more liquid than mutual funds. Investors do not have to wait at the end of the day like with mutual funds in order for their transactions to be executed. This makes them more flexible than mutual funds and offers lower transaction costs compared to mutual funds because they do not consider shareholder services, transfer agency services, sales load, distribution fees and others. This is also because the creation and redemption of ETFs does not cause the trading of the underlying assets, like mutual funds do, which usually will increase the

costs. The tax charges on ETFs are also lower than mutual funds as the creation and redemption of the ETFs are free from taxable capital gains as it does not involve the trading of the underlying assets (Aber et al., 2009). This is supported by Dellva (2001) who compares the performance of the Vanguard Index 500 (mutual fund), iShare S & P 500 Fund and SPDR (both are ETFs) based on their annual expenses and finds that ETFs have lower significant costs. Agapova (2010 and 2011) examines the substitutability of ETFs and index mutual funds. She concludes that the coexistence of both funds can be explained, to a certain degree, by the clientele effect and ETFs were found to be lower in tracking errors and fund expenses than mutual funds.

The substitutability effect of ETFs on mutual funds has also been checked according to the fund flows between ETFs and mutual funds. Boney et al. (2006) study the implication of SPDR S&P 500 ETF flows on S&P 500 indexed mutual funds. In general, they find that the inception of the ETF has caused negative fund flows to the indexed mutual funds. Hence this may signal the substitutability effect of the ETFs on the indexed mutual funds, in which the positive fund flows have changed direction to ETFs. In another words, the investors have preferred ETFs to mutual funds. The explanation of this phenomena was discussed by Guedj and Huang (2009). They find that ETFs are superior to mutual funds when it comes to tracking the more volatile and less liquid indices. This is because of the cost associated in the transaction activities, in which mutual funds providers practise active management while ETFs' do not. They also suggest that mutual funds may be more suitable for risk-averse investors than ETFs.

Based on their market share, the ETF market has been found to be catching up with the mutual funds market fast. Cheng et al. (2013) mentioned that the growth the ETF market globally is astounding compared to mutual funds market as it recorded a 40% annual increase from the period 2001 to 2010. The mutual funds market only recorded 5% annual increase globally over the same period. This stood as a signal that ETF will lead other investment funds in the future when it comes to investors' choices. According to Calamia et al. (2013), ETFs are an alternative to mutual funds. They attract a lot of investors but they do not yet perfectly substitute for mutual funds. The main reason behind this is that although ETFs have cost advantage compared to mutual funds, their market share is still inferior to the mutual funds market share at the moment.

Svetina (2010) shows that starting from 1993 to 2007, the number of ETFs being offered has increased from 1 to 584 while the number of mutual funds has increased from 68 to 373. The assets under the management of ETF investments expanded from USD0.46 billion to USD608 billion, while in the case of mutual funds, it grew from USD28 billion to USD860 billion. According to Guedj and Huang (2009), the mutual funds only track 63 different indices while the ETFs track 268 different indices.

In general, most researchers conclude that ETF does have certain advantages compared to mutual funds and may act as a substitute for mutual funds. This is the case when the objective of the investors is trying to match the performance of certain investment indices. ETFs are found to be better than mutual funds in tracking certain indices or prices.

Although many studies have been devoted to examining the substitutability of ETFs and mutual funds, none has considered gold ETF and gold mutual funds as their main interest. So far, their main study consists of ETFs and mutual funds that track the performance of stock based indices. Hence, this study will try to fill this gap by examining the role of gold ETFs and gold mutual funds, i.e. whether there is evidence that they are substitutes for each other. This study will also try to test the suggestion by Miller (1986), Ross (1989), Tufano (2003) and Svetina (2010) that the newly created financial instruments are an improvement on the existing financial instruments. Whether this suggestion applies to gold ETF and gold mutual funds is still unanswered.

In general, the objective of the gold mutual funds and gold ETF are similar: to offer investors a system to hold an investment which exposes them to the ups and downs of physical gold prices or an index which is related to physical gold prices at low cost, compared to physical gold trading. The relationship between gold ETF and gold mutual funds has raised concern, hence motivate us to conduct this study. The first question that comes to mind when a fund that has a similar objective to the existing fund is introduced into the market is: Is the new fund a substitute? If it is, this will be shown by the response of the investors and fund's issuer to the newly introduced fund and also to the current funds, respectively. The investors who used to trade the current funds will move their trading to the newly introduced funds to achieve their objectives, since both the funds have similar objectives, but the latter is an improved version. Hence, the current fund's trading volume should increase during the introduction of new fund and gradually decrease (Barnhart and Rosenstein, 2010). The current fund's issuer, on the other hand, would improve their achievements through returns (Agapova, 2011). This is the case

when the investors and mutual funds issuers regard gold ETFs as substitutions for gold mutual funds. Therefore, our objectives in this study are:

(1) To determine whether the introduction of gold ETF will result in gold mutual fund's abnormal volume.

(2) To determine whether the introduction of gold ETF will result in gold mutual fund's abnormal return.

According to Morningstar (2014), gold mutual funds consist of gold commodity mutual funds and sector equity gold mutual funds. Thus, in this study, we combine physical gold ETFs, synthetic gold ETFs and sector equity gold ETFs into one category; gold ETF category, similar to previous chapter. However, we exclude the leveraged and inverse gold ETFs as their trading mechanism is different from gold mutual funds, hence they would attract a different type of investor because of their trading mechanism characteristics.

By using event study methodologies, this study will examine the effect of the introduction of the gold ETF in the market to the gold mutual funds. So far, there is no study that uses event study method in analysing the introduction of gold ETFs. This study will contribute to the existing literature in this sense.

The arrangement of this chapter is as follows. The first section introduces the objective of this second study. The second section explains the reasons for pursuing the study. The third section reviews the previous literature related to this study. The fourth section analyses the previous literatures related to this study. The fifth section describes the gaps that this study tries to fill. The sixth section explains the development of the hypotheses in this study. The seventh and eighth sections describe the data and the methodologies used in this study, respectively. The ninth section reports the results from the analyses while the tenth section discusses and concludes the findings of the study.

4.2 Motivation of Study

According to Scholes (1972), substitution hypothesis can be applied in asset purchasing. He points out that the substitution hypothesis signifies that the asset's demand curve is basically horizontal as the investors are always empowered with the capability of substituting any asset with another asset or another combination of assets in order to achieve a particular stream of income. Furthermore, this hypothesis emphasises that a particular security has many closely perfect substitutes and as a result; the price of that security will not move away from the price that is designated by a perfectly elastic demand trajectory for that security. This happened because any security should be characterised according to its profile, which is based on risk and return, thus it can be mimicked in many ways.

As this substitution hypothesis can be applied in asset purchasing, it is said that the improvement in financial markets with the introduction of new financial products is a kind of response to this hypothesis. According to Miller (1986), the financial improvement around 30 to 50 years ago that led to the creation of many financial instruments, is because of 'financial revolution' which can mainly be described as a response to regulation, taxes and investors' demand. Ross (1989) believes that the introduction of new financial products is often regarded as avant-garde as they are positioned to untangle certain problems that are rooted by certain people hired by investment management companies. Tufano (2003) suggests that the financial innovation that results in the newly created products aims to tackle many issues in the financial market such as integration of the market, costs, agency problems and the laws relating to taxes and regulations.

The introduction of ETF can be regarded as a substitution for mutual funds. The comparison between ETF and mutual funds was mentioned in Guedj and Huang (2009, p.1). It is stated on the first page of their study that:

> 'Lee Kranefuss, the former CEO of iShares at Barclays Global Investors, argues that ETFs are to mutual funds what compact discs were to records: *"a better product with more features for less money,"* especially since *"long-term ETF investors don't subsidize the costs of active traders in ETFs."*

The analogy of compact discs to records has been used in comparison between ETF and mutual funds. This can be understood as ETF is regarded as a substitution for mutual funds as the compact disc replaced records many years ago.

Kranefuss is not alone in making this suggestion. In fact, the idea of ETF as a substitute for mutual funds has been a topic of interest in many academic research studies. Christoffersen et al. (2008) found that mutual funds do have more expensive trading costs than other funds because of the rigidness of the mutual funds in satisfying the needs of liquidation. In brief, these findings conclude that mutual funds do come with higher costs compared to ETF. Guedj and Huang (2009) elaborate that according to the performance report of mutual funds and ETFs, mutual funds are found to be lesser in performance than the ETFs as the calculation of the returns is different. This is because the mutual funds investors have to share the flow-caused transaction costs impartially between them and as a result this negatively affects the mutual fund's performance report. The flow-caused costs are obtained only by the ETF investors that need to liquidate, hence does not affecting the whole ETF performance report.

The main difference in costing between ETF and mutual funds is that ETF were created to have no flow-caused trading costs. That is, ETFs are traded on the stock exchange and any particular investor can trade while carrying its own transaction costs. The other difference is that ETFs are allowed to be created and redeemed as they feature the in-kind redemption capability. The mutual fund does have this feature but it is not similar to the ETF's, as this capability of mutual funds will lead to the flow-caused trading costs. This does not happen to the ETF as it received or paid out the underlying assets

directly to investors. As a result, ETF does not need to buy or sell the underlying assets or to gain any related costs in the buying or selling process of the underlying process in that sense.

The activity of creating and redeeming the ETF has one advantage over mutual funds. That is, the arrangement costs that occur in the process of acquiring the required underlying assets to build a particular portfolio are covered by the managing companies. This structure of ETFs' arrangement permits the institutional investors to exploit the arbitrage opportunities should the price of the ETF differ from its NAV. The other difference between the ETF and mutual funds worth mentioning is the taxation on each of the financial products. On the occasion that the mutual fund experiences a capital gain that is not counterbalanced by a realised loss, it must allocate the capital gains to the shareholders and those capital gains are taxable. However, ETF does not involve any redemption process, in the sense that the holders just have to sell their ETFs on the stock exchange if they want to be out of their current position, hence the capital gains that are taxable only incur when the investors sell the shares.

ETFs are usually created to mirror or mimic an index or performance. Svetina (2010) suggests that the newly available ETFs in a market that tracked similar benchmarks to the incumbent mutual funds does offer a better performance of investment compared to mutual funds. This implies that they have to restore balance of their positions should the composition of an index shift. Mutual funds, on the other hand, do not have to entirely mimic an index and this provide them with more freedom should the index change. Probably because of this, certain investors still admire mutual funds. This is

supported by Kostovetsky (2003), who mentioned that there are still some investors who, because of their trading behaviour and preference, choose to invest in mutual funds instead of ETFs.

The existence of many types of investment funds nowadays may or may not be due to the improvement process or because of investors' demand. One may ask whether their existence is due to the need to overcome the disadvantages of the other. In order to answer this question, Massa (2000) argues that the availability of the funds that were created in great numbers by managing companies is as a consequence of the marketing strategies to make the most of the diverse investors in the market. Market forces caused the non-optimal number of funds and their categories. Massa (2000) added that the function of the zest and technology of investors and managing companies internally determined the fund's performance. That is, the newly introduced funds are not necessarily better than the previous funds.

Contrary to Massa (2000), Svetina (2010) suggests that the introduction of the ETF is as a consequence of the demand from investors. He also argues that the ETFs that are introduced to the market and aimed at competing with the existing mutual funds tracked a more confined sector of the market or a market sector which is still untracked. He also found that local equity ETFs underperform their benchmark indices by 0.26% in a year and international equity ETFs underperformed their benchmark indices by 0.19% in a year. Their tracking errors were also found to be statistically significant at an average of 0.47% for local equity ETFs and 1.13% for international equity ETFs. The variation of the funds caused by many fund issuers, he added, can also be explained by economic

differences in the way each of the funds seek capital. The ETFs that were introduced to track similar indices or benchmarks to the present mutual funds were found to be redundant and the only variation that they have is the capability to be traded intraday on stock exchanges in which their prices will be determined. Meanwhile, the newly created ETFs that were introduced to track indices that have not been tracked before by any mutual funds do definitely broaden the investor's opportunity set. In analysing the similarities and differences between ETFs and retail mutual funds, Svetina (2010) found that on the fundamental of aggregate return, there is no contrasting significant statistical figure between the performance of the ETFs and the matched mutual funds. However, by not taking into account the transaction costs, the ETFs did outperform the matched mutual funds but this is statistically insignificant. By taking the comparison to the ETFs and institutional mutual funds, Svetina (2010) did not find any distinctive features between their performance before or after any fees.

Hortacsu and Syverson (2004) also give a few clarifications to the conjunction of "comparable" monetary instruments enquiry. They investigate why such a large number of firms, which costing investors with scattered fees, work in a part where the costs of money are identical. Assessment from their model shows that '*product differentiation plays an important role in the assumed homogeneous product industry*'.

The market players, such as the investors, seem to evaluate the investment funds by looking at the non-portfolio traits, for example, the age of the fund, the number of funds managed by the issuer in the same family of funds and the tax considerations, in a great extent of expected ways. Their evaluations likewise demonstrate that minimal

search prices can overcome the advantage of funds that offer the highest value in the entire market. Another of their exciting findings is that the dissemination of the cost of searching athwart the investors has been changing from time to time while preserving the quoted prices and market shares.

The ETF is not a financial product without defects that would simply lure away any investors from their current investment in mutual funds. Cheng et al. (2013) agrees that the ETFs deliver the low cost benchmark tracker to investors as it offers a cheaper warrant of capital to the investors than mutual funds. This has been tested and confirmed in their study. This happened as a result of ETFs short selling the lending securities in the market between financial conglomerates and the affiliated banks. As a consequence, there are conflicts of interest that could shake the stability of financial markets and be a threat to the end investors because those financial institutions are exposed to financial distress.

Nevertheless, those studies only considered stock-based mutual funds as their main interest. Nowadays, there are many types of mutual funds, based on the type of asset they are investing. One is commodity mutual funds, which have also regained their popularity among investors. According to Plantier (2012), the reason why the commodity mutual funds are highly demanded by investors is based on two decisive factors. Firstly, the returns from the commodity mutual fund's investment were not highly correlated with other common investment vehicles such as stock and bond. Commodity mutual funds investment is also found to be an offsetting or hedging vehicle against the increasing daily costs of living such as food and energy. In addition, mutual funds investment is vital to the growth the economy, since they are held by institutional investors who hold a

significant portion of the commodity assets and offer professional management to investors. One of the commodity assets that are being invested by commodity mutual funds is gold.

There are two types of gold mutual funds that are considered in this study: gold commodity mutual funds and sector equity gold mutual funds. At the time of this study, these two are the only types of gold mutual funds in the UK. Gold commodity mutual funds are mutual funds that invest in securities or derivative instruments which provide exposure to physical gold prices. Hence, the performance of physical gold prices acts as their benchmark in achieving their investment's objective. Sector equity gold mutual funds, however, mainly invest in shares of domestic and foreign companies that are mainly involved in mining, exploration and distribution of gold. They usually benchmark themselves to an index which tracks the performance of gold-related companies' shares.

In conjunction to that, Blose (1996) studied gold mutual funds in the US market and presented a model in evaluating the theoretical gold price elasticity of the value of mutual funds which invests in gold mining firms. The theoretical gold price elasticity shows that if the mutual funds invest in firms whose assets consist primarily of operating gold mines, the return from the investment in the mutual funds will be at least as great as an investment in physical gold. He also found that gold mutual funds do have a significant amount of risk which cannot be explained either by market risk or gold price risk. He further concludes that gold mutual funds and physical gold do not bring equal risks to an investor's portfolio.

However, gold ETF has a stronger attraction than gold mutual fund. According to Nedeljkovic (2005), gold ETF attracts investors because of its simplicity and accessibility compared to other products. It also offers cost efficiency, security and high liquidity to investors. One of the major players in the gold market today is gold investment funds and ETFs. This can be seen by their large holding of physical gold. For example, one of the gold ETFs' providers, the SPDR Gold Shares ETF, in 2010, stored an amount of physical gold which was about 16% of the US Treasury's gold holding. This implies the huge amount of gold ETF investors, gold ETFs issued and gold ETF transactions in the market (Jagerson and Hansen, 2011). Further, by comparing gold ETF and gold mutual fund, Lauricella (2009) concluded gold ETFs are regarded as a long-term investment instrument, a safe shelter and an alternative to physical gold itself.

Most previous researchers suggest that ETFs offer different advantages and may act as a substitute for mutual funds. This substitution hypothesis can only be supported when evidence is found that investors regard the ETF as a substitution to mutual funds. In the case of gold mutual fund and gold ETF, so far there is no study can be found in providing the evidence. Gold mutual fund and gold ETF are chosen in this study because of the attractiveness of gold ETF compared to gold and gold mutual fund, as mentioned in Chapter 3.

Therefore, based on this motivation, this study is conducted to examine the substitutability of the gold mutual funds to their gold ETFs counterpart.

4.3 Literature Review

4.3.1 ETF and Mutual Funds Interactions

At the time of this writing, there is no literature found on examining the relationship between gold ETF and gold mutual fund. However, the relationship between index ETF and index mutual funds has been studied by many researchers.

Boney et al. (2006) investigate whether the added value in ETFs has received attention from investors. By using 33 index mutual funds that mimic the S&P 500 in comparison to SPDR ETF, they found that the index mutual funds suffer 3.8% depletion in the inflow of funds, due to the introduction of the SPDR ETF. Although there might be other factors that they did not consider, Boney et al. (2006) added that SPDR ETF is the most practicable explanation. The money value of the fund inflow that was lost by the index mutual funds was more than $2.9 billion.

Further, Aber et al. (2009) compare ETFs from iShares to their matching mutual funds, in which assets from both classes mimic similar indices. They found that ETFs were traded mostly at prices that were above their net assets value. This implies that they were overrated by the market compared to mutual funds. In addition, the ETFs' prices highly fluctuated in a day compared to mutual funds, which derived opportunities for investors to make high daily return. However, the returns of ETFs and mutual funds, on a daily basis, were estimated to move by the same degree as their index benchmarks. Nevertheless, the capability of tracking the indices is superior in ETFs, in general.

The impact of other ETFs on mutual funds has also been investigated. Chen et al. (2009), for example, found that the World Equity Benchmarks (WEBS) ETFs have influenced the liquidity of their matching mutual funds. This implies that the role of mutual funds as the key in achieving the exposure of country-specific risk in equity investment has decreased. This finding was supported by the trading volume and frequency of the mutual funds that have decreased throughout their study. They also found that the mutual funds' market depth enlarged and their bid and ask spread narrowed as the matching ETFs were introduced. Hence, they hypothesised that mutual funds investors might have moved on to ETFs.

Later, Guedj and Huang (2009) examine 296 index mutual funds (open-ended funds) and 320 ETFs in the US market that were available from 1992 to 2006 that tracked 289 individual indices. Their main purpose is to investigate the impression that the popularity of the index ETF that causes negative effect on mutual funds is due to the benefit and drawback of the index mutual fund itself. They developed a hypothetical model of equilibrium choice between the index mutual funds and the index ETFs to compare the competency of each of the financial products for small investors with different liquidity needs. From this, they indicate that index mutual funds do supply cross-subsidisation among their investors by partaking in transaction costs for investors who are exposed to the shocks of large liquidity, with the cost of lesser mean returns for the other remaining investors. The mutual fund activity is a zero-sum game which contributes incomplete coverage against upcoming liquidity needs based on anticipated changes, especially for investors who are risk averse. Nevertheless, that characteristic of the index mutual fund would encourage the issue of individual ethics in the response to unwarranted trading hence raising the cost.

They further stressed that investors who require higher liquidity will benefit from the liquidity promised by the index mutual funds and, as a consequence, they will choose index mutual funds instead of index ETFs. What is appalling is that this situation that is caused by this type of investor, who focused themselves on the index mutual funds investment, does not result in higher flow-caused trading costs because each investor in that category is different in terms their liquidity needs and this will be cancelled out at the fund level. As a consequence, the index mutual funds are not overshadowed by the index ETFs in the equilibrium developed by them. In conclusion, they anticipate that the index ETF is an investment vehicle which is more suitable to investors who are seeking more correlated liquidity shocks or when the indices that act as a basis for the ETF are less liquid or thinner. In other words, the index ETF is not equal to the index mutual fund.

In the case of substitutability and complimentary, Romero-Perez (2010) analyses the substitutability and complementary effects between index mutual funds (open-ended funds) in the US that tracked similar indices. Both the funds that were used in the study are offered by similar fund companies, or commonly known as side-by-side funds. The study was done to answer the question of whether the index mutual funds and the index ETFs are substitutes or complementary to one another. In determining the answer, the demand side of both funds were investigated by measuring the funds flow to each of them. Two categories were considered in the process: one is when the index ETF was created after the index mutual fund and the other is when the index ETF and the index mutual funds were established at a similar point in time.

This is because the hypothesis for each of the categories is different. For the first category, the hypothesis is that when the index ETF is made available to the investors, it will draw the index mutual fund investors and, as a consequence, there will be a contrary impact on the index mutual fund's flow of funds. This indicates the substitution effect from the index ETF to the index mutual fund. For the second category, the hypothesis is that, as the company that offers the mutual funds chooses to introduce the index mutual fund and the ETF index at a similar point in time, this happened because both the products are regarded as complementary to each other. Hence, the assumption is that there is a direct relationship between the fund flow of the index mutual funds and the index ETF. By using data from 2000 to 2008 and the methods from Agapova (2011) (not officially published yet at that time), the equations involved were estimated by the ordinary least square method. The study found that the index ETFs and the index mutual funds are complementary to one another. This characteristic of complementarity is found in the category of when the index ETF was created after the index mutual fund and also in the category of when the index ETF and the index mutual funds were established at a similar point in time. This implies that the index ETFs which is the newer investment product, does act as a supplement to the investors and the investors may split their allowance in investing in the index mutual funds and the index ETFs.

In the case of mutual funds and ETFs, Barnhart and Rosenstein (2010) investigate the relationship between ETFs and closed end mutual funds (CEF) in the US market. They found that in the week after an ETF that is similar to the CEF was introduced, the CEF recorded a significant wide average discount, which is likely to indicate the substitutionality effect of the ETF to the CEF. The relative daily volume of the CEF also significantly declined due to the ETF's introduction. They also show that the return's

correlation coefficient and the CEF-ETF's slope on coefficient of regression are negatively significant in relationship to the abnormal premium and relative volume. These present additional evidence to support the substitution hypothesis.

Their findings are in line with other studies, such as by Agapova (2010). She suggests that from the existing studies, exchange traded funds and mutual funds are substitutes when it comes to luring money from investors, meaning that investors usually identify both type of funds as 'similar'. In her study, however, by using ETFs and mutual funds from Vanguard, she finds that the ETFs and the mutual funds are not substitutes for each other but rather complementary. The investigation was done by determining the flow of funds between those two funds and they were found as affecting each other positively.

Agapova (2011) investigates the contest between ETFs and open end index mutual funds in the investment market. According to her, although mutual funds were introduced long before ETFs and offer various kind of sub-products and advantages to the investors, the introduction of ETFs around 1993 and their trading have grown popular among investors, especially as an option to the usual index mutual funds. Hence, the study of substitutability between those two investment products and inspection of the possible explanations of their simultaneous availability in the investment market are well reasoned. By using a sample of 171 index mutual funds and 11 ETFs that tracked similar indices from the US market, the substitutability and clientele effect between mutual funds and ETFs were checked. The method used to test for the substitution effect is regression analysis in which two equations were developed. The aggregate flows to the mutual funds and ETFs each served as independent variables with the explanatory variables represented

by the lagged flows to the mutual funds and ETFs and the aggregate flows to the other funds. In other words, the independent variable for the first equation will serve as the explanatory variable in the second equation and vice versa.

The model for testing the tax clientele effect also uses regression method which consists of four equations. The variables used for this purpose in the first two equations are similar to the previous equations except that this time the explanatory variables include a variable that was assumed as a relation that confines the marginal effect of tax changes on flows to the funds. The other two equations also have similar variables to the equations in the substitution effect testing except that they include variables that measure the value weighted capital grows distributions to the mutual funds and the ETFs by index. Although that it is well known that the mutual funds and ETFs that are based on equity index differ because of the trading characteristics, taxes, fees and other related costs, Agapova (2011) found that the two investment products are substitutes for one another. It is further elaborated that an increase in ETF flows does have a relationship that may cause an increase in mutual fund purchasing activity. On the clientele effect side, the study explained that the mutual funds and the ETFs are not substitutes for one another. It was suggested that the ETFs may have an advantage in the preference of the investors who are tax averse while the mutual funds are preferred by tax-insensitive investors.

From these reviews, in the majority, the introduction of ETFs is found to have a negative impact on the matched mutual funds.

4.3.2 ETF and Other Financial Instruments

The effect of ETFs on other financial instruments besides mutual funds has also been studied by previous researchers. The earliest researchers who empirically examine the effect of an ETF's volatility on its own underlying asset, which is stock, are Lin and Chiang (2005). Their research examined the effect of the inauguration of the Taiwanese ETF, the Taiwan Top 50 Tracker Fund on the volatility of the underlying stocks. Based on their results, which analysed intraday data, there was overall increase in the volatility of the underlying stocks because of the introduction of the ETF. Their result also shows that there is no significant difference on size of the companies. Nevertheless, there are differences between stocks of companies based on different sectors. The volatility of the mixed sector companies' stock declined significantly while the volatility of the electronic and financial companies stock increased significantly; all of those stocks are included in the ETF. Their results are in line with Cheng and Madhavan (2009), who extend their data by including the inverse and leveraged ETFs. A newer empirical study regarding the effect were done by Chen and Huang (2010). By considering stocks from nine markets of developed and developing countries, they found significant relationship between the volatility of ETFs and their corresponding stock index performance.

In conjunction to that, Curcio et al. (2012) investigate whether ETFs that can be connected to real estate stocks improve the liquidity of real estate stocks. The ETFs that were considered consist of ten different ETFs that can be categorised into ordinary ETFs, leveraged ETFs and inverse ETFs. The ETFs were later categorised into four categories based on their inception date. Based on their statistical analysis, the ETFs from three

categories did significantly increase the real estate stocks' volatility, especially during their introduction to the market.

The effect of ETFs to futures has also been studied. For example, Deville et al. (2014) examine the relationship between futures, their underlying indices and ETFs, especially during the inception of the ETFs in the market. They found that the relationship between spot and futures improved after the inception of the ETFs. That is, the mispricing between the two markets decreased. However, they did not find any explanation for this situation that can be traced back to the ETFs. In other words, there is no evidence that ETFs caused an improvement between the spot and futures market. They hypothesised that the structural transformation of the index trading because of the existence of ETFs might have scattered the index traders. For example, the long-term hedgers and the traders that are interested in liquidity might have migrated to the ETF market. Hence, the futures market and the index market were left with many arbitrageurs and this might have converged those two markets as their main participants are from similar categories.

Li and Zhou (2014) examine the reaction of stock markets from the trading of leveraged ETF that mimic the stock indices. Their main interest stems from the fact that there is not enough evidence to support the hypothesis that leveraged ETFs' trading results in the addition of stock market volatility. By using event study analysis and extensive calculation of liquidity, they found that the stocks' spread becomes wider after the leveraged ETFs were introduced into the market but the stocks' liquidity did not change significantly. The stocks' volatility, however, was reduced and the trading volume of both leveraged ETFs and the stocks was positively correlated. Further analysis revealed

that the decrease in stocks' volatility was not as a consequence of leveraged ETFs trading. However, the effect of the leveraged ETFs' trading volume could be observed on the stocks on the following session. That is, during a trading day, the leveraged ETFs' trading volume in the morning session would affect the stocks' trading volume in the evening session. In conclusion, their findings do not support the hypothesis that leveraged ETFs' trading results in the increasing of stock market volatility

The effect of other financial instruments on ETF is also a topic of study for certain researchers. Hunsader et al. (2012) investigate the effect of the ETF options inauguration to the financial markets, in terms of whether the effect is positive or negative. After considering 233 ETF options in their analysis, they found evidence that the introduction of the options does lead to the increasing of returns of the underlying ETFs and their trading volumes, and also to the decreasing of bid ask spreads. This is because the ETFs, by their nature, usually will not be overvalued as they can be shorted and the options have enhanced this feature as shorting the ETFs by using options is found to be a cheaper option. Hence, the usage of options in the ETF trading has boosted the ETF market. Therefore, the inauguration of ETF options has a positive effect on the ETF market as it eradicates the frictions in ETF trading.

From the literature reviews, the effect of ETF on other financial instruments and the effect of other financial instruments on ETF have been debated since the introduction of ETF in the market. There are research studies that found that the introduction of ETF improves the investment opportunities while there are research studies that found that the introduction of the ETF does not improve anything in the investment activities. Although

there are many advantages and disadvantages that can be associated with ETF, the superiority of the ETF to other financial products, if it does exist, should have been perceived and appreciated by investors. Hence, if it is true that ETF does offer an improvement to the readily available financial products, such as mutual funds, the introduction of the ETF should just lure away the investors from their current investment. This study is trying to discover whether this is in fact the case.

4.3.3 Event Study

As this study will use event study methodologies to examine the substitutability effect of gold ETF on gold mutual funds, reviews of literature have been carried out regarding event study methodologies.

For a start, Aydogan and Muradoglu (1998) study the effect of the announcement, the use of stock dividends and the rights offerings on transferring the new information in a market that can be considered as thin and information is not available, and undependable. They use common event study procedure and the phases of the market for different institutions were controlled. Parametric tests and nonparametric tests were applied but the latter were found to be inappropriate in their study. A total of 109 events with 35 which happened during the initial stage of the market were analysed in connection to the price response, in which the events occurred because of decisions by board members and the application decisions in stock dividend rights offering.

The stocks were also grouped in accordance to their firm's ownership structure in order to analyse the price response. The price responses were significant when tested by parametric tests in every market stage and also during the board decision making and the application of the decisions. The results indicate positive significant price responses during the initial stage of the market, especially during the release of the board decision making, in which the returns are abnormal up to 13.5%. In the market's second stage, as the market advanced, the responses are found to be insignificant to the event of board decision making or during the application of stock dividend rights offerings. The results can be understood as a signal of the advancing of the market to efficiency, through stages, despite of various information releases' trend as they found that there are no dissimilarities between closely and widely held companies according to their stock prices responses, which can be witnessed nearby decision making dates of the boards.

Further, Gao and Tse (2001) investigate the influence of the declaration of annual earnings by using an event study of the Shanghai and Shenzhen stock exchange. In their study, they found that for the duration of the earnings announcement, there are abnormal volatility and trading volumes. The stock market response is more serious in the A-stock market, prior to the release of the news regarding annual earnings to the public. This result is in line with the assumption that native investors in the A-stock market are at an advantage in accessing firm-specific information compared to the public. The prior to the event prominent trading volumes with insignificant price changes in the A-stock market indicate that it does contain information which can act as an evidence of the information outflow and unofficial information environment in that market.

Regarding the tests used in event study, Serra (2002) explains many of them from the context of finance, which includes parametric and nonparametric tests. Her explanations start with a hypothesis on how a specific event influences the other values that are associated with the value of a company. The hypothesis was then tested by indicating whether there is any change in the value of the company, commonly indicated by abnormal return or volume traded of the company's shares. The tests were conducted with the belief that the information regarding the events is readily absorbed into the company's share price. The main issue that is of interest in the event study is to show whether there exists abnormal return or volume traded in order to accept or reject the hypothesis and it is in this part that many researchers have come out with their own methodologies. She also tells researchers interested in doing event study that they may detect many patterns of returns or volume traded during the event and this might be confusing. This situation happened because the return and volume traded patterns are a combination of many factors such as share markets, other markets and other firm happenings. In order to properly measure the event and its effect on the particular share price of a company, it is essential that the researcher controls other factors that might affect the share price. Hence, the right choice of tests or model in order to test the hypothesis is the main discussion in her explanation.

In practice, Martins and Serra (2007) study the effect of sporting and cultural events on stock markets by using the tests. The sporting events include the World Football Cup, the European Football Cup and the Olympic Games while cultural events include World Exhibitions. The procedure on investigating the effect starts with the announcement of the event's winning bidders, which is during before and after the date of announcement of the winners, in which they investigate the impact on the stock market

and the related industries, including whether any abnormal returns occur. After that, they study the factors associated with the variation in the abnormal returns that can be found because of the events and also in the related industries, while the factors that might influence the returns before the announcement or the events are controlled. They also examine abnormal performance regarding the impact of the events to the losing bidders, which in their study includes the countries that failed to win the rights to organise the events. They found that the abnormal returns on the stock markets and industries involved are not significantly different from zero. They found that the stock market of the organising countries experienced positive reactions while the stock markets of the failed countries experienced negative reactions.

In addition, Christensen (2009) investigates the impact of the Petroleum Exporting Countries Organisation announcements on stocks in Scandinavian countries. The hypothesis is that as the stock prices in that countries represent the present values of the companies' discounted future cash flows, the consumers involved would react to such announcements, hence affecting the values of the companies. This would be depicted through the stock prices of the companies. Event study methodologies were used to investigate whether there are any abnormal returns around the date of the announcements. The study also considers the prices of stocks on different sectors, other than the spot price of Brent crude oil. The tests include parametric and nonparametric tests. It is found that the announcement does not have any significant effects on the oil prices and the effect on the main sectors involved is restricted. The reason behind that is that the announcements were done by giving notice of the meetings, prior to the announcement, a long way advance causes the prospects to grow slightly but steady up to the meeting and this has eradicated the assumption of unsuspected event.

Regarding the event study test, Corrado (1989) investigates and introduces a new nonparametric rank test that aims to check the abnormal returns, considered as better than the parametric *t*-test for a broad spectrum of fat-tailed returns of security distributions. He shows that this test is more enhanced than the parametric tests and other nonparametric tests, as this test is correctly specified although the skewness of the excess returns' cross-sectional distribution may vary from one sample to another. It is also better as it is less influenced or unsusceptible to the increasing of the variance of excess returns during the event date, compared to the conventional parametric tests.

As a contribution to the event study test, Corrado and Zivney (1992) analyse the performance of a sign test with regard to the other tests, which are *t*-test and a rank test. By using an imaginary event date for each of the portfolios that were constructed from 600 companies, the distribution of the returns of the portfolios was determined. They found that the specification under the sign test and rank test is better than the *t*-test when the null hypothesis is no abnormal return and the variance shows no sign of increasing. But when variance increases during the event date, all of the tests conducted shows some misspecification, with the *t*-test being the worst. In examining the consequence of the performance of the test statistics on shorter durations to acquire the parameters of interest, all of the test statistics show no signs of serious deterioration. Hence, they conclude that in their experiment, the sign test presents solid and well particularised inferences in event studies as it is better specified than the *t*-test, but the rank test should be favoured when evaluation of statistical significance that is not dependable to a parametric assumption is the matter of interest.

Cowan (1992) however, tries to tackle issues that mainly surrounded an event study that used nonparametric tests. In this study, the nonparametric tests that were analysed are the generalised sign test and the rank test. First, the performance of the tests was evaluated by using comprehensive simulations with data from NYSE and NASDAQ. He found that the generalised sign test is well specified and better than the rank test. Second, he evaluates the capability of the generalised sign test relative to the rank test in identifying the abnormal returns. He found that the rank test is superior in that sense to the generalised sign test. Third, the phenomenon of return variance increases during the event day; whether it will affect the power and specification of the tests was checked. He found that not only is the generalised sign test well specified when the event day variance increases, which the rank test failed to do, but it is also better than the Brown and Warner (1985) test in that sense. Fourth, the effect of outliers that occur in the sample which has an enormous abnormal return although other stocks have a normal return were analysed. He found that the generalised sign test is less sensitive than the rank test to the extraordinary return. Fifth, when it comes to the examination that includes more than one day in an event study, the generalised sign test is better than the rank test.

In analysing the event study tests, Giacotto and Sfiridis (1996) came up with three vital criteria in determining a new statistical method for testing event studies. They start by stating that the test should be vigorous to numerous magnitudes and structures of variance changes. Secondly, the test should not one hundred percent determine the exact nature of the heteroscedasticity. Lastly, the test should not be drastically different from the original ordinary least squares method, as this will make it easier to be adopted by the researcher in the event study. They also tested the Corrado (1989) test, the Corrado and Zivney (1992) test, the Cowan (1992) test, the Boehmer et al. (1991) test and the standard

ordinary least squares test and compared them in an event study. The comparisons were done by creating a number of experiments under four types of changes of variances. They found that there was no uniformly most dominant test between those four in all of the circumstances, but they suggest that the Cowan (1992) test should be used for a study in which the researcher knows the exact number of the events.

To test the reliability of the event study tests, Harrington and Shrider (2007) analyse the effect of an event by focusing on short horizon by using parametric and nonparametric tests, and then by focusing on models of irregular returns during events without any considerations given to the possibility of endogeneity of decision's announcement with the existence of private information. They found that for nonzero mean abnormal return test, the test should be robust to the variation because of cross-sectional effect. Hence, they suggest that it is unsuitable to use a test that uses the standard prediction error. They also found that the Boehmer et al. (1991) test, which is lucid and which also has an expansive theoretical ground, is superior to the ordinary cross-sectional test. As a result, the Boehmer et al. (1991) test should be used by researchers who are looking for a parametric test that is robust. Their results also show that the ordinary least squares and the weighted least squares should not be used in order to provide answers regarding the effect of an event to the returns. Despite that, they emphasised that their result does not signify that any other studies done should be considered to be without merit.

For comparison between parametric and nonparametric test in analysing event study, Campbell and Wasley (1996) examine the empirical characteristics of samples of securities from the NASDAQ market. The properties that were of interest are daily trading volume and abnormal trading volume. They matched these properties with securities from the New York Stock Exchange (NYSE) market to determine the similarities and differences between them. In doing so, they also compared the performance of the parametric test and the nonparametric test used by the previous researchers, in which Ajinkya and Jain (1989) and Cready and Ramanan (1991) used the parametric test while Corrado (1989) used the nonparametric test. They found that in their case, which uses data from the NASDAQ and NYSE, the parametric test is less powerful than the nonparametric test in detecting the volume of abnormal trading, hence they suggest the use of the latter test in the study of detecting abnormal trading volume.

Further, according to Campbell et al. (2010), based on their literature reviews, in examining the abnormal returns during events, researchers prefer to use statistical test based on Brown and Warner (1980 and 1985). Other tests that are also familiar are based on Patell (1976), Mikkelson and Partch (1986) and Boehmer et al. (1991). There are not many studies that used nonparametric tests. They are usually used as a concomitance to the parametric tests. Those several studies usually used nonparametric tests based on Corrado (1989) and Cowan (1992), which are rank test and generalised sign test, respectively. By using simulation method, Campbell et al. (2010) examine the efficiency and capability of Patell (1976) test, Brown and Warner (1980 and 1985) test, Corrado (1989) test and Cowan (1992) test. The last two tests, which are nonparametric tests, were found to be more prevailed than the first two tests, which are parametric tests.

In a situation where there exists an increasing large return variance during the date of an event, the nonparametric test showed the habit of rejecting the hypothesis too often. However, their specification is superior to the parametric tests when the increasing of the variance is more moderate. The Patell (1976) test is found to be well specified when there is an increasing of the variance and more powerful than the Brown and Warner (1980 and 1985) test. The nonparametric tests (Corrado, 1989 and Cowan, 1992) were also found to be well specified and more powerful than those two parametric tests when tested by using samples from a single market or samples from the most focused markets or markets where their returns are distributed as not normal.

In a more recent study, Kolari and Pynnonen (2011) mention that Patell (1976) and Boehmer et al. (1991) tests, which are parametric tests, are well utilised in many event studies because of their enhanced power properties by using standardised abnormal returns. However, the nonparametric tests, such as the tests developed by Corrado (1989) and Corrado and Zivney (1992), are usually used as they do not have an assumption that stock prices are normally distributed and are well suited for investigating the abnormal returns on a single event day. Despite that, the power of those nonparametric tests to produce results decreases as the event expanded to more than one day. Hence, they were used either moderately, or in certain conditions or as a mechanism to verify the robustness of the parametric tests that were also being used in the event studies.

The usage of event study test on ETF and mutual fund has also been documented. For example, Barnhart and Rosenstein (2010) study the effect of ETF introduction to the closed-end fund discount and volume. As the distributional properties of CEF discounts

are not known, they test abnormal premia for statistical significance using two parametric tests based on normality and two nonparametric tests. The first test based on normality is the standardised abnormal return *Z*-test developed by Patell (1976), which accounts for unequal variances across securities. For tests over intervals longer than one week, they account for potential serial correlation using the adjustment developed by Mikkelson and Partch (1988). As ETFs tend to be introduced in groups, resulting in event-clustering, they also present Brown and Warner's (1985) "crude dependence adjustment" (CDA) test, also based on normality. This statistic calculates a single-variance estimate using the time series and cross-section of discounts across the entire sample being tested. The nonparametric statistics include the sign test, which compares the proportion of positive average abnormal premium, AAP or cumulative average abnormal premium, CAAP to the proportion of positive premia in the estimation period, and the rank test developed by Corrado (1989).

From these review, the tests that should be used to examine the effect of the introduction of ETF to the incumbent mutual fund are parametric tests and nonparametric tests. The parametric tests have been regarded as powerful tests because of the distribution of probability involved in the tests, however the nonparametric tests should also be considered as they were shown to have certain characteristics that made them better, as pointed out by Corrado (1989) and Cowan (1992).

4.3.4 Funds Comparison

In order to determine the characteristics of gold mutual funds, which are essential to use in this study, reviews on funds comparison research studies have also been done.

For example, Mallin et al. (1995) compares the performance of ethical investment funds and non-ethical investment funds in the UK by matching each of the funds in the former category to their equivalents in the latter category according to fund size and the date the fund was made available. This method of comparison tries to eliminate the effect of small company size and the time that the funds are available to be traded. For benchmark purposes, they used the Financial Times All Share Actuaries to act as market returns and the Treasury Bill's three months return to represent the risk-free return, to compare those two type of funds. By analysing the performance using the Jensen's alpha, Sharpe ratio and Treynor measure, they found that both funds underachieve the market returns, in terms of risk-adjusted returns, while according to mean excess returns, ethical funds underachieved both the market returns and non-ethical funds returns. However, by taking the ranking of all those three examination measurements, the ethical funds were found to leave the non-ethical funds behind. This may conclude that the wakefulness of the ethical investing has arisen because the interest and importance of ethical investing has been translated into demands by the investors.

Further, Gregory et al. (1997) re-examine the results of Mallin et al. (1995) and examine the small company effects and the fund value effects by using cross-sectional analysis. By using matched pairs of ethical and non-ethical funds in the UK, they employed the regular Jensen's alpha and a Jensen's alpha that was modified by

incorporating the extended CAPM to determine the performance of the ethical funds. They found that the non-ethical funds do not underperform the ethical funds and the ethical funds have more exposure to the small firm's effect than the non-ethical funds. The first cross-sectional analysis was determined by using regression to explain the former Jensen's alpha methods used. By using age, which was represented by a dummy variable called youth, fund size and a dummy variable called ethical as explanatory variables, they found that only youth was significant in explaining the performance of the funds that were measured by both type of Jensen's alpha. The second cross-sectional analysis was done to find out the difference in returns between both funds and whether there is any difference of small firm's effect between those two funds. They found that the ethical funds underperformed the non-ethical funds and the fund size variable that was used to determine the small firms effect was incorporated by other variables, hence there is no clear evidence of the difference of this effect between those two funds.

Also, Bauer et al. (2005) extend the works of Mallin et al. (1995) and Gregory et al. (1997) by investigating the performance of the ethical mutual funds in the UK, US and Germany. Their study differs from the previous one as they used multi-factor methods to control the effects of size, book-to-market and momentum. This was done as they tried to control the influences that might make the performance valuation of the ethical funds biased. It is worth mentioning that this method was adopted from the method that was used to measure the performance of mutual funds by Carhart (1997). The performance of the ethical mutual funds was determined by comparing their risk-adjusted returns and style of investment with the conventional mutual funds in the corresponding countries. Their main objectives are to examine whether the returns from the ethical mutual funds exceed the returns from the market and to determine the style of investments that were

practised by the ethical mutual funds. To determine the performance of the ethical mutual funds compared to the conventional mutual funds, the former were matched with the sample of the latter according to their age of being traded and fund size.

They were then benchmarked to the indices provided by Worldscope. The Jensen's alpha one factor model and Carhart (1997) four factor model that lengthens the Fama and French (1993) three factor model were deployed. They found three motivating findings from their study. First, there is no proof that the returns from the ethical mutual funds and the returns from conventional mutual funds differ according to the statistical tests. Second, the investment styles of the ethical mutual funds differ from the investment styles of the conventional mutual funds. Third, the ethical equity indices that were tested, which are the Dow Jones Sustainability Global Index (DJSI), the Ethical balanced index, the Dow Jones Sustainability US Index and the Domini Social Index (DSI), failed to describe the returns of ethical mutual funds and they also did worse than the standard equity indices in that sense.

From these reviews, fund size is the factor that is used in pairing or matching two or more funds in order to compare them. This is also supported by Barnhart and Rosenstein (2010) who used this similar characteristic in their study.

4.4 Analysis of the Literature

From literature reviews, it is understood that the ETFs introduction affect the mutual funds in terms of their trading volume and returns. However, there are results from previous studies that can be regarded as questionable. In the case of Aber et al. (2009), they only use 4 ETFs that are provided by the same company and also 4 mutual funds that are also provided by the same company. That is, they didn't capture the variation in the ETFs and mutual funds that should be used in explaining the event of the introduction of ETFs to the market. Hence, the generalisability of their results to the overall market is questionable. This also applies to the findings by Chen et al. (2009). This is because their analyses only consists of general statistics without any inferences.

Most of the previous studies use multiple regression without any pre-determined tests been done to the factors considered in the multiple regression. For example, Boney et al. (2006) use multiple regression in determining the impact of index ETFs on index mutual funds. However, there is no test done prior to the multiple regression in determining whether the factors used in the multiple regression are properly identified. Also, they do not consider every possible variable that could have influenced the flow of funds in and out of the index mutual funds during the introduction of the ETFs. The pre-determined tests to the variables are vital as ETFs and mutual funds from different markets or based on different underlying assets are different in terms of liquidity and returns. That is why Agapova (2010) pre-determined the variables that are used in the multiple regression analyses by performing the tracking error analyses. That is, whether the ETFs have an advantage over mutual funds in that sense. Also, Barnhart and

Rosenstein (2010) use event study analyses before proceeding to multiple regression analyses as to fully understand the impact of the ETF's introduction to the mutual funds.

Regarding many event study tests that have been suggested by many previous studies, the suggestion by Kolari and Pynnonen (2011) is the best. That is, every parametric test used in the event study should be accompanied by nonparametric test. This is because the distribution of the market data is not known. There are researchers who suggest that the distribution can be assumed as normal as the sample size is more than 30, hence the Central Limit Theorem applies. There are also researchers who suggest that the distribution of the market data is a modification of normal distribution, while there are researchers who suggest that they are not normally distributed at all. Hence, to be on the safe side, bot parametric and nonparametric tests should be used.

4.5 Gaps in the Literature

From the literature review above, we found that no study has yet been done to determine the effect of the introduction of gold ETFs to gold mutual funds. Over time, many gold-related products are offered to the investors. They may have different names but whether there is evidence that gold ETFs are regarded as substitutions to gold mutual funds is not known. If the gold ETFs and the gold mutual funds are substitutes for each other, the gold ETF's gain in trading volume will result in the gold mutual funds' loss, vice versa. This means that they negatively affect each other in that sense. The demand and the effect of substitution are also often said to be determined by the price of the affected products, which in this case is gold mutual funds.

Most of the studies that compare ETFs and mutual funds were done by using ETFs and mutual funds that used stock indices as their underlying or benchmark. We consider that an investigation of the relationship between gold ETFs and gold mutual funds should be done to confirm the suggestions made by Tufano (2003), Ross (1989) and Miller (1986) that the ETF, as a newer product than the mutual fund, should have improved the performance of the existing mutual funds in order to become significant and sustainable. Because of that, the introduction of the gold ETFs should have stressed these qualities on gold mutual funds and, as a consequence, the return performance of the mutual funds should become more visible. This phenomenon should be detected from the event study carried out in this study. If not, then there is a possibility that the introduction and availability of the newly launched ETFs is only because of marketing strategies by the managing investment companies as concluded by Massa (2000), hence would not significantly affect the mutual funds. This is because it only involves low search costs in determining which investment is better than another as pointed out by Hortacsu and Syverson (2004).

4.6 Hypotheses Development

Previous studies, according to Chen et al. (2009), find that the relationship between a new financial instrument and its matching financial instrument that is readily available in the market can be divided into two: whether the new financial instrument is a substitute for or complementary to the latter. In the first scenario, the introduction of a substitute financial instrument will usually negatively affect the readily available financial instrument. The negative effect can be observed by the increase in the cost or friction, the decrease in liquidity and the decline in volume traded of the readily available financial

instrument. This happens as the newly introduced financial instrument offers more beneficial characteristics than the readily available financial instrument, hence lures away investors. This kind of scenario has been documented by Subrahmanyam (1991), Jegadesh and Subrahmanyam (1993), Gorton and Pennacchi (1993) and Choi and Subrahmanyam (1994).

In the second scenario, the introduction of a complementary financial instrument however, would positively affect the readily available financial instrument. The positive effect can be seen from the increase of the symmetrical of market information and the increase in the liquidity of the underlying or the indexed instrument, hence the readily available financial instrument. In this case, the investors flocked to the newly introduced financial instrument but at the same time did not abandon the readily available financial instrument. The evidence has been recorded by Kumar et al. (1998) and Hegde and McDermott (2004). Therefore, Chen et al. (2009) suggested that the introduction of ETF should attract mutual funds' investors, as it applies to both the scenarios, although there is no conclusion yet whether they are complementary to or substitutes for each other. That is, the introduction of ETF would affect the mutual funds' volume and liquidity.

According to Svetina (2010), the introduction of newly created ETFs that contest existing mutual funds has resulted in new financial products that bear marginally better or equivalent performance. The better performance is found to be a characteristic of those ETFs. This is in line with the findings of Miller (1986), Ross (1989) and Tufano (2003). As a result, this will lessen the liquidity and trading of mutual funds as the latter would have gone to the ETFs, he added. Svetina (2010) found that in the US market, in the six

month time frame during the introduction of ETFs that track a similar index to the incumbent mutual funds, the mutual funds endured an average decrease in liquidity and trading volume. This is because the investors may have moved from the mutual funds to the ETFs. Previous research studies other than Svetina (2010) also show that ETFs and conventional index mutual funds are substitutes, as their liquidities are negatively related to each other (e.g. Barnhart and Rosenstein (2010)).

The definition of liquidity can also be described as the share turnover ratio or the amount of shares traded divided by the amount of shares outstanding, as pointed out by Datar et al. (1998), Rowenhorst (1999), Chan and Faff (2005) and Bekaert et al. (2007). This definition of liquidity is used in this study.

Gold ETFs are the alternative for gold mutual funds' investors, who require passive managed portfolios that can be traded throughout the day. Thus, all things being equal, we believe that when gold ETF that has a similar objective to an existing gold mutual fund is introduced, the sign of the abnormal relative volume around the event date of the gold mutual funds would be positive as the investors would trade out the gold mutual funds. After a certain time, the amount of the abnormal volume would decrease as the investors have moved their activity in the gold ETF's market. This leads to our first hypothesis:

H2A: *The introduction of gold ETFs will lead to abnormal trading volume of gold mutual funds, relative to their shares outstanding, compared to their expected share turnover ratio.*

The introduction of ETF as a product substitute for mutual fund will result in an improvement of mutual fund's return performance (Agapova, 2011) as a response from the gold mutual fund's management to keep the investors attracted to the mutual funds. Thus, we would like to examine whether this is also true in the case of gold ETFs and gold mutual funds. Hence, all things being equal, we expect that the presence of the gold ETF will result in abnormal returns in gold mutual funds during the introduction of the gold ETF, which leads to our second formal hypothesis:

H2B: *The introduction of gold ETFs will lead to abnormal returns in gold mutual funds, compared to their expected return.*

As explained in the previous section, size of the fund will be used in matching the gold ETFs to the gold mutual funds as to study the effect of the gold ETFs introduction to the gold mutual funds. We also want to check whether the introduction of the gold ETF will lead to abnormal volume and abnormal returns of the gold mutual funds that can be explained by the substitutability of the returns between gold mutual funds and the gold ETFs. All things being equal, the substitutability here should be seen from the correlations of those two funds' returns. The measurement of the correlations are correlation coefficients and regression coefficients. This leads us to our third and fourth hypotheses:

H2C: *The abnormal trading volume of gold mutual funds, relative to their shares outstanding during the introduction of gold ETFs, is directly related to their return's correlation.*

H2D: *The abnormal returns of gold mutual funds during the introduction of gold ETFs is directly related to their return's correlation.*

4.7 Sample Description

As we do not have a specific index to represent gold mutual funds, we will try to examine the effect of the gold ETF to gold mutual funds by using proxy. That is, we will try to examine the effect on the individual gold mutual fund or a value weighted portfolio of several gold mutual funds. To find the list of active gold mutual funds, we used 31st December 2013 as the reference date as this date is the most recent during this study. That is, we checked which gold mutual funds are active and available from Thomson Reuters Datastream (2004) on that date. Also, based on the date, we checked which gold ETFs are active and available from Thomson Reuters Datastream (2004).

After we obtained the list of the gold mutual funds and gold ETFs, we acquired daily NAV, market capitalisation and inception date for each of the gold funds. After that, the gold mutual funds and gold ETFs were matched in pairs according to their fund sizes and inception dates (Barnhart and Rosenstein, 2010). Their fund sizes will determine which categories they are in, while the inception dates were used to make sure that the gold ETFs were introduced after the gold mutual funds. Based on Agapova (2011), fund size is a typical factor in determining whether an ETF is a substitute for a mutual fund. That is, the closer the fund size of an ETF to the fund size of a mutual fund, the more significant that ETF is as a substitute for the mutual fund. This is because fund size determines the market share of a fund. According to the fund sizes and dates, we found that a gold mutual fund can be paired with several gold ETFs and vice versa. Hence, the dates of the matched gold ETFs' introduction will be used to determine the events effect on the gold mutual funds, in line with the methodology used by many previous researchers, such as Aydogan and Muradoglu (1988).

From the search, there are 13 pairs of gold ETFs and gold mutual funds that can be examined. The list of the pairs is shown in Table 4.1. The fund sizes of the gold ETFs and gold mutual funds are based on the date when the gold ETFs were introduced to the market. The inception date of the gold mutual funds starts from as early as 30th December 1994 to 4th September 2009. The inception date of the gold ETFs starts from as early as 15th April 2004 to 15th November 2012. Fund sizes are categorised into six categories: GBP10 million and below, above GBP10 million to GBP50 million, above GBP50 million to GBP100 million, above GBP100 million to GBP150 million, above GBP150 million to GBP200 million and above GBP3000 million to GBP4000 million. These categories were created based on the nature of the fund sizes of the gold mutual funds and gold ETFs themselves. The UK repurchase agreement (GILT Repo) that will be used in the analysis section is taken from the Bank of England website (Bank of England, 2014). To control for the effect of financial recession, we exclude the dates from 1st January 2008 to 31st January 2010 (Bank of England, 2010).

Table 4.1: List of Gold Mutual Funds and Gold ETFs Pairs.

The gold mutual funds and the gold ETFs are paired according to their market capitalisations and inception dates. The inception dates and market capitalisations for gold mutual funds and gold ETFs were taken from Thomson Reuters Datastream (2014). There are 13 pairs of gold mutual funds and gold ETFs in the period of study.

Gold Mutual Funds names	Inception dates	Gold ETF names	Inception dates
SF t1ps Smaller Companies Gold A	04/09/2009	ETFS GBP Daily Hedged Gold	27/02/2012
		UBS (Irl) ETF plc – Solactive Global Pure Gold MinersI-dis	15/11/2012
		db Physical Gold Hedged	07/06/2011
Smith & Williamson Glbl Gold & Resources	03/12/2004	db Physical Gold G Hedged	01/04/2011
		ETFX DAXglobal Gold Mining Fund	11/09/2008
Investec Global Gold A Acc Net	10/04/2006	RBS Market Access Arca Gold Bugs	11/01/2007
		Lyxor ETN Gold	20/03/2009
		SPGS Gold	27/04/2010
LO Funds – World Gold Expertise PA	07/08/2003	ETFS Gold	22/09/2006
		iShares Physical Gold	08/04/2011
BGF World Gold A2	30/12/1994	ETFS Gold Bullion Securities	15/04/2004
BGF World Gold E2	11/11/1998	ETFS Gold Bullion Securities	15/04/2004
BGF World Gold B2	01/07/2002	ETFS Gold Bullion Securities	15/04/2004

4.8 Methodology

In examining the relationship of the gold ETF and gold mutual fund, first we assume that the introduction of the ETF will have the greatest effect on the similar mutual funds' volume and return.

4.8.1 Event Study Analysis

Event study analysis is used in this study to investigate the effect of gold ETF's introduction to gold mutual funds. That is, the effect to the volumes and returns of the gold mutual funds.

4.8.1.1 Abnormal Volume

Volume and abnormal volume are based on the percentage of outstanding shares of each gold mutual fund traded each day. Volume is defined as:

$$V_{it} = \ln \frac{100 n_{it}}{S_{it}} \tag{4.1}$$

where n_{it} is the number of shares of gold mutual fund *i* traded on day *t* relative to the gold ETF introduction day and S_{it} is the number of shares outstanding of gold mutual fund *i* on day *t*. If more than one gold mutual fund are involved between certain dates, we create a value weighted portfolio which consists of the affected gold mutual funds, based on their market capitalisation. That is, between the dates, we have a pair of gold mutual fund portfolios and a gold ETF. Then the volume is taken from the portfolio, instead of individual gold mutual fund for those dates. According to Ajinkya and Jain (1989) and Campbell and Wasley (1996), volume is not normally distributed and need to be log transformed. Hence, we performed a log transformation on the percentage of outstanding shares traded measurement.

Abnormal volume or specifically, abnormal daily percentage relative volume for gold mutual fund *i* on day *t* is specified as:

$$AV_{it} = V_{it} - V_i \tag{4.2}$$

where V_i is the mean estimation volume for mutual fund *i* or portfolio i. Hence, the abnormal volume can be understood as the residual between the observed and estimated volume. The estimation period used to determine the estimated volume is 120 days ending

before one month from the day of introduction of the gold ETF. This is because we want to check the impact of the gold ETF's introduction to the gold mutual funds during the month of the introduction.

We measure the average abnormal percentage volume as

$$AAV_t = \frac{\sum_{i=1}^{N} AV_{it}}{N} \tag{4.3}$$

where N is the number of pair between gold ETFs and gold mutual funds or gold ETFs and gold mutual funds portfolio. The average abnormal percentage volume is also known as average residuals ($\overline{AR}_t$) of the volume traded. The cumulative average abnormal percentage volume is:

$$CAAV_{t1,t2} = \sum_{t=t1}^{t2} AAV_t \qquad t1 \le t \le t2 \tag{4.4}$$

where $t1$ and $t2$ are trading days relative to the event. Dividing the cumulative average abnormal percentage volume ($CAAV$) by the number of days in an interval yields a daily average of abnormal percentage volume, AAV_t. This abnormal volume calculation is essential to test hypotheses 2A and 2C.

We test for abnormal volume using the same test statistics as in the abnormal return, which is described in the next section. The test statistics are standardised residual test by Patell (1976), crude independence adjustment by Brown and Warner (1985) and standardised cross-sectional test by Boehmer, Musumeci and Poulsen (1991). The

nonparametric tests are the rank test by Corrado (1989) and generalised sign test by Cowan and Sergeant (1996).

4.8.1.2 Abnormal Returns

The abnormal returns, *ARt* for gold mutual fund *i* or portfolio *i* over day *t* is specified as

$$ARt_{it} = Rt_{it} - Rt_i \tag{4.5}$$

where Rt_{it} is the return for gold mutual fund *i* or portfolio *i* on day *t*, and Rt_i is the mean return during estimation period for gold mutual fund *i* or portfolio *i*. That is, similar to volume calculations in the previous part, if there is more than one gold mutual fund involved during the introduction day, the similar portfolio from the volume section (previous section, section 4.8.1.1) is be used to determine the return, instead of individual return. Hence, the abnormal return can be understood as the residual between the observed and the estimated return. The estimation period used is 120 days ending before one month to the day of introduction of the gold ETF, similar to the abnormal volume. The average abnormal return, *AARt* over day *t* is defined as

$$AARt_t = \frac{\sum_{i=1}^{N} ARt_{it}}{N} \tag{4.6}$$

where *N* is the number of pair between gold ETFs and gold mutual funds or gold ETFs and gold mutual funds portfolio. Similarly, this can be understood as averaging the residuals or abnormal returns across gold mutual funds in common event time, hence obtaining what is commonly known as average residuals ($\overline{AR_t}$) of the returns, or $AARt_t$. By cumulating the periodic average residuals over a particular time interval (*L* days

around the introduction date), we obtain the cumulative average residuals ($\overline{CAR}$), or *CAARt*:

$$\overline{CAR} = \sum_{t=1}^{L} \overline{AR}_t \tag{4.7}$$

or

$$CAARt_{t1,t2} = \sum_{t=t1}^{t2} AARt_t \qquad t1 \le t \le t2 \tag{4.8}$$

where $t1$ and $t2$ define the interval over which the abnormal return is cumulated relative to the event, for example $t1 = -1$ and $t2 = 0$ is for the time frame starting from a day before the introduction day to the day of the introduction. The cumulative average abnormal return (*CAARt*) is useful for statistical testing over intervals, although unlike event-studies using abnormal returns, the *CAARt* has no economic meaning. For example, if the average abnormal return (*AARt*) is −1% on day 1 and −1% on day 2, the *CAARt* would be −2% although there has been no additional decline in abnormal return or value on day 2. When *CAARt* is divided by the number of days in a given period, we obtain an average daily *AARt*. This abnormal returns calculation is essential to test hypotheses 2B and 2D.

We test the abnormal volume and abnormal return to check for its statistical significance by employing three parametric tests which are based on normality and two nonparametric tests. These tests will provide answers in testing hypotheses 2A and 2B. The parametric tests are standardised residual test by Patell (1976), crude independence adjustment by Brown and Warner (1985) and standardised cross-sectional test by Boehmer, Musumeci and Poulsen's (1991). The nonparametric tests are the rank test by Corrado (1989) and generalised sign test by Cowan and Sergeant (1996). We use

parametric and nonparametric tests as there is evidence that parametric and nonparametric tests are different in certain features and nonparametric test can be more powerful than parametric test, as stated by Campbell and Wasley (1996). However, Aydogan and Muradoglu (1998) suggest that the nonparametric tests such as the rank test and the sign test which are usually used for thinly traded markets are not superior to the traditional event study methodology in their study. On the contrary, the rank test is known to be sensitive to the length event window (Cowan, 1992) and the sign test is superior to the rank test in the case of extreme abnormal returns. As a conclusion, for robustness of our study, we used parametric and nonparametric tests.

4.8.1.3 Event Study Tests

Our event study tests consist of parametric and nonparametric tests. For the parametric tests, as suggested in the literature, the underlying important assumption is that individual or portfolio of gold mutual funds abnormal volume and returns are normally distributed. Thus, the standard statistic, based on *t*-distribution is:

$$t = \frac{\overline{AR}_t}{S\left(\overline{AR}_t\right)} \tag{4.9}$$

where $\overline{AR}_t$ can be defined as average residuals and $S\left(\overline{AR}_t\right)$ is an estimate of standard deviation of the average residuals, $s_{\overline{AR}_t}$.

4.8.1.4 Patell (1976)

Patell (1976) identified that since the event-period residual is subject to higher standard deviation than the estimation period residual, it should be standardised using the following formula, which moreover controls for heteroskedastic event-day residuals. Furthermore, it prevents other samples with large variances from dominating the test. The cross-sectional *t*-test does not account for event-caused variance and thus overstates significant levels. The rationale of the standardisation is to ensure that each abnormal volume or returns will have the similar variance. The standardised abnormal volume or returns can be calculated by dividing each gold mutual fund's abnormal volume or returns by its standard deviation that are obtained over the estimation period:

$$AR'_{it} = \frac{AR_{it}}{S\left(AR_i\right)} \tag{4.10}$$

The test statistic of the hypothesis that the average standardised abnormal volume or returns across gold mutual funds is equal to zero is calculated by:

$$z = \frac{\overline{AR}'_t}{S\left(\overline{AR}'_t\right)} = \frac{\left(1/N\right)\sum_{i=1}^{N} AR'_{it}}{S\left(\overline{AR}'_t\right)} \tag{4.11}$$

The z-statistic is assumed to be normally distributed for large N, based on Central Limit Theorem.

4.8.1.5 Brown and Warner (1980, 1985)

However, during the event time, the dependence across gold mutual funds' average residuals should also be considered and this was not pointed out by Patell (1976). By using Brown and Warner (1980, 1985) method, the standard deviation of average residuals is estimated from the average abnormal volume or returns time series over the estimation period:

$$S^*\left(\overline{AR}\right) = \sqrt{\frac{\sum_{t=1}^{T}\left(\frac{\sum_{i=1}^{N} AR_{it}}{N} - \overline{AR}^*\right)^2}{T-d}} \tag{4.12}$$

in which

$$\overline{AR}^* = \frac{\sum_{i=1}^{N}\left(\frac{\sum_{t=1}^{T} AR_{it}}{T}\right)}{N} \tag{4.13}$$

By using this method, the null hypothesis is there is no abnormal volume or returns. Also, the statistic in the equation above is distributed as Student-*t* with *T*-*d* degrees of freedom, where *T* is the number of days, *d* is the parameters estimated during the estimation of volume and returns, and *t*-statistics were obtained by taking the average residuals using equation (4.13) and their standard deviations using equation (4.12) into equation (4.9).

4.8.1.6 Boehmer, Musumeci and Poulsen (1991)

However, by using the procedure by Patell (1976) and Brown and Warner (1980, 1985), there is one major problem. That is, the variance of the average abnormal volume or returns are estimated by using non-event period data time series. Thus, if the variance of the abnormal volume or returns increases while approaching the event date, the null hypothesis will be rejected too often. To overcome that, by using Boehmer et al. (1991) method, the variance of average abnormal volume or returns are estimated from the cross-section of event date prediction errors and not prediction errors from estimation period. Thus, based on Boehmer et al. (1991) the standardised residuals should be:

$$S^{\diamond}\left(AR'\right)=\sqrt{\frac{1}{N\left(N-d\right)}\sum_{i=1}^{N}\left(AR'_i-\frac{\sum_{i=1}^{N}AR'_i}{N}\right)^2} \tag{4.14}$$

This treatment is based on the assumption that the variance during the event date is proportional to the variance in the estimation period. To use this treatment, the equation (4.14) will be the denominator in equation (4.11).

4.8.1.7 Corrado (1989)

Corrado (1989) propose a rank test instead of parametric test. This is because it is correctly specified although the skewness of the excess returns' cross-sectional distribution may vary from one sample to another. The rank test requires each of the gold mutual fund or portfolio abnormal volume and returns to be transformed in ranks. The

ranks , (K_i) is from all over the combined period that includes the estimation and the event window (T_i) (Serra, 2002). For example, for abnormal returns:

$$K_{il} = rank\left(AR_{il}\right)$$
$$AR_{il} > AR_{is} \Rightarrow K_{il} > K_{is}$$

After that, the ranks are compared for each gold mutual fund or portfolio during the event period. The null hypothesis is there is no abnormal volume or returns and the expected average rank is $\overline{K}_i = 0.5 + T_i / 2$. Further, the test statistic hypothesis test is:

$$R = \frac{\frac{1}{N}\sum_{i=1}^{N}\left(K_{i0} - \overline{K}_i\right)}{S\left(\overline{K}\right)} \tag{4.15}$$

and the denominator is given by

$$S\left(\overline{K}\right) = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\frac{1}{N^2}\sum_{i=1}^{N}\left(K_{it} - \overline{K}_i\right)^2} \tag{4.16}$$

The test statistic given by equation (4.15) is asymptotically distributed as unit normal. The rank statistic with multi-day event period is given by:

$$R = \frac{\sum_{l=1}^{L}\frac{1}{N}\sum_{i=1}^{N}\left(K_{il} - \overline{K}_i\right)}{\sqrt{\sum_{l=1}^{L}S^2\left(\overline{K}\right)}} = \frac{\sum_{l=1}^{L}\overline{K}_l}{S\left(\overline{K}\right)} \cdot \frac{1}{\sqrt{L}} \tag{4.17}$$

4.8.1.8 Cowan and Sergeant (1996)

However, according to Cowen and Sergeant (1996), if the variance increases to a certain level during the event day, the Corrado (1989) test would be misspecified. To overcome that, Cowen and Sergeant (1996) propose another test, which is the sign test instead of the rank test.

Based on binomial test, the sign test examines the frequency of positive abnormal volume or returns of gold mutual fund or portfolio equals 50%. Further, the null hypothesis for this test is the positive abnormal volume or returns is not equal to 0.5. For that, the proportion of gold mutual funds or portfolios in the sample need to be checked if they have positive abnormal volume or returns. Then the average fraction of gold mutual funds or portfolios with positive abnormal volume or returns is used to estimate the null hypothesis value. Across gold mutual funds or portfolios, if the independent holds for abnormal volume and returns, then the amount of positive abnormal volume and returns is distributed binomially with parameter *p*, which is our null hypothesis. For alternative hypothesis however, the proportion of abnormal performance is not equal to 0.5, at any level. Therefore, our test statistic, which is distributed in unit normal is:

$$Z = \frac{\left| p_0 - p \right|}{\left(p\left(1-p\right)/N \right)^{\frac{1}{2}}} \tag{4.18}$$

where p_0 is the surveyed fraction of positive abnormal volume or returns calculated across gold mutual funds or portfolios in one particular event day, or over multiple days. If we are interested in examining the negative abnormal performance, then the positive abnormal performance in this method should be substituted with negative abnormal

performance. This Cowan and Sergeant (1996) method however also has its own weakness as stated by them. That is, it is inferior to rank test if the expected variance do not increase to a certain level during the event period (Cowan and Sergeant, 1996).

4.8.2 Regression Analysis

This method is used to test hypotheses 2C and 2D. The variables involved are described in following sections.

4.8.2.1 Independent Variables

Regarding hypotheses 2C and 2D, we measure the degree of the gold ETFs introduction effect to the gold mutual funds in two ways: i) correlation coefficients (*Corr*) between daily return differences of both funds with risk free return and ii) the slope coefficient of regression (*RegCoeff*) between daily return differences of both funds with risk free return. In the case of (ii), the daily price differences of gold mutual funds with risk free return will serve as dependent variable while the daily price differences of the gold ETF with risk free return will serve as independent variable. Both ways measure how closely the movement of returns from a substitute fund, which is gold ETF, to another fund, which is gold mutual fund. In addition, this will offer an explanation if there is abnormal volume or abnormal returns phenomena on gold mutual funds during the introduction of gold ETF. That is, because of similar price movements, investors have changed their investments to gold ETFs. Those two measurements will then be put into regression equation (3.19) to (3.26) as independent variables.

Besides correlation coefficients and slope coefficient, there are also other factors that are worth checking using the regression analysis, because of their relationship with mutual fund's performance. They are market excess return, size or market capitalisation factor, book-to-market ratio factor and past performance factor. The model which these factors serve as exogenous variables is known as four-factor model and was used by Carhart (1997), Otten and Bams (2002) and Fletcher and Marshall (2014).

For the market excess return, we used the return from the value-weighted aggregate market proxy (Carhart, 1997) which is developed from the return on total universe of the mutual funds in the UK minus the risk free return. This is because we do not have an index which represents mutual funds as mutual funds track different benchmarks. This kind of situation has also been raised by Barnhart and Rosenstein (2010). The use of total universe of mutual funds has also been applied by Otten and Bams (2002). For the risk free return, we used the return from the UK repurchase agreement (GILT Repo). The use of the government repo instead of Treasury bill is because we need daily risk free return. The usage of repo instead of Treasury bill has been suggested by Suppa-Aim (2010).

The size of the funds also has been suggested to influence the performance of mutual funds. For example, Elton et al. (1996) show evidence that the performance of mutual funds move in tandem with the size of the mutual funds. Their findings have been supported by Payne et al. (1999) by using the data from 1993 to 1995 and also by Indro et al. (1999). For the UK and other European countries, there is also a positive significant relationship between size and mutual fund's performance, as demonstrated by the study

of Otten and Bams (2002) and Annaert et al. (2003). The book-to-market ratio is included as suggested by Fama and French (1993).

The performance of mutual funds in the UK is also suggested to have been influenced by past performance (Blake and Timmermann, 1988). Their findings are supported by Otten and Bams (2002) who show evidence that past performance affected the performance of mutual funds in the UK but not in the case of their European counterparts. In addition, the past performance also affected mutual fund's performance in the New Zealand market (Bauer et al., 2006) but not in the US (Prather et al., 2004) and Sweden (Dahlquist et al., 2000).

We rank our mutual funds according to their size or market capitalisation based on the nature of the mutual funds in our universe itself. That is, we divide the mutual funds into two portfolios: i) small market capitalisation portfolio for mutual funds that has market capitalisation of less than or equal to 20% bottom of total mutual funds market capitalisation and ii) large market capitalisation portfolio for mutual funds that has market capitalisation of greater than 20% bottom of total mutual funds market capitalisation. We then rank our mutual funds according to their book-to-market ratio. The top 30% mutual funds go into the high book-to-market portfolio while the bottom 30% go into the low book-to-market portfolio. We then rank our mutual funds based on their prior six months return. The top 30% mutual funds based on their return go into the winner portfolio while the bottom 30% go into the loser portfolio. The data for mutual fund's market capitalisation, book-to-market ratio and prior six months return were taken from Thomson Reuters Datastream.

4.8.2.2 Dependent Variables

For the dependent variables of our regression analysis, we use *AbVolume* and *AbReturns*, which are abnormal volume and abnormal returns, respectively. The calculations of the dependent variables, *AbVolume* and *AbReturns*, are similar to section 4.8.1.1 and 4.8.1.2, respectively. However, in this section, the time window in which both the dependent variables are considered is 120 days after the introduction day of the gold ETF. This is because we want to include the correlation measures between the gold mutual funds and the gold ETFs.

If *AbVolume* and *AbReturns* are to be used as endogenous variables in the regression analysis, they are likely to be subject to simultaneity bias (Barnhart and Rosenstein, 2010). To overcome this issue, two methodologies are used: i). instrumental variables and two-stage least squares. This is to provide consistent estimators in our regression analysis. The two-stage least squares will also provide robustness of the results from the first regression that uses instrumental variables.

4.8.2.3 Instrumental Variables

We use a 240-day period after the introduction of the comparable gold ETFs and divide it into two subperiods with 120 days each. Instrumental variables are created by taking the *Corr* and *RegCoeff* starting from the first subperiod. That is, they are taken 120 days before each day of the second subperiod. The dependent variables, abnormal volume (*AbVolume*) and abnormal returns (*AbReturns*) are taken from the second subperiod. The factor variables, which are market excess return, size (SMB), book-to-market ratio

(HML) and past performance (PR), are taken from the second subperiod. This method is used to prevent misspecification from using the variables that are correlated with the error term in the regression analysis. The *AbVolume* variables are obtained by dividing the cumulative average daily abnormal volume with 120, which is the number of days for the subperiod. The cumulative average daily abnormal returns are also divided with 120 to obtain the *AbReturns*.

Hence, the regressions that we used are:

$$AbVolume_t = \alpha + \beta_1 Corr_{t-1} + \beta_2 \left(R_{mt} - r_{ft} \right) + \beta_3 SMB_t + \beta_4 HML_t + \beta_5 PR_t + \varepsilon_t \quad (4.19)$$

$$Ab\,\mathrm{Re}turns_t = \alpha + \beta_1 Corr_{t-1} + \beta_2 \left(R_{mt} - r_{ft} \right) + \beta_3 SMB_t + \beta_4 HML_t + \beta_5 PR_t + \varepsilon_t \quad (4.20)$$

$$AbVolume_t = \alpha + \beta_1 \,\mathrm{Re}\, gCoeff_{t-1} + \beta_2 \left(R_{mt} - r_{ft} \right) + \beta_3 SMB_t + \beta_4 HML_t + \beta_5 PR_t + \varepsilon_t \quad (4.21)$$

$$Ab\,\mathrm{Re}turns_t = \alpha + \beta_1 \,\mathrm{Re}\, gCoeff_{t-1} + \beta_2 \left(R_{mt} - r_{ft} \right) + \beta_3 SMB_t + \beta_4 HML_t + \beta_5 PR_t + \varepsilon_t \quad (4.22)$$

where

$AbVolume_t$ = the abnormal volume of gold mutual funds in the second subperiod.

$AbReturns_t$ = the abnormal returns of gold mutual funds in the second subperiod.

$Corr_{t-1}$ = the correlation coefficient between gold mutual funds and gold ETFs 120 days before.

$RegCoeff_{t-1}$ = the regression coefficients between gold mutual funds and gold ETFs 120 days before.

R_{mt}-r_{ft} = the value weighted market returns minus risk free return in the second subperiod.

SMB_t = the return difference between the small market capitalisation portfolio and large market capitalisation portfolio in the second subperiod.

HML_t = the return difference between the high book-to-market portfolio and low book-to-market portfolio in the second subperiod.

PR_t = the return difference between the past (six months) winner portfolio and the loser portfolio in the second subperiod.

4.8.2.4 Two-Stage Least Squares Regression Analysis

To check whether there is significant reaction between abnormal volume and abnormal return, we used two-stage least squares regression analysis. This also done to determine the robustness of the previous regression analysis. The regression analysis used in this section is similar to the previous regression analysis but for exogenous variables; we include *AbVolume* and *AbReturns* variables. That is, if the endogenous variable of our system is *AbVolume*, then *AbReturns* will be included as exogenous variable and if the endogenous variable of our system is *AbReturns*, then *AbVolume* will be included as exogenous variable. The *AbVolume* and *AbReturns* that have been added as exogenous variables are taken from the second subperiod.

To prevent misidentification on our regression system, we exclude one variable that has been determined outside of the regression system and include in the other regression equation so that every regression equation has different exogenous variables (Brooks, 2008) and our two simultaneous equations model are identified (Wooldridge, 2009). Because of that, we assume that the errors from each of the regression equations in every simultaneous equation are uncorrelated with each other (Kocenda and Cerny, 2014). Thus, our simultaneous equations 1 is:

$$AbVolume_t = \alpha + \beta_1 Corr_{t-1} + \beta_2 Ab\,\mathrm{Re}turns_t + \beta_3 SMB_t + \beta_4 HML_t + \beta_5 PR_t + \varepsilon_t \quad (4.23)$$

$$Ab\,\mathrm{Re}turns_t = \alpha + \beta_1 Corr_{t-1} + \beta_2 AbVolume_t + \beta_3 \left(R_{mt} - r_{ft}\right) + \beta_4 HML_t + \beta_5 PR_t + \varepsilon_t \quad (4.24)$$

and our simultaneous equations 2 is:

$$AbVolume_t = \alpha + \beta_1 \mathrm{Re}\, gCoeff_{t-1} + \beta_2 Ab\,\mathrm{Re}turns_t + \beta_3 SMB_t + \beta_4 HML_t + \beta_5 PR_t + \varepsilon_t \quad (4.25)$$

$$Ab\,\mathrm{Re}turns_t = \alpha + \beta_1 \mathrm{Re}\, gCoeff_{t-1} + \beta_2 AbVolume_t + \beta_3 \left(R_{mt} - r_{ft}\right) + \beta_4 HML_t + \beta_5 PR_t + \varepsilon_t \quad (4.26)$$

4.9 Analyses and Results

This section reports the outcomes from the event study tests and regression analyses.

4.9.1 Event Study Tests on Abnormal Volume

The abnormal volume results are presented in Table 4.2. In the table, we include the time window for five working days before until five working days after the introduction day of the gold ETFs (-5,5), five working days before until the introduction day (-5,0), five

working days before the introduction day (-5), during the introduction day (0), a day after the introduction date (1) and so on. We do not report the results for other time windows as they are not significant and for table presentation simplicity.

The abnormal volume is tested based on the assumption that even though an introduction of new gold ETFs will lead to the exodus of gold mutual funds investors, the sign of the abnormal relative volume around that event date would be positive as the investors would trade out the gold mutual funds. After a certain time, the amount of the abnormal volume would decrease as the investors have move their activity in the gold ETF's market. As a whole, the abnormal volume is represented by the cumulative average abnormal volume (CAAV) if the time window consists of more than one day, or the CAAV will be average abnormal volume (AAV) if the time window consists only one day. The null hypothesis for the event study tests is the CAAV or AAV is equal to zero. This means that under null hypothesis, there is no difference between the daily abnormal volume of gold mutual funds during the introduction of the gold ETFs and during other days prior or after the introduction day.

Table 4.2 shows that from five tests that were used in this study, three tests give us all significant values for the CAAV. Based on the three tests, the CAAV of gold mutual funds are significant starting from five days before until five days after the introduction day, starting from five days before until the introduction day, on the fifth day before the introduction day, on the day before the introduction day, on the introduction day, on the day after the introduction day, on the second day after the introduction day and on the third day after the introduction day. During the first time window (-5,5), the CAAV is the

largest and most significant compared to the other time window. It can be seen that the values of the CAAV significantly declined from five days before, one day before and during the introduction day. The values continue to be significant and declining until three days after the introduction day. After that, the CAAVs are not significant.

All results from nonparametric tests are not significant. Hence, if we based our results from Patell (1976), Brown and Warner (1985) and Boehmer et al. (1991), the results indicate that there is an increased and decreased of magnitude of gold mutual funds abnormal volume during and after the introduction of the comparable gold ETFs and these results support Hypothesis 2A.

Table 4.2: Gold Mutual Fund's Volume Reaction to the Introduction of Gold ETFs.

The table shows the results of the abnormal volume testing under null hypothesis of no abnormal volume. The results show that the abnormal volume is significant during all time windows mentioned by using parametric test. Further, the abnormal volume also significant on the day before the introduction, on the introduction day and other days after the introduction day.

Day	CAAV or AAV	Patell	Brown & Warner	Boehmer et al.	Corrado	Cowan & Sergeant
(-5,5)	27.035%	4.7093*	2.9189*	8.1781*	1.1417	0.4549
(-5,0)	15.966%	3.6108*	2.8964*	8.3734*	0.7683	0.4549
(-5)	11.712%	3.0778*	2.9050*	8.3754*	-0.238	0.4549
(-1)	9.573%	2.7859*	2.9130*	8.3777*	-0.1417	0.4549
(0)	7.46%	2.4541*	2.9219*	8.3706*	-0.5968	0.4549
(1)	5.334%	2.0721*	2.9301*	8.3610*	-0.6518	0.4549
(2)	3.213%	1.6011*	2.9337*	8.3489*	-0.9818	0.4549
(3)	1.08%	0.926*	2.9451*	8.3413*	-0.8502	0.4549

* significant at 0.05

4.9.2 Event Study Tests on Abnormal Returns

The abnormal returns are tested based on the assumption that the returns of gold mutual funds will improve as a reaction to the entrance of gold ETFs in the market. The abnormal returns of the gold mutual funds are represented by the cumulative average abnormal returns, CAAR if the time window consists of more than one day. For a day time window, CAAR is average abnormal returns, AAR. The null hypothesis for the event study tests is the abnormal returns of the gold mutual funds is equal to zero during the introduction of the gold ETFs.

Table 4.3: Gold Mutual Fund's Returns Reaction to the Introduction of Gold ETFs.

The table shows the results of the abnormal returns testing under null hypothesis of no abnormal returns. The results show that the abnormal returns phenomenon did not happen for all time window or on a single day or on any other day for up to one month. For simplicity, the results for time window and day other than mentioned in this table is not reported.

Day	CAAR or AAR	Patell	Brown & Warner	Boehmer et al.	Corrado	Cowan & Sergeant
(-5,5)	-0.22%	0.5566	-0.9616	0.7093	0.4745	0.7127
(-5,0)	-0.3%	0.0981	-0.9887	0.1078	-0.4867	-0.1782
(-5)	-0.2%	0.047	-0.989	0.0755	-0.4311	-0.1782
(-1)	-0.21%	0.1388	-0.9842	0.2143	-0.0867	0.7127
(0)	-0.2%	0.0505	-0.988	0.0752	-0.2702	0.7127
(1)	-0.26%	-0.1332	-0.9916	-0.1566	-0.5232	0.7127
(2)	-0.13%	-0.1539	-0.9939	-0.2938	-0.3752	0.7127
(3)	-0.04%	-0.6378	-1.0263	-2.2839	-1.1374	-1.069

As can be seen from Table 4.3, all of the CAAR or AAR are not significant in all of the time windows and days presented. Other time windows and days are not included in the table as they are also not significant and for presentation simplicity. Hence, hypothesis 2B is not supported by using this test.

4.9.3 Regression Analysis

The regression analysis is used in this study to test hypothesis 2C and 2D. The statistics of the variables that are used in this study can be seen from Table 4.4.

Table 4.4: **Descriptive Statistics of Variables**.

AbVolume and AbReturns are calculated from previous sections. Corr is the correlation coefficients between daily return differences of gold ETFs and gold mutual funds with risk free return. RegCoeff is the slope coefficient of regression between daily return differences of both funds with risk free return. Risk free return is taken from the UK repurchase agreement (GILT Repo) (Suppa-Aim, 2010). Market excess return, is taken from the return of the value-weighted aggregate market proxy (Carhart, 1997) which is developed from the return on total universe of the mutual funds in the UK minus the risk free return because we do not have an index which represents mutual funds as mutual funds track different benchmarks (Otten and Bams, 2002).while size or market capitalisation factor, book-to-market ratio factor and past performance factor are based on the work by Carhart (1997), Otten and Bams (2002) and Fletcher and Marshall (2014).

Variable	Minimum Value	Maximum Value	Mean	Standard Deviation
AbVolume	-0.1994	0.7839	0.0429	0.2184
AbReturns	-0.0047	0.0045	0.0003	0.0032
Corr	0.0360	0.9973	0.5043	0.3212
RegCoeff	-0.7368	0.9190	0.0012	0.4145
Market Return	-0.0859	0.0967	-0.0017	0.0391
Fund Size	-0.0189	0.6110	0.0078	0.0164
Book-to-Market Ratio	-0.0196	0.0211	-0.0005	0.0089
Past Performance	-0.0546	0.0478	-0.0009	0.0192

4.9.3.1 Single Regression Equation for Abnormal Volume and Abnormal Returns

Single equation model with instrumental variable method is used in this study to ensure consistent estimation. The abnormal volume regressions are presented in columns 1 and 3 of Table 4.5. In regression 1 and 3, the *F*-statistic suggests that the regression is significant. From five of the variables tested, only one variable is significant in describing the *AbVolume,* which is the fund size.

Other variables are not significant in describing the variation of *AbVolume*. For regression 3, the fund size is also found to be significant in describing the variation of *AbVolume*, while other variables are not. The R^2 is around 60% for both regression 1 and regression 3. From these results, it can be said that the slope coefficients and correlation coefficients do not have any association to the abnormal volume of the gold mutual funds during the introduction of the similar gold ETFs. This evidence rejects the hypothesis 2C that the abnormal volume of gold mutual funds is directly related to the slope coefficient and correlation coefficients between the gold mutual fund's return differences and the gold ETFs return differences with risk free return.

The abnormal returns regressions are shown in column 2 and 4 in Table 4.5. Both of the equations have F statistics that are not significant. This tells us that in both regressions, the predictors are not suitable in the regressions simultaneously. This is supported by the *t*-statistics of all the predictors in both equations that are also not significant. Hence, this evidence rejects hypothesis 2D that the abnormal returns of gold mutual funds are directly related to the slope coefficient and correlation coefficients between the gold mutual fund's return differences and the gold ETFs return differences with risk free return.

Table 4.5: Abnormal Volume and Returns Regression Estimates.

F-statistic from regression 1 and 3 are significant while F-statistic from regression 2 and 4 are not significant. Further, from regression 1 and 3, only fund size are significant in explaining the AbVolume while from regression 2 and 4, there is no variable found to be significant in explaining AbReturns.

Regression	1	2	3	4
Dependent variable	AbVolume	AbReturns	AbVolume	AbReturns
Intercept	-0.061	0.0008	-0.03	−0.001
t-statistic	-1.286	0.007	-1.103	0.386
p-value	0.208	0.994	0.278	0.702
RegCoeff	-	-	-0.002	−0.61
t-statistic	-	-	-0.037	-0.045
p-value	-	-	0.971	0.965
Corr	0.062	0.0002	-	-
t-statistic	0.794	0.261	-	-
p-value	0.433	0.796	-	-
Market returns	0.030	0.022	0.036	0.022
t-statistic	0.044	1.455	0.051	1.480
p-value	0.965	0.156	0.960	0.149
Fund size	9.61	0.011	9.584	0.011
t-statistic	6.366	0.315	6.037	0.306
p-value	0.0001	0.755	0.0001	0.762
Book-to-market ratio	4.726	0.066	4.329	0.063
t-statistic	1.669	1.059	1.535	1.024
p-value	0.105	0.298	0.135	0.314
Past Performance	-0.761	-0.026	-0.886	-0.027
t-statistic	-0.587	-0.912	-0.682	-0.948
p-value	0.561	0.369	0.5	0.35
R^2	0.597	0.071	0.59	0.069
Adjusted R^2	0.547	-0.045	0.538	-0.048
F-statistic	11.875	0.609	11.492	0.591
p-value	0.000	0.659	0.000	0.672

4.9.3.2 Two-Stage Least Squares Regression

We apply two simultaneous systems to determine if significant reaction occurs between abnormal volume and abnormal returns. The equations we estimate are similar to the regression analysis before, but here the *AbVolume* equation now includes the simultaneous *AbReturns* as explanatory variable. We then substitute the *AbVolume* with *AbReturns* as the dependent variable and *AbReturns* with *AbVolume* as the explanatory variable.

Based on Table 4.6, we found that no significant feedback exists between *AbVolume* and *AbReturns*. That is, both variables are found to be not significant as independent variables in all of the regression equations. Hence, there is no relationship between both variables. The regression coefficients, correlation coefficients, market returns, book-to-market ratio and past performance are also not significant in any of the regressions. The only significant variable in the regressions is the fund size, in the equations with *AbVolume* as dependent variable. This further supports the findings of the previous regression analysis.

Table 4.6: Two-Stage Least Squares Regressions.

In these regressions, AbReturns becomes independent variable while AbVolume becomes dependent variable at the same time and vice versa. This is done to check if there is significant reaction between those two variables. The results show that AbVolume and AbReturns are not significant as independent variables in all of the regressions.

Model	1		2	
Regression	a	b	c	d
Dependent variable	AbVolume	AbReturns	AbVolume	AbReturns
Intercept	-0.0608	0.000	-0.032	0.000
t-statistic	-1.286	0.222	-1.168	0.569
p-value	0.208	0.826	0.252	0.573
RegCoeff	-	-	-0.002	0.0001
t-statistic	-	-	-0.029	-0.038
p-value	-	-	0.977	0.97
Corr	0.058	0.0000	-	-
t-statistic	0.748	0.124	-	-
p-value	0.46	0.902	-	-
AbVolume	-	0.004	-	0.004
t-statistic	-	0.97	-	0.996
p-value	-	0.34	-	0.327
AbReturns	7.744	-	8.017	-
t-statistic	0.97	-	0.996	-
p-value	0.34	-	0.327	-
Market returns	-	0.022	-	0.023
t-statistic	-	1.550	-	1.581
p-value	-	0.131	-	0.124

(*continued*)

Table 4.6-*Continued*

Model	1		2	
Regression	a	b	c	d
Fund size	9.528	-	9.498	-
t-statistic	6.296	-	5.974	-
p-value	0.0001	-	0.0001	-
Book-to-market ratio	4.211	0.048	3.82	0.047
t-statistic	1.46	0.74	1.332	0.727
p-value	0.154	0.465	0.192	0.473
Past Performance	-0.558	-0.023	-0.669	-0.024
t-statistic	-0.425	-0.806	-0.508	-0.822
p-value	0.674	0.426	0.615	0.417
R^2	0.609	0.098	0.602	0.098
Adjusted R^2	0.546	-0.047	0.538	-0.048
F-statistic	9.67	0.674	9.39	0.671
p-value	0.0000	0.646	0.0000	0.648

4.10 Discussion and Conclusion

This study finds that although there are increased in returns of gold mutual funds during the introduction of gold ETFs, the phenomenon is not significant, either tested by parametric tests or by nonparametric tests. However, there occurs abnormal volume in gold mutual funds trading during the introduction of gold ETFs, only by using parametric tests. The abnormal volume phenomenon however, is not significant when tested by using nonparametric tests. The abnormal volume detection by using parametric tests but not by using nonparametric tests should not be seen as conflicting results. Kolari and Pynnonen (2011), among others, explain that parametric tests and nonparametric test used different measures in detecting the effect of certain event to financial market. That is, in the event study in this chapter, the nonparametric tests are based on rank and sign but the parametric tests are based on *t*-distribution. Not only that, there are also different kind of measures between the parametric tests (Serra, 2002). Also, nonparametric tests usually

used as a mechanism to verify the robustness of the parametric tests (Kolari and Pynnonen, 2011).

In conjunction to that, for the sample of this study, there are 13 sets of sample based on pairs which are taken from 13 gold mutual funds that contains more than 200 daily observations. The population of gold mutual funds in the UK in the period of study is 28. The sample is only 13 as we want to control for fund size effect which is vital (Barnhart and Rosenstein, 2010; Agapova, 2011, among others). The remaining 15 gold mutual funds were not considered because they have huge fund size compared to the gold ETFs. Thus, the power to detect the true effect by using parametric tests during the event to generalise them have been reduced because of low statistical power as the number of gold mutual funds in the UK is only 28.

Pett (1997) suggests that the minimum amount of data or observations should be greater than 30 in order to carry out any parametric test. Her suggestion is supported by Salkind (2013) which also finds that greater than 30 is adequately suitable for any parametric test. In other publication, Warner (2012) suggests that greater than 20 is the minimum amount to deploy the parametric test while greater than 10 is the absolute minimum amount if the sample consists of groups. She even devoted a discussion relating to the minimum size of data or observations in doing research.

However, as Lehmann (2006) and Hollander et al. (2013) point out, to be on the safe side, nonparametric analysis can be used to analyse small sample or population. Further, according to Corrado (1989), Cowan and Sergeant (1996), Kolari and Pynnonen (2011) and Ross (2014), among others, nonparametric test should be used when the necessary size of the sample is not met to fully utilise the parametric test.

Therefore, the results of no abnormal volume and no abnormal returns in gold mutual funds during the introduction of gold ETFs based on nonparametric tests are more robust. As for the results obtained from the parametric analyses, indications of the results should be treated with caution because they may not be generalizable over time in the UK, or to other countries, due to the small sample size that they are obtained from.

To examine the relationship between gold mutual funds daily volume and daily returns with gold ETFs during the introduction, we employed regression analyses; single equation and two stage least squares. Both analyses used instrumental variables and factor variables. The reason why instrumental variables were used is to examine whether relationship factor between gold ETFs and gold mutual funds could explain the volume and returns experienced by the gold mutual funds. The factor variables, however, were used to control the other factors such as market, size, book-to-market and past performance. From the results, the volume of gold mutual funds does not have any relationship with the returns from the gold ETFs and other factors, which are market, book-to-market ratio and past performance. In the case of gold mutual funds returns, the regressions further verify the results from the event study analyses. That is, it doesn't have any relationship with the introduction of gold ETFs.

Thus, we find no evidence that gold ETFs can be regarded as substitutes for gold mutual funds based on abnormal volume and abnormal returns. That is, the introduction of gold ETFs does not affect the gold mutual funds in that sense. The possible explanation for this is offered by Broman and Shum (2015). They found that there are investors who are attracted to different kind of funds. For example, investors may be attracted to ETFs but not to mutual funds, vice versa. The reason behind this is they are looking for different styles of investment, rather than invest randomly in different funds and this includes individual and institutional investors. Further, there are many factors that may influence gold prices. Hence, mimicking the gold prices is such a difficult task. That is why certain people may be attracted to gold mutual funds as they believe that active management can achieve or overachieve gold prices (Blose, 1996; Gastineau, 2004). However, there are certain people who thinks that passive management is the right choice because it is impossible to achieve or overachieve gold prices by using active management funds (Dellva, 2001). Not only that, these findings are also in line with Kostovetsky (2003). That is, it depends on the trading behaviour and preference of the investors, although gold ETF may be regarded as a new and attractive kind of investment in gold. Therefore, the introduction of gold ETFs does not necessarily attracts gold mutual funds investors.

Further, the findings in this study show that gold ETFs and gold mutual funds relationship is different compared to the relationship between stock index ETFs and stock index mutual funds. This is because stock index ETFs and stock index mutual funds are regarded as substitutes, based on the findings by Agapova (2010 and 2011), Barnhart and Rosenstein (2010) and Svetina (2010). To the best of our knowledge, this is the first study that that try to relate the introduction of gold ETFs to the existing gold mutual funds.

CHAPTER 5

DO GOLD ETFs PROVIDE A MORE EFFECTIVE HEDGE AGAINST INFLATION THAN INFLATION-LINKED BOND ETFs?

5.1 Introduction

Investors who want to invest in assets which will generate returns that will be protected against the effect of inflation will likely invest in inflation-linked bonds or commodities, because of their characteristics (Garcia-Zarate, 2011). Inflation-linked bond ETFs are instruments that should mimic the returns and risks of inflation-linked bonds. Previous studies have shown that inflation-linked bonds provide the expected hedge against the effect of inflation and that the tracking performance provided by inflation-linked bond ETFs is acceptable, although not perfect (Fulkerson et al., 2014). Previous studies have also shown that commodities are more effective for hedging against inflation than financial assets and that gold, in particular, is more effective for hedging against inflation than other commodities (Moore, 1990; Aggarwal, 1992; Ranson and Wainright, 2005; McCown and Zimmerman, 2006). Further, previous studies have shown that gold ETFs mimic the performance of physical gold fairly well, although not perfectly (Ivanov, 2011 and Murphy and Wright, 2010, among others). The evidence reported for gold ETFs in the UK in Chapter 2 of this thesis is consistent with this observation in the literature. However, there is no information in the literature about whether gold ETFs provide a good hedge against inflation and, more importantly, about whether they (gold ETFs) provide a more effective hedge against inflation than inflation-linked bond ETFs. It will be useful to examine this two issues because investors are interested in assets that

generate returns that are protected against the effect of the inflation, judging from the huge amount of money invested in inflation-linked bonds at the moment (Campbell et al., 2009).

In this study, we use physical gold ETFs as they promise returns that will track the performance of physical gold prices return. This is because the relationship of physical gold prices return and inflation has been found in the studies. Not only that, but there is a strong relationship between inflation-linked bond ETF and inflation as suggested by the previous studies. Hence, investors have two types of ETF to choose from and should select the best suited to their needs, if their main purpose is to hedge against inflation.

This research aims to answer and analyse two main ideas:

(1) To determine whether physical gold ETFs and inflation-linked bond ETFs provide a good hedge against inflation in the UK.

(2) To determine whether physical gold ETFs provide a more effective hedge against inflation than inflation-linked bond ETFs.

The arrangement of this chapter is as follows. The first section introduces the idea and objectives of this first study. The second section explains the motivation for pursuing the study. The third section reviews the previous literatures related to this study. The fourth section analyses the previous literatures related to this study. The fifth section describes the gaps that this study tries to fill. The sixth section explains the development of the hypotheses in this study. The seventh and eighth sections describe the sample data

and the methodologies used in this study, respectively. The ninth section reports the results from the analyses while the tenth section discusses and concludes the findings of the study.

5.2 Motivation of the Study

Gold ETFs that promise to track gold prices and inflation-linked bond ETFs that promise to track inflation-linked bonds have become our interest in this study because of the inflation hedging capability that they could offer. Not only that, both ETFs have also recorded a significant growth, in terms of numbers that have been issued, issuers and investors of those type of ETF (London Stock Exchange, 2014). Because of that, they have been positioned among the popular investment instruments nowadays. According to Garcia-Zarate (2011), the reason why they are popular among investors is because the investors believe that the inflation risk hedging capability of gold commodity and inflation-linked bond can be achieved through that type of gold ETF and inflation-linked bond ETF, respectively. However, no study to date has been conducted directly between the inflation-risk hedging capability of that type of gold ETF and inflation-linked bond ETF to support this claim.

The gold ETF background has been well described in Chapter 3 of this thesis. In the case of inflation-linked bond, they are usually issued by government. They have a high positive correlation with inflation and are very effective hedges. They are a staple of many fixed income portfolios as they provide good liquidity and direct inflation protection. They generally outperform commodities, precious metals and energy as they are directly linked to the rises in the consumer price index or retail price index, depending

on the measurement of inflation in a particular country (Campbell et al., 2009). This feature makes them one of the best hedges in investors' inflation arsenal and provide investors with a guaranteed rate of return over the inflation rate. They work by matching returns to changes in inflation, measured by reference to the index ratio, which is pegged to some base level. The index ratio is then applied to the original principal amount of the bond to determine the payment obligation. The bond principal may increase or decrease each year to keep pace with inflation. The major advantage is that the investor receives periodic interest payments on the increasing principal during inflationary periods.

In order to achieve the performance of the inflation-linked bond, investors may purchase and hold the inflation-linked bond directly, or may also access this performance through purchasing and holding inflation-linked bond ETFs. Inflation-linked bond ETFs may be pegged to a single security, a basket of securities or indices that are correlated to the inflation-linked bond performance. In order to do that, inflation-linked bond ETFs hold assets such as inflation-linked bonds or other securities that they believe could match the performance of inflation-linked bonds. Hence, inflation-linked bond ETFs should provide the investor with exposure to changes in the inflation-linked bonds without holding the actual bonds in a portfolio. Similar to gold ETF, investors receive the benefit of diversity and flexibility through inflation-linked bond ETF.

Many studies can be found that are devoted to inflation-linked bonds. In contrast, reports on inflation-linked bond ETFs are few, especially on their performance. The study by Baldwin (2014) has sparked our interest in conducting this study. According to Baldwin, the inflation-linked bond ETFs usually own inflation-linked bonds and other

notes that were issued mostly by government and their principals and coupon payments are in line with the inflation rates. This feature enables inflation-linked bonds to eliminate inflation risk. However, that feature does not eliminate the entire risk. As an example, the iShares TIPS Bond ETF in 2013 experienced a decrease in its price. The bond is an inflation-link bond that has a huge market share in the US market. The decrease in its price was around 8.7%. The reason behind this, as explained by Baldwin (2014), is because the Treasury increased their interest rate at that time. At the same time, the inflation rate remained stable and did not increase as expected. As a consequence, the real rates increased. When this happened, the bond price decreased and as did the iShares TIPS Bond ETF.

From these reports, inflation-linked bond ETFs may have tracked the inflation-linked bond fairly well during ups and down, but overall, whether they are the best in providing inflation hedging is still arguable.

In addition, in order to make investors interested in ETFs, some form of standardisation of the global bond market is required; this would allow investors to participate without the nuances of having to understand the intricacies of the bonds and the countries themselves (Drenovak et al., 2012). This standardisation is what we call an index. The index itself is built from rating, market capitalisation, total return and others, which represent the performance of the inflation-linked bond. As a result, the performance of inflation-linked bond ETF may also differ from the performance of the inflation-linked bonds to a certain degree (Garcia-Zarate, 2014).

Based on these reports, the claim by the investors that inflation-linked bond ETFs can be used to hedge against inflation rate as reported by Garcia-Zarate (2011) is not necessarily true. This is because inflation-linked bond ETF might not give the return anticipated by investors, which is to enable them to get over the inflation rate.

Therefore, this study will contribute to the existing studies by determining whether physical gold price benchmark ETF and inflation-linked bond ETF do provide a good hedge against inflation in the UK and also check which of the two funds provides a better hedge against inflation risk than the other.

5.3 Literature Review

5.3.1 Inflation-Linked Bond and Inflation-Linked Bond ETF

According to Falbo et al. (2010), the first inflation-linked bonds were issued by the Finnish and French governments after the Second World War. However, according to Credit Suisse (2013), it was the Massachusetts state government (in the US) which first issued inflation-linked bonds in 1780. Anyway, the first major issue of the bond, according to Liebenberg (2008), was by the UK government in 1981. This is in line with the suggestions by Campbell et al. (2009) and Schulz and Stapf (2014) that it was the UK government which first issued the inflation-linked bonds in the early of 1980s followed by the US government in 1997. The US government issued their own inflation-linked bonds, known as Treasury Inflation-Protection Securities (TIPS). The UK is one of the earliest and most reputable countries dealing in inflation-linked bonds (NBER, 2013). The inflation-linked bonds that are issued by the UK government are also known as gilts.

The gilts are important in the UK economy. They represent about 30 percent of the UK public debt and contribute to around 10 percent of the UK gross domestic product, as mentioned by Campbell et al. (2009). Not only do they signify the importance of inflation-linked bonds in the UK, they also implicate that a lot of money is involved in inflation-linked bonds in the UK market and that they attract a lot of investors.

Because of the attraction, Oakley (2013) concludes that inflation-linked bonds are one of the most costly assets in the world. The reason is their popularity. Further, because their prices are high, they offer negative real yields. That is, they offer real rates of return that are not as much as the inflation rate. The evidence can be easily observed in the inflation-linked bonds market in the US and UK. The negative real yields occur because of the good performance of the inflation-linked bonds, hence attracting many people looking for the best way to protect the value of their money. Because of this, which can be interpreted as a demand force, the prices of inflation-linked bonds have gone up but at the same time the yields have gone down. For reference, at the time of writing, the US Treasury 0.625% 2021 inflation-linked bond recorded a real yield of -1% while the UK 2.5% 2024 showed a real yield of -1.06%.

The pricing of inflation-linked bonds is also more complex than the pricing of other financial assets. According to Liebenberg (2008), for inflation-linked bonds, the payment of coupons and principals can be increased or decreased, as a result of the ups and downs of the inflation rate. This typical characteristic is dissimilar to nominal bonds. Regarding their return, in general, they can be determined as equivalent to the inflation rate with the addition of real yield. Signifying their name, the inflation rate is the main

'ingredient' in their return. The real yield however, is somewhat similar to other bonds. That is, as a real reward for the money lent by creditors (investors) to the debtor (government). To verify what drives the real yield of inflation-linked bonds is a complicated task, but normally they are guided by the economic conditions of the issuing country and also the forces of supply and demand. It is also important to state that the real yield varies from time to time hence results in the increase or decrease of capital. As an example, when inflation-linked bonds are traded at a low price, the real yield will go up. This will result in the price of the inflation-linked bonds going down, at a rate that is similar to the increased in the real yield. It will be worse if the price decreases to a rate that is less than the inflation rate. To overcome this, investors need to invest in the inflation-linked bonds from the beginning to the end, in order to achieve the initial real yield (Liebenberg, 2008).

In addition to that, Falbo et al. (2010) agree that the inflation-linked bonds, in terms of pricing, have a sophisticated structure, hence determining their accurate prices is a tricky process. The main reasons behind that are their popularity among many types of investors and because of their financial structure is not straightforward. Similar to Oakley (2013), Falbo et al. (2010) stress that the popularity of inflation-linked bonds has caused ups and downs in their prices, in a dynamic manner as a result of supply and demand forces. Further, their financial structure, made up from coupon payments and the repayment of capital, changes accordingly to the economic conditions. Rather, their capital or face value is re-evaluated from time to time based on the corresponding inflation rate. As a result, the return from inflation-linked bonds can generally be said as receiving the coupon payments which are calculated or re-calculated by using an initial

rate to the re-evaluated capital or face value. In simple terms, it is the inflation rate that complicates the pricing of the inflation-linked bonds.

Added to the expensive price and pricing complexity, the inflation-linked bonds, as one type of fixed-income instrument, also suffer from few disadvantages compared to other financial instruments. Their market lack of liquidity, price transparency and trading flexibility. This can be seen from their trading, which usually occurs over the counter (Tang and Xu, 2014).

Because of the expensive price, pricing complexity and the market condition of the inflation-linked bonds, inflation-linked bond ETFs were introduced to enable investors to take part in inflation-linked bonds investment. The inaugural of this type of ETF, as part of fixed-income ETF, has brought liquidity, transparency, and diversification to the bond market and improved investors' participation in bond investing, hence enhancing their portfolio management (Fulkerson et al., 2014; Tang and Xu, 2014). The first inflation-linked bond ETF that was introduced in the UK market is the iShares Barclays Euro Inflation Linked Bond which tracks the Barclays Euro Government Inflation Linked Bond Index. The inception date of the first inflation-linked bond ETF in the market was 18 November 2005 (Thomson Reuters, 2015).

5.3.2 Inflation-Linked Bond and Inflation-Linked Bond ETF as Inflation Hedge

According to Lingane (2008), many countries issued inflation-linked bonds as one of their financing mechanisms and this includes the US government. The US Treasury Department firstly issued inflation-linked bonds, named Treasury Inflation-Protection Securities (TIPS), in 1997. Although the name TIPS has been changed to Treasury Inflation-Indexed Security by the department itself, they are still known as TIPS, especially by investors. TIPS pay coupons based on the rate calculated from the principal value of the bonds. The principal value is adjusted daily according to inflation or deflation rate. In terms of performance, TIPS did offer higher returns than conventional bonds during the 1990s. This is based on Lingane's analysis starting from a decade before. He concludes that TIPS are most suitable for investors who are seeking funding future obligations in a long horizon because of their inflation tracking capability and this is true when TIPS were bought at the original auction and held until maturity.

Further, Campbell et al. (2009) conduct a thorough study on inflation-linked bonds issued by the UK and the US government starting from their introduction in the market until 2008. They find that inflation-linked bonds in the US and UK moved inversely to the stock market during the market downturn. They conclude that inflation-linked bond is a type of secure investment for investors with long-term objectives. This is because inflation-linked bonds do offer future incomes with real spending capability. This has been proven through their analysis that coupon payments of inflation-linked bonds do respond well to the inflation rate. In the case of zero-coupon inflation-indexed bonds, they added that this type of bond delivers a known real payment in a guaranteed time. This type of bond is suitable for investors who want to receive spending power at a

single time. They further conclude that their findings are validated throughout their period of study, although there were few incidents that occurred in the 1990s and 2000s that could invalidate their results.

In another study, Campbell (2009) compares the performance of government bills, nominal bonds and inflation-linked bonds. Based on the US market, although there are many low risk financial assets that can be considered by investors, such as Treasury bills and government bonds, he points out that government bonds are superior to Treasury bills. This is because Treasury bills are exposed to the uncertainty of the interest rates years ahead, especially when the Treasury bills need to be rolled over. In the case of government nominal bonds, they are inferior to government inflation-linked bonds when inflationary conditions are not certain. In this case, in order to match the return of the inflation-linked bonds, investors need to combine many financial assets such as Treasury bills, stocks and nominal bonds in their portfolios in order to minimise the portfolio's risk. However, when the inflationary conditions are stable, the nominal bonds can substitute the role of inflation-linked bonds.

By using broader datasets, Swinkels (2012) examine the inflation-linked bonds and nominal bonds issued by Argentina, Brazil, Chile, Colombia, South Korea, Mexico, Poland, South Africa and Turkey. Comparing between inflation-linked bonds and nominal bonds, he estimated the regression $R_t^{ILB} - R_t^{NORM} = \alpha + \beta INFL_t + \varepsilon_t$ where ILB is the inflation-linked bonds, $NORM$ is the nominal bonds and $INFL$ is the realised inflation in a particular country. He found a significant positive beta of the regression estimated; when compared to nominal bonds, the inflation-linked bonds returns correlated

more with realised inflation. This indicates that inflation-linked bonds are a better hedge against inflation risk than nominal bonds. Thus, investors with a long-term objective to achieve real return should be attracted more by inflation-linked bonds than nominal bonds.

In a more recent study, Fulkerson et al. (2014) examined nine inflation-linked bond ETFs as part of the 140 bond ETFs in the US market in their study. In their case, the inflation-linked bond ETFs invest in the Treasury Inflation-Protected Securities (TIPS). TIPS, being bonds offered by the US government, are known to have low risk investment. The bonds' par value follows inflation rate measured by the Consumer Price Index (CPI) so their interest rate is fixed. They found that the inflation-linked bonds ETF give NAV return that is positive, at 0.0345%. Based on their findings, they conclude that this is expected because the inflation-linked bond ETFs NAV is based on the bid price of the underlying bond portfolio. Hence, the inflation-linked bond ETFs tracked the inflation-linked bonds fairly well.

Not only that, the price discovery in inflation-linked bonds markets has also been an interest in previous study. For instance, Schulz and Stapf (2014) examine the price discovery by using French, German and US government inflation-linked bonds, nominal government bonds and inflation swaps for break-even inflation rate. They found that updates which have a significant effect on inflation expectations are assimilated slightly quicker in the French and German market for bond that matures in five years or less. However, for bonds that mature beyond that, the bond markets progressively edge the price discovery process in all of the markets. They also suggest that their finding is

dependent on the volume and liquidity of the bond markets. This can be seen from the US where the bond market, because of its large volume, always leads the price discovery process for break-even inflation rate. As for swap markets, the break-even inflation rate is always priced higher than the bond markets, because of their liquidity and risk differ from the bond markets.

It is also possible to anticipate inflation risk by using the inflation-linked bonds. Grishchenko and Huang (2013) show that by using data of TIPS from January 2000 to September 2008 and expected inflation, they are able to come out with a good estimation of the inflation risk returns. The expected inflation is based on three proxies: realised CPI, vector autoregression of real activities and inflation variables, and surveys of inflation forecasts. Their estimation approach does not include arbitrage opportunities and can be considered as parsimonious.

5.3.3 Gold as Inflation Hedge

The discussion on the theory that commodities can be used to hedge against inflation started decades ago. As a result, much evidence has been put forward to support the idea of commodities in inflation hedging. Greer (1978) and Bodie and Rosansky (1980), for example, found that there are negative correlations between the inflation rate and returns of bonds and stocks. In the case of commodities, they found that the return from commodities does correlate with the inflation rate but in positive sign. Further, their interest was also tested by other researchers and their findings were confirmed by using more complicated methods and wider samples (Gay and Manaster, 1982; Ankrim and Hensel, 1993; Froot, 1995; Kaplan and Lummer, 1998; Gorton and Rouwenhorst, 2006;

Hoevenaars et al. 2008; Spierdijk and Umar, 2013). The later studies also found that unanticipated inflation and longer time period that were considered in their analyses do positively affect the correlations value between inflation and commodities.

From that, there are also other researchers that considered the hedging capabilities of a specific subsector within a commodity, or any singular commodity. Ulrich (2013) reveals that log utility along with Knightian uncertainty regarding trend inflation can explain the term returns in US Treasury bonds. The commodity price-inflation relationship is essential in this case for at least two reasons. First, commodities are often suggested as inflation hedges that may be accustomed to motivate commodity investments. Secondly, if commodity prices come before general inflation in the economy, they can be made use of by monetary authorities in policy judgements.

The empirical results on the long-run relationship between gold prices and inflation and the use of gold to hedge against inflation have also been reported. For example, Moore (1990) reports that gold is a good hedge against inflation in the long run and short run. Aggarwal (1992) finds that there exists a long-run relationship between gold prices and inflation, and there is a significant price volatility in the short run between those two. Ghosh et al. (2004) proposed a model that investigates the existence of a long-run linkage between gold prices and inflation. They found that there is gold influence on inflation volatility but under certain conditions.

Further, Capie et al. (2005) conclude that gold can become an inflation hedge and hence offers protection against dollar devaluations. Their findings is also supported by Hammoudeh et al. (2009). Ranson and Wainright (2005) explore the association between gold prices and inflation using data from the US and UK. They found positive linkage between inflation level and gold prices and noted that the rise of gold prices is 2–3 times higher than the rise in inflation in the study period. This implies that gold prices are hedges against inflation in both countries. Further, Levin and Wright (2006) used the supply and demand framework to investigate the relationship between gold investment and inflation by utilising the data on the US economy over the period 1976–2005. They found cointegration among variables toward a long-term relationship. Moreover, they noted that there is unit elastic positive relationship from inflation to gold prices. The results showed long-run cointegration between variables in the data series. Moreover, the results prove that inflation has a positive effect on gold prices, i.e. gold prices could be a good hedge against inflation. Moreover, McCown and Zimmerman (2006) examine the role of gold to hedge against inflation and found that gold is an asset without market risk and inflation-free. By using wider datasets, Tkacz (2007) analyses gold prices and inflation data of 14 countries over the period 1994–2005 and found that gold can be used to predict future inflation for various countries.

Dicle et al. (2011) found that nominal interest rate has a positive impact on inflation and inflation leads gold prices in the US economy. Not only that, Ciner et al. (2012) used data in the US and UK to answer the question of whether gold prices are hedged and a safe haven against inflation. They report that gold investment is not only hedged against inflation but also against exchange rate volatility. In the case of Turkey, Omag (2012) found that nominal interest rates lead to inflation and inflation has a positive

impact on gold prices which validates that gold prices are hedges against inflation in the case of Turkey. Similarly, Chua and Woodward (1982), Ghosh et al. (2004), Jaffe (1989), Tully and Lucey (2007) and Reboredo (2013) found that gold can be used to hedge against inflation.

Not only gold can be utilised to hedge against inflation, it is also found better than other commodities in that sense. For example, Ciner et al. (2012) use the dynamic conditional correlation (DCC) approach with a GARCH specification, originally put forward by Engle (2002) and found that gold can be considered a secure sanctuary against exchange rates in the UK and US, displaying its monetary asset function and gold's hedging property against both dollar and equities could be more than merely behaving against inflation risk, as a vital relation would also be observed in the bond market. Hence, there is a strong fundamental in supporting the suggestion that gold can be used to hedge against the inflation rate. Gold is also found to be better than other commodities in hedging against inflation.

Later, Beckman and Czudaj (2013) analyse the question of whether gold provides the ability of hedging against inflation from a new perspective. They show that gold is partially able to hedge future inflation in the long run and this ability is stronger for the US and the UK compared to Japan and the Euro area. In addition, the adjustment of the general price level is characterised by regime-dependence, implying that the usefulness of gold as an inflation hedge for investors crucially depends on the time horizon. A more extensive study by Dempster and Artigas (2010) use the spot price of gold, the S&P GSCI, the Bloomberg Real Estate Investment Trust Index (BB REITs) and Barclays' Aggregate

US Treasury Inflation-Protected Securities Index (TIPS) and investigate the real returns, annualised average volatility, correlations and comparison with US Treasury bonds, global corporate bonds, the MSCI US Index, and the MSCI World ex US Index as benchmark for their portfolio optimisation to study. They conclude that if the world economy encounters resurgence in inflation, then gold, much like the other traditional inflation hedges, will probably outshine mainstream financial assets.

The motivation behind associating gold and inflation has been underlined by Bialkowski et al. (2014). They mention that gold price increased significantly from late 1970s to the early 1980s as a result of the increasing inflation rate at that time. The reason behind that is because of the oil crisis, and monetary and fiscal programmes that have been enforced worldwide. As a result, most investors have turned to gold investment, as it was and still is considered as an established investment, especially during turbulent times. Likewise, the recent European government debt crisis and the current world financial situation have pushed gold prices up, as a result of the excess demand by the investors. Furthermore, the introduction of gold ETF has also contributed to the increasing of the gold price and at the same time the increasing of the gold ETF price itself

In a more recent study, Shahbaz et al. (2014) investigate whether a gold investment is a hedge against inflation in the case of Pakistan. Their findings reveal that "*investment in gold is a good hedge against inflation*" not only in the long run but also in the short run. Gold is found to provide a hedge against inflation not only in the UK but also in the US and India, according to Van Hoang et al. (2016). In their study, the inflation

in the UK was calculated by using consumer price index (CPI) while the gold was represented by gold prices that were taken from the London Bullion Market Association (LBMA) website.

From the literature reviews, we find may studies that associate gold and inflation. However, we could not find any research studies that examined whether gold ETF can be used as a tool to hedge against inflation risk.

5.3.4 Cointegration and Causality

As in the previous section, it is found that most of the previous studies use cointegration and causality techniques when determining the association between gold or other instruments or variables and inflation.

In finance, hedging is defined as minimising the risk in an investment. Based on conventional sense, a good hedge against an asset's returns can be achieved by acquiring another asset that has returns that is negatively correlated with the former asset's returns (Baur and McDermott, 2010; Pullen et al., 2014). That is, to hedge asset A with asset B, an investor should make sure that in an event of a unit rise of asset A is coincided with an event of a unit fall of asset B. However, not all hedging fall into this definition. Gatarek and Johansen (2014) for example, define hedge '*as a function of correlation and cointegration parameters*'. Further, they explain that the purpose of hedging is to find an optimal hedge based on the minimum variance portfolio. This is also in line with the definition of hedge by Markowitz (1952), Alexander (1999), Lien and Tse (2002), Haq

and Rao (2013), Beckmann and Czudaj (2013), Jiang et al. (2016) and Naser (2017), among others. In relation to this study, the rise in inflation means that the fall of the value of money, simultaneously (Beckmann and Czudaj, 2013). Hence, to hedge against inflation, an investment returns that is keeping up with the inflation is needed. Also, according to Alexander (1999), hedging that is solely based on correlation results in prices or returns co-movement of different assets and this may not be true for the entire study period. Thus, the assets need to be rebalanced over time to maintain the correlation. This is why cointegration is widely used in inflation hedging as it determines the co-movements of the assets' values in the long-run, although during the study period, the static correlations are small.

For example, Engsted and Tanggaard (2000) use a vector autoregressive (VAR) approach to investigate the relationship between bond and inflation, and between stock returns and inflation. Using the US and Danish markets, they find that the relationship between stock returns in the US market and expected inflation weakens as the timeline of the study becomes larger. This contradicts the results that they obtained from the Danish stock market. In the case of bonds, for the US market, the returns have a strong relationship with the expected inflation in the long-run but have a weak relationship in the short run. For the Danish market, the bonds returns were found to be weakly correlated to the expected inflation and this relationship weakens as the horizon increases. One of their conclusion, as they stated, is that there is no evidence found to support the hypothesis that stock returns have a hedging capability against unexpected inflation.

In another study, Ciner (2011) tested for unit roots using the ADF and KPSS tests and examined cointegration between commodity prices and CPI using the Johansen framework as well as the less well-known Saikkonen and Lutkepohl test. The contemporaneous relation between consumer inflation and commodity price changes was estimated within the context of a conventional time series regression. The contemporaneous relation between commodity prices and inflation can be estimated by a conventional time series regression; $CPI_t = \alpha + \delta CRB_t + e_t$ with CPI_t is the consumer price index and CRB_t is the commodity futures index. However, by using this regression, it is possible to test the relationship as there are uncovered dependencies between the variables at individual frequencies.

Hence, Ciner (2011) re-conducts the regression by using a one-sided, rather than a two-sided band-pass filter. In essence, Ciner (2011) decompose X_j into frequency components by applying the same transformation in a moving M-month window, keeping only the most recent value and shows that this transformation effectively resolves estimation problems due to possible feedback. In this manner, with an M-month window, parameters on all frequencies can be estimated without any a priori selection of frequency bands. The analysis above indicates that consumer price inflation is sensitive to commodity price movements at several frequencies. Ciner (2011) further analyses to determine whether there is a lead-lag relation between the CPI and CRB in addition to contemporaneous linkages by using frequency domain Granger causality test. Multiple causality tests were conducted after that using regression analysis.

Also, Kamrul et al. (2011) investigate the relationship between the prices of commodities and inflation, unemployment rate and interest rate. Their chosen country is Australia. Regarding the interest rate, they chose short-term interest rate because of several factors. By using Granger causality test, VAR model and cointegration analysis, they found that commodities lead the inflation rate. Nevertheless, there is no evidence to support the contra relationship between them. They further suggest that the commodities can be used to predict the trend of inflation rate.

Regarding Granger causality test, Ashley and Ye (2012) study the Granger causality between inflation and price dispersion of the sub-components of the CPI in the US. By using in sample and out of sample, the Granger causality was checked both from the inflation to the price dispersion and from the price dispersion to the inflation. They used different methodology from previous studies as their measurement of inflation is defined as the median change in the weighted log price while the measurement of the price dispersion is the interquartile range of the weighted log price. Previous studies measured inflation with the average of CPI and price dispersion with standard deviation. From the in-sample test, they find that there is a strong relationship between inflation and price dispersion and the relationship is high, in which both are results from the Granger causality tests. From the out-of-sample test, they find that the inflation has a strong predictive power for price dispersion and there is not enough evidence that price dispersion Granger caused the inflation.

In another example, Jaoul-Grammare and Terraz (2013) use Granger causality test to investigate the relationship between union density and economic growth. The purpose of the study is to check whether trade unions have a significant impact on the economy. They find that there is not much evidence to support the causal relation between those two elements, however, there exists Granger causality between those two elements in four out of eleven countries in Europe. In three of those four countries, they find that there is negative causal effect of GDP growth on the union density while in the remaining country, France, it is found that union density positively impacts the growth.

Apart from Granger causality test, Beckman and Czudaj (2013) conclude that cointegration techniques seem to be the appropriate tools to examine the relationship between consumer prices and the price for gold. They use a Markov-switching vector error correction model (MS-VECM) to examine the relationship between the price for gold and the CPI as well as PPI for the data set.

Apart from gold, Stevens (2014) studies the connection between the net oil price and macroeconomic activity by using Granger causality test. From his model, he finds that a rise in the oil price does have an adverse effect to the economy if the new price goes above the maximum price witnessed over a reference timeline of arbitrary interval. He added that the Granger causality tests often gives results that are sensitive to the selection of the timeline of the reference. In conclusion, it is stated that the rise of the oil price does Granger caused the growth in the real GDP of the US.

In the case of UK, Bampinas and Panagiotidis (2015) explore the effectiveness of gold and silver in the UK and US to hedge against consumer price level for the long run. They use cointegration analysis on their two centuries of data, taking into account time-varying and time-invariant methodologies in the analysis. From the historical fluctuations analysis, they found that the gold price is stationary in the UK and US. They later revealed that the gold price is not only effective in inflation hedging but also performed better than expected CPI. From both the time-varying and time-invariant approach, they found that gold capability in hedging against inflation is superior in the US compared to in the UK. The gold's capability has become steadier over these later decades.

In conclusion from this part of literature review, cointegration test and Granger causality test are the most common tests that have been used to examine the relationship between certain variables and inflation rate, especially in inflation hedging. Hence, both tests will be considered in this study to investigate the relationship between gold ETFs and inflation-linked bond ETFs with inflation.

5.4 Analysis of the Literature

From literature reviews, although some reports found that inflation-linked bonds failed to protect investors against inflation in certain times, most research studies agree that inflation-linked bonds do provide protection against inflation. These research studies that agree use longer time horizon in analysing the performance of the inflation-linked bonds. This is essential as many researchers also agree that inflation-linked bonds are targeted at long-term investors.

Further, although not many studies on the performance of the inflation-linked bonds against inflation can be found, the research can be considered as sufficient. This is because it has covered the UK market that is used in this study. In addition, it also covers the US market, which is the biggest inflation-linked bond market at the present time. The lesson that can be learned is that the inflation-linked bonds are intended for long-term investors and they offer protection against inflation to that type of investor.

In the case of inflation-linked bond ETFs, no literature can be found regarding the UK market at the time of writing. Only two reports were found regarding inflation-linked bond ETFs, which are by Baldwin (2014) and Fulkerson et al. (2014). Both considered the US market. Baldwin (2014) only reports the performance of one inflation-linked bond ETF while Fulkerson et al. (2014) report the performance of nine inflation-linked bond ETFs. Both agree that inflation-linked bond ETFs do track their indices fairly well, but not perfectly. However, no study reports whether inflation-linked bond ETFs can be used to hedge against inflation. Inflation-linked bond ETFs are from the ETF family and are traded more frequently than inflation-linked bonds. This is because ETF is not intended for long-term investors only. Hence, this study will examine whether inflation-linked bond ETFs are capable of overcoming the inflation rate.

It is also understood that there are many methods can be used in determining the hedging capability of gold, inflation-linked bonds or any other instruments against inflation rate. However, not all of the results from the methods are simple to be explained. For instance, Engsted and Tanggaard (2000) use VAR approach while Ciner (2011) uses one-sided band-pass filter but the explanation of the relationship between the instruments

studied by them and inflation is hard to be understood and applied by the investors, especially. Further, they found that there is a relationship between those two in one period but not at any other period and there is sensitivity in one instrument's price movements at several frequencies. Also, they concluded that the results improved when the period is increased. However, to what extend does that applies is not mentioned and how the investors can make used of these findings is not explained. In fact, these are one of the disadvantages when using a complex method in explaining the relationship between two variables.

This also one of the reasons why cointegration and Granger causality tests are widely used in determining the relationship of one variable and inflation rate. That is, they are simple to be understood while at the same time consider the overall relationship between the inflation rate and the other variable.

5.5 Gaps in the Literature

Majority of the studies regarding the usage of gold as a hedging mechanism against inflation rate support the idea of gold as inflation hedging. Most of them used gold prices as their main representative of gold. If gold price can be used against inflation rate, the question of whether gold ETF can be used against inflation rate is still unanswered. Gold ETF can be considered as a representative investment in physical gold, as can be seen in most of gold ETF's prospectuses. In addition, physical gold ETF, especially, promised to track the performance of gold prices. However, none of them follow the ups and downs of gold prices perfectly, as shown in Chapter 3. The main premise is that if investors

regard gold as inflation hedging, then they should invest in gold to protect themselves against inflation and one of the ways to invest in gold is through gold ETF.

Majority of the studies regarding the usage of inflation-link bond against inflation rate support the idea of inflation-linked bonds as inflation hedging. However, this is true if the investors intend to hold the bonds for the long term, that is, starting from the time they were first issued until maturity. However, ETF is not targeted only to that type of investor. Furthermore, inflation-linked bond ETF does not necessarily mimic the performance of the inflation-linked bonds perfectly as they are usually based on certain indices. So far, there is no study which focuses on the usage of inflation-linked bond ETF as a mechanism to protect against inflation rate.

5.6 Hypotheses Development

Based on the literature reviews above, there is no concrete conclusion about whether any gold ETF offers an inflation proof investment. It is also found that there is no evidence that inflation protected investments are superiors to gold investment when it comes to inflation hedging. Furthermore, no study has been conducted to determine whether any gold ETF is capable to be used to hedge against inflation.

This study is different from previous studies as it tests the effectiveness of physical gold ETF in hedging against inflation. As can be read from the physical gold ETF prospectuses, ETFs act as an alternative to physical gold investment. They offer a more practical way of gold investing. Based on previous studies, one of the main objectives

that drives investors to invest in gold is to hedge their investment against inflation. Hence, it is sensible to say that the examination of whether gold ETF (physical gold ETF) offers inflation hedging capability or not is vital. It can also be read from the objectives of inflation-linked bond ETF that the ETF's objective is to try to achieve performance that reflects the performance of the government inflation-linked bonds. Most people bought those bonds because it offers security to their investment, either because of default risk or inflation risk (Garcia-Zarate, 2011). The inflation-linked bond ETF offers investors an alternative way to hedge against inflation risk, instead of government inflation-linked bonds.

Further, similar to the physical gold ETF, it is sensible to say that the examination of whether inflation-linked bond ETF offers inflation hedging capability or not is vital. The effectiveness of the inflation-linked bond ETFs in comparison to gold ETFs in offering inflation hedging capability has not received much attention in the finance literature. Hence, this study tests the following hypotheses:

Hypothesis 3A: *Physical gold ETFs hedge inflation risk well*.

Hypothesis 3B: *Inflation-linked bond ETFs hedge inflation risk well*.

So far, no study compares the performance of any gold ETF and inflation-linked bond ETF in protecting investors against inflation rate. However, there are studies that compare the performance of commodities and bonds in that sense. As Greer (1978), Bodie and Rosansky (1980), Gay and Manaster (1982), Ankrim and Hensel (1993), Froot (1995), Kaplan and Lummer (1998), Gorton and Rouwenhorst (2006), Hoevenaars et al.

(2008), Spierdijk and Umar (2013), Gorton and Rouwenhorst, (2006), Ankrim and Hensel (1993), Gorton and Rouwenhorst (2006) and Roache and Attie (2009) have pointed out, the commodities have been examined to be superior to bonds when it comes to inflation hedging. Dempster and Artigas (2010) suggest that when it comes to inflation, the usage of gold is probably the best, compared to other financial instruments, including bonds. However, none of those studies includes inflation-linked bonds. Gold is also found to be correlated, particularly strongly in the case of inflation over long horizons. As physical gold ETF represents investment in gold and inflation-linked bond ETF represents investment in inflation-linked bonds, our third hypothesis is:

Hypothesis 3C: *Physical gold ETFs hedge inflation risk better than inflation-linked bond ETFs*.

5.7 Sample Description

The sample of physical gold ETFs and inflation-linked bond ETFs are based on the London Stock Exchange (2014). That is, the sample is based on the physical gold ETFs and inflation-linked bond ETFs that are active on and available on 31st December 2014 as this date is the most recent during this study. According to the London Stock Exchange (2014), there are 12 physical gold ETF and 16 inflation-linked bond ETFs that are available at that time. Thus, their monthly NAVs were taken from Thomson Reuters Datastream (2015).

Physical gold ETFs are chosen as it uses physical gold as their underlying asset and they also created to track the returns of gold. Furthermore, physical gold ETF is found in Chapter 3 to have minimum tracking error compared to other gold ETFs. Inflation-linked bond ETFs are used in comparison to physical gold ETF in inflation hedging. Each of physical gold ETF and inflation-linked bond ETF NAV are on monthly basis as inflation rate in the UK are also based on monthly basis. Also, their NAVs were taken from the month of their inception dates until December 2014. Therefore, the earliest data is on April 2004. Table 5.1 lists all the physical gold ETFs and inflation-linked bond ETFs that are used in this study.

Table 5.1: **Sample Description**.

The table lists down the physical gold ETFs and inflation-linked bond ETFs that are used in this study along with their inception dates. Their monthly NAVs were taken starting from the month of their inception dates until December 2014. The earliest data is on April 2004. Monthly data are used as inflation rate is released on monthly basis.

	Fund Name	Type	Inception Date
1	db Physical Gold	Physical Gold ETF	15/06/2010
2	db Physical Gold G Hedged	Physical Gold ETF	01/04/2011
3	db Physical Gold Hedged	Physical Gold ETF	07/06/2011
4	ETFS Gold Bullion Securities E	Physical Gold ETF	15/04/2004
5	ETFS Gold Bullion Securities	Physical Gold ETF	15/04/2004
6	ETFS Physical Gold	Physical Gold ETF	24/04/2007
7	ETFS Physical Gold G	Physical Gold ETF	24/04/2007
8	ETFS Physical Swiss Gold	Physical Gold ETF	16/12/2009
9	iShares Physical Gold	Physical Gold ETF	08/04/2011
10	iShares Physical Gold G	Physical Gold ETF	08/04/2011
11	Source Physical Gold P	Physical Gold ETF	26/06/2009
12	Source Physical Gold P G	Physical Gold ETF	26/06/2009
13	CS ETF (IE) on iBoxx EUR Inflation Linked	Inflation-Linked Bond ETF	02/06/2009
14	CS ETF (IE) on iBoxx EUR Inflation Linked GBP	Inflation-Linked Bond ETF	02/06/2009
15	iShares Barclays Euro Inflation Linked Bond (IE)	Inflation-Linked Bond ETF	18/11/2005
16	iShares Barclays Global Inflation-Linked Bond (IE)	Inflation-Linked Bond ETF	01/08/2008
17	iShares Barclays Global Inflation-Linked Bond (IE) E	Inflation-Linked Bond ETF	01/08/2008

(*continued*)

Table 5.1-*Continued*

	Fund Name	Type	Inception Date
18	iShares Barclays Global Inflation-Linked Bond (IE) G	Inflation-Linked Bond ETF	01/08/2008
19	db x-trackers II iBoxx UK GILT Inflation-Linked UCITS ETF 1D	Inflation-Linked Bond ETF	12/10/2007
20	iShares Barclays £ Index-Linked Gilts (IE)	Inflation-Linked Bond ETF	01/12/2006
21	Lyxor ETF iBoxx UK Gilt Inflation-Linked G	Inflation-Linked Bond ETF	01/12/2010
22	db x-trackers II iBoxx Global Inflation-Linked UCITS ETF Hdg 3D	Inflation-Linked Bond ETF	25/01/2011
23	db x-trackers II iBoxx Global Inflation Linked TRI Hdg 2C	Inflation-Linked Bond ETF	06/02/2013
24	CS ETF (IE) on iBoxx USD Inflation Linked G	Inflation-Linked Bond ETF	03/06/2009
25	CS ETF (IE) on iBoxx USD Inflation Linked U	Inflation-Linked Bond ETF	03/06/2009
26	db x-trackers II USD Treasuries Inflation-Linked UCITS ETF 1C	Inflation-Linked Bond ETF	19/08/2009
27	iShares Barclays TIPS (IE) G	Inflation-Linked Bond ETF	08/12/2006
28	iShares Barclays TIPS (IE) U	Inflation-Linked Bond ETF	08/12/2006

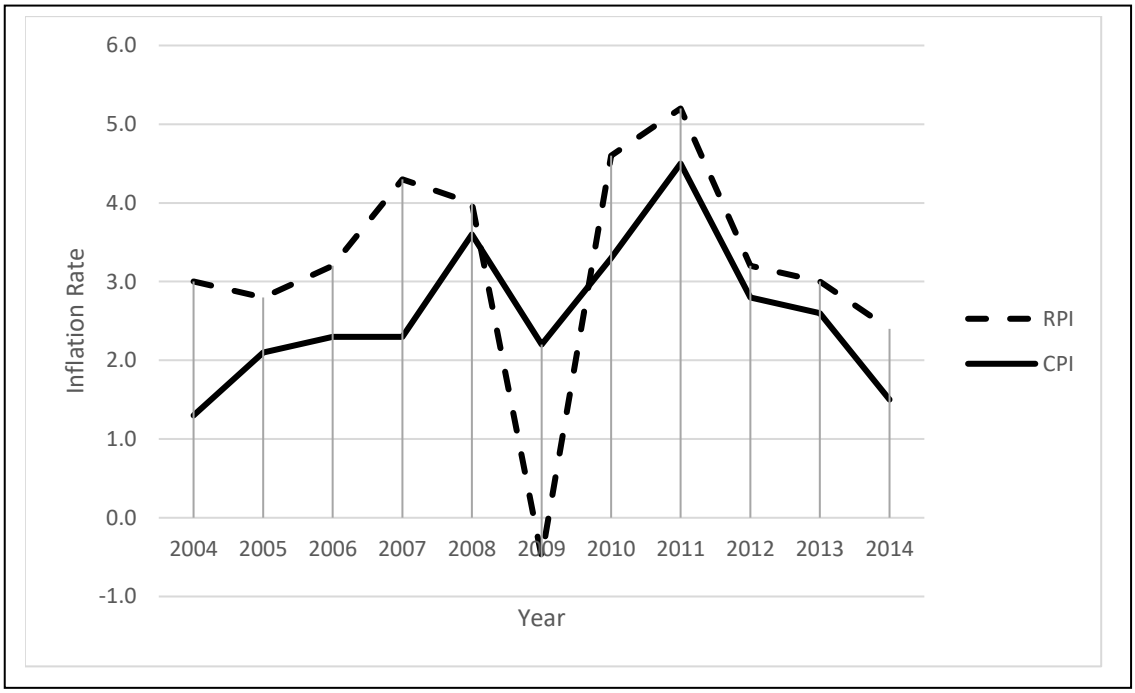
Regarding inflation rate, it is measured by using Retail Prices Index (RPI) and Consumer Price Index (CPI) in the UK. Although we know that the UK inflation-linked bonds are based on RPI, the CPI is still considered in this study as it is also being considered as an inflation measurement in the UK. According to the Office for National Statistics (2011), the RPI started as a remuneration benchmark, created as a guide to shield common labourers from cost increments related to the First World War. It was much later, after various improvements, that it came to be utilised as the fundamental household measure of inflation. The CPI, which was propelled in 1996, is a globally tantamount measure of inflation which utilises philosophies and structures that are taken from worldwide enactment and rules. The CPI is the UK administration's focus on inflation monitoring, the objective of which has been to set them at 2 percent, starting from December 2003. Also, at that time, the UK's Chancellor of the Exchequer declared

that henceforth, the monetary and fiscal strategy would be founded on the CPI, as a new measure of inflation, instead of RPI. The essential way to deal with the estimation of inflation embraced by both the CPI and RPI is similar, in which both track the dynamic prices of a fixed basket of products and services after some time and both are created by composing around 180,000 different prices for more than 650 items that were chosen. Contrasts between CPI and RPI emerge because of the scope, the populace base of the records and the route in which singular price quotes are consolidated at the principal phase of accumulation.

Thus, for this study, the RPI and CPI are used. Inflation rate (RPI and CPI) were downloaded from the Office for National Statistics website (Office for National Statistics, 2015). Chart 5.1 plots the timeline of RPI and CPI in the UK during this study period.

Chart 5.1: Timeline of RPI and in the UK from 2004 to 2014 (Office for National Statistics, 2015).

The trend for both indices during the period of study are mixed but at different level. This is because they are measured in different scope, base and principle. Both exhibit mixed trends. This is one of the reasons why investors are always looking for the best investment that can be used as an inflation hedge (Garcia-Zarate, 2011).



5.8 Methodology

The methodology used in this study uses techniques that have been used by previous researchers. This is because the techniques are well known and widely used in finance research studies.

5.8.1 Diagnostic Tests on Returns

Diagnostic tests include kurtosis and skewness test on the returns of all ETFs, their portfolios and inflation rates. This is done to examine the distribution of the data, such as to determine whether the returns are normally distributed or not. In addition, the returns

were also tested for ARCH effects as financial assets over short horizons are likely to exhibit these effects.

5.8.2 Stationarity Test

Before cointegration and causality tests can be done, the monthly return of the ETFs, the portfolios and the inflation rates will be tested for their stationarity. The stationary test is pre-requisite as, if the variables do not satisfy the stationarity requirement, then the cointegration or the causality test cannot be done. For this, the Dickey–Fuller–GLS test for stationarity that is based on the work by Elliott, Rothenberg and Stock (1996) is used. According to Maddala and Kim (1998), it is one of the best in stationarity testing. It has also been used by previous studies to check the ETF's stationarity (Drenovak et al., 2012). Unit root test aims at verifying the integrated order of time series and deciding to utilise the level or differential variable for the empirical process.

5.8.3 Cointegration Test

Once the stationarity requirement has been satisfied, the returns of the ETFs will be checked as to whether they are cointegrated with the inflation rate. A variable that cointegrates well with another variable means that the former variable tracks the latter variable well (Alexander, 1999). Also, in determining whether the physical gold ETFs, the inflation-linked bond ETFs and both their portfolios can be used as hedges against inflation, first they must cointegrate with the inflation rate well (Engsted and Tanggaard, 2000; Kamrul et al., 2011; Beckman and Czudaj, 2013; Bampinas and Panagiotidis, 2015). Thus, in this case we examine whether the returns from the physical gold ETF and

inflation-linked bonds ETF (individually and portfolio) track the inflation rate well. The cointegration test used in this study is the Johansen Cointegration test (Johansen, 1991), which is based on trace test and maximum eigenvalue test. Johansen Cointegration test is a standard econometric procedure that is used in determining the cointegration between variables, as can be seen in the literature reviews.

If they do track the inflation rate well, then it can be said that they are able to provide inflation hedging. This is to test Hypothesis 3A and Hypothesis 3B. To test Hypothesis 3C, we will compare the residuals from the cointegrating regression of each ETF and portfolio. Therefore, the ETF or portfolio that has the lowest coefficient of autocorrelation of the residuals is a better ETF or portfolio in hedging inflation risk. This method is based on the work of Alexander (1999) and Drenovak et al. (2012).

5.8.4 Granger Causality Test

To further support the results obtained in Johansen Cointegration test, Granger causality test will be used. The Granger causality test that employed in this study is based on the work of Granger (1980, 1988a and 1988b), Toda and Yamamoto (1995) and Lutkepohl (2006). This test is used as we try to check whether the inflation rate affects the performance of the physical gold ETFs and inflation-linked bond ETFs. This test is also commonly used in previous studies to check the association between variables, especially relating to inflation (Ciner, 2011; Kamrul et al., 2011; Ashley and Ye, 2012; Jaoul-Grammare and Terraz, 2013; Beckman and Czudaj, 2013 and Stevens, 2014).

5.9 Analyses and Results

This section reports the outcomes from the diagnostic tests, stationarity tests, cointegration tests and Granger causality tests. For reading convenience and continuity, Table 5.3 to Table 5.14 are put at the back of this study.

5.9.1 Diagnostic Tests

From diagnostic tests, all of the physical gold ETFs, inflation-linked bond ETFs, their portfolios, gold prices, RPI and CPI do not violate normality assumptions (Kline, 2011). As for ARCH effects, according to p-value, the effects are not severe, hence we may proceed to stationarity test (Lai, 1993; Gonzalo, 1994; Lee and Tse, 1996; Silvapulle and Podivinsky, 2000; Rahbek et al., 2002; Kurita, 2010).

Table 5.2: Diagnostic Tests for Returns on Physical Gold ETFs, Inflation-Linked Bond ETFs, Portfolios, Gold Prices, RPI and CPI.

The table shows the skewness value, kurtosis value and p-value of ARCH effects test on each of them. The results show that all of them do not violate the normality assumption. The ARCH effects are also not severe based on their p-value.

	Fund/Instrument	Skewness Value	Kurtosis Value	ARCH Effects p-value
1	db Physical Gold	0.15	0.10	0.59
2	db Physical Gold G Hedged	0.76	0.90	0.62
3	db Physical Gold Hedged	0.03	0.75	0.18
4	ETFS Gold Bullion Securities E	0.53	0.11	0.84
5	ETFS Gold Bullion Securities	0.08	0.31	0.04*
6	ETFS Physical Gold	0.25	0.12	0.09
7	ETFS Physical Gold G	0.28	0.18	0.32
8	ETFS Physical Swiss Gold	0.11	0.12	0.18
9	iShares Physical Gold	0.27	0.32	0.68
10	iShares Physical Gold G	0.26	0.33	0.71
11	Source Physical Gold P	0.01	0.06	0.16
12	Source Physical Gold P G	0.03	0.06	0.49
13	CS ETF (IE) on iBoxx EUR Inflation Linked	0.54	2.33	0.03*

(*continued*)

Table 5.2-*Continued*

	Fund/Instrument	Skewness Value	Kurtosis Value	ARCH Effects p-value
14	CS ETF (IE) on iBoxx EUR Inflation Linked GBP	0.34	0.78	0.53
15	iShares Barclays Euro Inflation Linked Bond (IE)	1.15	5.48	0.87
16	iShares Barclays Global Inflation-Linked Bond (IE)	1.41	4.56	0.46
17	iShares Barclays Global Inflation-Linked Bond (IE) E	0.38	0.83	0.99
18	iShares Barclays Global Inflation-Linked Bond (IE) G	0.09	1.75	0.09
19	db x-trackers II iBoxx UK GILT Inflation-Linked UCITS ETF 1D	0.04	0.16	0.32
20	iShares Barclays £ Index-Linked Gilts (IE)	0.65	1.52	0.88
21	Lyxor ETF iBoxx UK Gilt Inflation-Linked G	0.17	0.02	0.29
22	db x-trackers II iBoxx Global Inflation-Linked UCITS ETF Hdg 3D	1.52	4.51	0.28
23	db x-trackers II iBoxx Global Inflation Linked TRI Hdg 2C	1.46	3.91	0.77
24	CS ETF (IE) on iBoxx USD Inflation Linked G	0.73	1.48	0.54
25	CS ETF (IE) on iBoxx USD Inflation Linked U	0.61	2.72	0.97
26	db x-trackers II USD Treasuries Inflation-Linked UCITS ETF 1C	0.51	2.86	0.94
27	iShares Barclays TIPS (IE) G	0.20	1.19	0.27
28	iShares Barclays TIPS (IE) U	1.15	5.21	0.64
29	Gold Price	0.23	5.85	0.04*
30	Physical Gold ETF Portfolio	0.32	0.45	0.53
31	Inflation-Linked Bond ETF Portfolio	1.02	3.87	0.47
32	RPI	0.52	4.96	0.07
33	CPI	1.05	5.36	0.89

*ARCH effects exist at 0.05 level

5.9.2 Stationarity Test

The lag length selection is based on Schwarz Information Criterion (SIC) (Brooks, 2008). The equation of unit root regression contains both constant and time trend. Therefore, the tests for the first order differential of the CPI and RPI are required for the next steps. It is found that the I(0) process of both CPI and RPI is presented with the first order differential of the variables, which helps to avoid the error results of spurious

regression. From Table 5.3, it is found that the CPI and RPI are all stationary at first difference. It is important to test the stationarity of CPI and RPI as it is preliminary before doing cointegration test. This is based on the work of Toda and Yamamoto (1995).

Based on Tables 5.4 and 5.5, all physical gold ETFs are not stationary at level but stationary at first difference. From 16 inflation-linked bond ETFs, 14 of them are not stationary at level but stationary at first difference. One of the 16 inflation-linked bond ETFs, is already stationary at level while the other one is not stationary at level or first difference, but stationary after differenced three times. It is quite interesting to see that all physical gold ETF are found to be stationary at first level, compared to the inflation-linked bond ETF, as this will make it easier to prove that the physical gold ETFs are cointegrated with the inflation rates rather than the inflation-linked bond ETF.

5.9.3 Cointegration Test

Tables 5.6 to 5.9 show the results of two tests for cointegration, which are the Johansen trace test and the Johansen maximum eigenvalue test. We test for a cointegrating relation between physical gold ETFs and CPI, physical gold ETFs and RPI, and between inflation-linked bond ETFs and CPI and inflation-linked bond ETFs and RPI. Furthermore, we also test the cointegration between portfolios built from those two types of ETF and the CPI and RPI. From Tables 4.6 to 4.9, we found that all of the physical gold ETFs , 14 of 16 inflation-linked bond ETFs and both portfolios from both type of ETF are cointegrated with consumer price index (CPI) and retail price index (RPI). This can be seen from the result of trace test and maximum eigenvalue that recorded the p-value of less than or equal to 5%. The choice of lag length of each cointegrated model is based on Schwarz Information Criterion (SIC) (Brooks, 2008). Both tests for both type of ETF show strong

support for the existence of one cointegrating equation, i.e. a common stochastic trend that relates the two variables. This shows that there is an equilibrium relation between the prices of all goods and services measured in the CPI and RPI, and the prices of each of the two ETFs, except for two inflation-linked bond ETFS, and that their stochastic movements are coordinated. We conclude from these cointegration tests that there is evidence of the ability of the physical gold ETFs and majority of inflation-linked bond ETF to hedge against inflation risk.

Based on Table 5.10, the portfolio of physical gold ETF has lower coefficient of autocorrelation of the residuals than the inflation-linked bond ETF portfolio. This suggests that the physical gold ETF portfolio correlates more with the CPI and RPI than the inflation-linked bond ETF portfolio.

5.9.4 Granger Causality Test

From Tables 5.11 to 5.14, we find that both the CPI and RPI have Granger caused the performance of all the physical gold ETFs and inflation-linked bond ETFs, at most at 10% level. Conversely, however, it is found that 12 physical gold ETFs have Granger caused CPI and only three inflation-linked bond ETFs have Granger caused CPI. Hence, it can be said here that most of the physical gold ETFs partly caused the ups and downs of the CPI. In the case of RPI, it is found that nine physical gold ETFs have Granger caused RPI and only two inflation-linked bond ETFs have Granger caused RPI.

5.10 Discussion and Conclusion

This study has analysed whether physical gold ETFs and inflation-linked bond ETFs can hedge inflation rate in the UK and whether one of them hedges the inflation rate better than the other. To the best of our knowledge, this is the first study to consider the abilities of gold ETF and inflation-linked bond ETF to hedge against inflation. In doing so, the cointegration analysis and Granger causality test have been employed. Our findings suggest that the physical gold ETFs, especially, move in tandem with the cost of living, which is represented by the CPI and RPI, and the physical gold ETFs have higher correlations with the CPI and RPI compared to inflation-linked bond ETFs. This can be seen from the results of cointegration and Granger causality tests. Cointegration is one of the tools used in many studies to determine hedging capability as it measures the minimum variance between two sets of data (Gatarek and Johansen, 2014; Markowitz, 1952; Alexander, 1999; Lien and Tse, 2002; Haq and Rao, 2013; Beckmann and Czudaj, 2013; Jiang et al., 2016; Naser, 2017).

The reason behind gold ETF as inflation hedger is the benchmark itself, which is physical gold prices. The majority of previous researchers conclude that physical gold prices can be used to hedge against inflation or may influence inflation risk (Chua and Woodward, 1982; Jaffe, 1989; Ghosh et al., 2004; Capie et al., 2005; Levin and Wright, 2006; Tkacz, 2007; Tully and Lucey, 2007; Hammoudeh et al., 2009; Kamrul Hassan and Salim, 2011; Omag, 2012; Reboredo, 2013; Beckman and Czudaj, 2013 and Bampinas and Panagiotidis, 2015, among others) although the exact relationship between gold prices and inflation rate is still being debated (Feldstein, 1980; Fortune, 1987; Batten et al., 2014). It is also found that physical gold ETFs in the UK have few tracking errors to

gold prices, as shown in Chapter 3. Hence, the physical gold ETFs returns can still be used as a hedge against inflation risk, although there exist tracking errors.

It is well known that the inflation-linked bond cointegrates with inflation. This is because the inflation rate, specifically the RPI, is used to determine the return of the bond. In this study, the majority of the inflation-linked bond ETFs have been shown to be moving well with inflation, either in the cointegration analysis or Granger causality test. However, two of them cannot be proved to be cointegrated with the inflation as they did not conform to the pre-requisite of the cointegration analysis. Furthermore, based on the residuals of cointegrating vectors, we find that the value for physical gold ETF portfolio is lower than the inflation-linked bond ETF portfolio. Hence, it can be said that this study found that the performance of inflation-linked bond ETF portfolio in inflation hedging is below the performance of the physical gold ETF portfolio.

Tables for Chapter 5

Table 5.3: **Stationarity Tests on CPI and RPI.**

The tests were done as a pre-requisite as CPI and RPI are tested using cointegration in this study. From the results, it is found that CPI and RPI are not stationary in indices but are stationary in first difference at 0.01 level of significant.

		Dickey-Fuller – GLS tests	
		t-Statistic	
		Level	First Difference
1	Consumer Price Index (CPI)	0.2166	-2.5758*
2	Retail Price Index (RPI)	1.645	-3.7415*

The critical values for Dickey-Fuller-GLS tests are: 1%:-2.5724, 5%:-1.9418, 10%:-1.6160.
*stationary at 1% level
**stationary at 5% level
***stationary at 10% level

Table 5.4: **Stationarity Tests on Physical Gold ETFs traded on the London Stock Exchange and their portfolio.**

All of them are found to be stationary at first difference but not at level.

	Fund Name	Dickey-Fuller – GLS tests	
		t-Statistic	
		Level	First Difference
1	db Physical Gold	-0.8094	-4.3628*
2	db Physical Gold G Hedged	-0.6364	-5.567*
3	db Physical Gold Hedged	-1.2034	-4.4236*
4	ETFS Gold Bullion Securities E	-0.0582	-8.496*
5	ETFS Gold Bullion Securities	-0.5482	-6.9448*
6	ETFS Physical Gold	-0.4497	-7.1495*
7	ETFS Physical Gold G	-0.5283	-7.0009*

(*continued*)

Table 5.4-*Continued*

	Fund Name	Dickey-Fuller – GLS tests	
		t-Statistic	
		Level	First Difference
8	ETFS Physical Swiss Gold	-0.8677	-6.2376*
9	iShares Physical Gold	-0.7727	-5.1113*
10	iShares Physical Gold G	-0.7695	-5.0905*
11	Source Physical Gold P	-0.7655	-6.1092*
12	Source Physical Gold P G	-0.7628	-6.2728*
13	Portfolio	-0.4900	-7.037*

The critical values for Dickey-Fuller-GLS tests are: 1%:-2.5724, 5%:-1.9418, 10%:-1.6160.
*stationary at 1% level
**stationary at 5% level
***stationary at 10% level

Table 5.5: Stationarity Tests on Inflation-Linked Bond ETFs traded on the London Stock Exchange and their portfolio.

There are 14 individual inflation-linked bond ETFs that are not stationary at level but stationary at first difference. One of them is already stationary at level while the other one is not stationary at level or first difference. However, the portfolio of inflation-linked bond ETF is stationary at first difference but not at level.

	Fund Name	Dickey-Fuller – GLS tests	
		t-Statistic	
		Level	First Difference
1	CS ETF (IE) on iBoxx EUR Inflation Linked	0.4048	-5.4897*
2	CS ETF (IE) on iBoxx EUR Inflation Linked GBP	-0.9188	-4.1408*
3	iShares Barclays Euro Inflation Linked Bond (IE)	-0.1007	-9.3386*
4	iShares Barclays Global Inflation-Linked Bond (IE)	-0.2015	-4.0957*
5	iShares Barclays Global Inflation-Linked Bond (IE) E	0.5010	-6.0470*
6	iShares Barclays Global Inflation-Linked Bond (IE) G	0.1906	-6.305*
7	db x-trackers II iBoxx UK GILT Inflation-Linked UCITS ETF 1D	0.9482	-5.1266*

(*continued*)

Table 5.5-*Continued*

	Fund Name	Dickey-Fuller – GLS tests	
		t-Statistic	
		Level	First Difference
8	iShares Barclays £ Index-Linked Gilts (IE)	0.8544	-6.4774*
9	Lyxor ETF iBoxx UK Gilt Inflation-Linked G	0.7022	-4.2971*
10	db x-trackers II iBoxx Global Inflation-Linked UCITS ETF Hdg 3D	-1.7963***	-3.6522*
11	db x-trackers II iBoxx Global Inflation Linked TRI Hdg 2C	-0.5352	-3.2635*
12	CS ETF (IE) on iBoxx USD Inflation Linked G	-1.0895	-4.9342*
13	CS ETF (IE) on iBoxx USD Inflation Linked U	-1.5464	-1.4831
14	db x-trackers II USD Treasuries Inflation-Linked UCITS ETF 1C	-0.3237	-5.7304*
15	iShares Barclays TIPS (IE) G	0.1304	-6.3785*
16	iShares Barclays TIPS (IE) U	0.2269	-6.2894*

(*continued*)

Table 5.5-*Continued*

	Fund Name	Dickey-Fuller – GLS tests	
		t-Statistic	
		Level	First Difference
17	Portfolio	-0.6052	-3.7128*

The critical values for Dickey-Fuller-GLS tests are: 1%:-2.5724, 5%:-1.9418, 10%:-1.6160.
*stationary at 1% level
**stationary at 5% level
***stationary at 10% level

Table 5.6: Cointegration Results between Physical Gold ETFs traded on the London Stock Exchange, their portfolio and CPI.

The table also reports the results of cointegration between physical gold ETFs, their portfolio and CPI. All of the physical gold ETFs and their portfolio are found to be cointegrated with the CPI.

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
1	db Physical Gold	2	0.3011	20.2190	15.4947	0.0090*	0.3011	18.6293	14.2646	0.0096*
2	db Physical Gold G Hedged	2	0.5068	33.1544	15.4947	0.0000*	0.5098	24.9520	14.2646	0.0007*
3	db Physical Gold Hedged	2	0.3783	24.8724	20.2618	0.0107*	0.3783	18.0613	15.8921	0.0225*

(*continued*)

Table 5.6-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
4	ETFS Gold Bullion Securities E	2	0.2459	37.7647	20.2618	0.0001*	0.2459	35.5559	15.8921	0.0000*
5	ETFS Gold Bullion Securities	2	0.2766	29.2660	20.2618	0.0022*	0.2766	26.8791	15.8921	0.0007*
6	ETFS Physical Gold	2	0.2585	30.9479	20.2618	0.0012*	0.2585	26.9138	15.8921	0.0006*
7	ETFS Physical Gold G	2	0.2707	30.6414	20.2618	0.0013*	0.2707	26.5190	15.8921	0.0008*

(*continued*)

Table 5.6-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
8	ETFS Physical Swiss Gold	2	0.3142	27.7961	20.2618	0.0038*	0.3142	21.8776	15.8921	0.0051*
9	iShares Physical Gold	2	0.3897	32.2101	20.2618	0.0007*	0.3897	20.7417	15.8921	0.0080*
10	iShares Physical Gold G	2	0.3892	32.1404	20.2618	0.0007*	0.3892	20.7063	15.8921	0.0081*
11	Source Physical Gold P	2	0.2907	29.2739	20.2618	0.0022*	0.2907	23.0140	15.8921	0.0032*

(*continued*)

Table 5.6-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
12	Source Physical Gold P G	2	0.2983	29.0960	20.2618	0.0023*	0.2983	22.3192	15.8921	0.0042*
13	Portfolio	2	0.2557	31.6151	20.2618	0.0009*	0.2557	28.6450	15.8921	0.0003*

* at least 1 cointegrating equation at 5% level

Table 5.7: **Cointegration results between Inflation-Linked Bond ETFs traded on the London Stock Exchange, their portfolio and CPI.**

The table also reports the results of cointegration between inflation-linked bond ETFs, their portfolio and CPI. 14 of the inflation-linked bond ETFs and their portfolio are found to be cointegrated with the CPI.

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
1	CS ETF (IE) on iBoxx EUR Inflation Linked	1	0.2989	20.6159	15.4947	0.0077*	0.2989	17.7586	14.2646	0.0135*
2	CS ETF (IE) on iBoxx EUR Inflation Linked GBP	4	0.3338	21.9308	15.4947	0.0047*	0.3338	19.0892	14.2646	0.0080*
3	iShares Barclays Euro Inflation Linked Bond (IE)	1	0.3072	42.9901	20.2618	0.0000*	0.3072	39.6357	15.8921	0.0000*

(*continued*)

Table 5.7-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
4	iShares Barclays Global Inflation-Linked Bond (IE)	1	0.2798	35.6326	20.2618	0.0002*	0.2798	24.6147	15.8921	0.0017*
5	iShares Barclays Global Inflation-Linked Bond (IE) E	5	0.2035	22.0089	15.4947	0.0045*	0.2035	15.7034	14.2646	0.0294*
6	iShares Barclays Global Inflation-Linked Bond (IE) G	2	0.2389	32.6633	20.2618	0.0006*	0.2389	20.2012	15.8921	0.0098*
7	db x-trackers II iBoxx UK GILT Inflation-Linked UCITS ETF 1D	2	0.3099	29.4603	20.2618	0.0020*	0.3099	22.9936	15.8921	0.0032*

(*continued*)

Table 5.7-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
8	iShares Barclays £ Index-Linked Gilts (IE)	1	0.2871	42.0134	20.2618	0.0000*	0.2871	32.1471	15.8921	0.0001*
9	Lyxor ETF iBoxx UK Gilt Inflation-Linked G	2	0.3254	21.6437	20.2618	0.0321*	0.3254	18.1104	15.8921	0.0221*
10	db x-trackers II iBoxx Global Inflation-Linked UCITS ETF Hdg 3D	-	-	-	-	-	-	-	-	-
11	db x-trackers II iBoxx Global Inflation Linked TRI Hdg 2C	5	0.9164	45.8238	15.4947	0.0000*	0.9164	42.1899	14.2646	0.0000*

(*continued*)

Table 5.7-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
12	CS ETF (IE) on iBoxx USD Inflation Linked G	1	0.4179	28.8504	20.2618	0.0026*	0.4179	26.5103	15.8921	0.0008*
13	CS ETF (IE) on iBoxx USD Inflation Linked U	-	-	-	-	-	-	-	-	-
14	db x-trackers II USD Treasuries Inflation-Linked UCITS ETF 1C	2	0.2737	21.9035	20.2618	0.0295*	0.2737	19.5074	15.8921	0.0129*
15	iShares Barclays TIPS (IE) G	2	0.2444	31.9357	20.2618	0.0008*	0.2444	26.3375	15.8921	0.0008*

(*continued*)

Table 5.7-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
16	iShares Barclays TIPS (IE) U	1	0.3045	39.2120	20.2618	0.0000*	0.3045	34.4973	15.8921	0.0000*
17	Portfolio	2	0.2686	30.4793	20.2618	0.0014*	0.2686	26.2784	15.8921	0.0008*

* at least 1 cointegrating equation at 5% level

Table 5.8: Cointegration results between Physical Gold ETFs traded on the London Stock Exchange, their portfolio and RPI.

The table also reports the results of cointegration between physical gold ETFs, their portfolio and RPI. All of the physical gold ETFs and their portfolio are found to be cointegrated with the RPI.

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
1	db Physical Gold	2	0.2986	19.2535	15.4947	0.0129*	0.2986	18.4467	14.2646	0.0103*
2	db Physical Gold G Hedged	2	0.3623	29.5263	20.2618	0.0020*	0.3623	18.8938	15.8921	0.0164*
3	db Physical Gold Hedged	4	0.5171	33.5226	20.2618	0.0004*	0.5171	27.6647	15.8921	0.0005*

(*continued*)

Table 5.8-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
4	ETFS Gold Bullion Securities E	2	0.1778	26.7489	20.2618	0.0055*	0.1778	24.6622	15.8921	0.0016*
5	ETFS Gold Bullion Securities	1	0.1839	22.3448	20.2618	0.0255*	0.1839	17.0724	15.8921	0.0325*
6	ETFS Physical Gold	2	0.1686	20.9772	20.2618	0.0398*	0.1686	16.6204	15.8921	0.0384*
7	ETFS Physical Gold G	1	0.1866	22.4800	20.2618	0.0244*	0.1866	17.5519	15.8921	0.0272*

(*continued*)

Table 5.8-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
8	ETFS Physical Swiss Gold	2	0.3211	27.7642	20.2618	0.0038*	0.3211	22.4644	15.8921	0.0040*
9	iShares Physical Gold	2	0.4068	32.0082	20.2618	0.0008*	0.4068	21.9334	15.8921	0.0050*
10	iShares Physical Gold G	2	0.4059	31.8992	20.2618	0.0008*	0.4059	21.8725	15.8921	0.0051*
11	Source Physical Gold P	2	0.2799	27.1030	20.2618	0.0049*	0.2799	22.0048	15.8921	0.0048*

(*continued*)

Table 5.8-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
12	Source Physical Gold P G	1	0.4173	42.2664	20.2618	0.0000*	0.4173	34.5602	15.8921	0.0000*
13	Portfolio	1	0.2150	27.1198	20.2618	0.0048*	0.2150	23.7222	15.8921	0.0024*

* at least 1 cointegrating equation at 5% level

Table 5.9: Cointegration Results between Inflation-Linked Bond ETFs traded on the London Stock Exchange, their portfolio and RPI.

The table also reports the results of cointegration between inflation-linked bond ETFs, their portfolio and RPI. 14 of the inflation-linked bond ETFs and their portfolio are found to be cointegrated with the RPI.

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
1	CS ETF (IE) on iBoxx EUR Inflation Linked	1	0.2717	18.2000	15.4947	0.0191*	0.2717	15.8493	14.2646	0.0279*
2	CS ETF (IE) on iBoxx EUR Inflation Linked GBP	6	0.3542	22.5794	15.4947	0.0036*	0.3542	19.6745	14.2646	0.0063*
3	iShares Barclays Euro Inflation Linked Bond (IE)	1	0.2244	30.4380	20.2618	0.0014*	0.2244	27.4381	15.8921	0.0005*

(*continued*)

Table 5.9-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
4	iShares Barclays Global Inflation-Linked Bond (IE)	1	0.2394	28.7847	25.8721	0.0211*	0.2394	20.5209	19.3870	0.0341*
5	iShares Barclays Global Inflation-Linked Bond (IE) E	7	0.2789	35.8225	20.2618	0.0002*	0.2789	22.5660	15.8921	0.0038*
6	iShares Barclays Global Inflation-Linked Bond (IE) G	1	0.2806	27.0527	25.8721	0.0355*	0.2806	24.7037	19.3870	0.0076*
7	db x-trackers II iBoxx UK GILT Inflation-Linked UCITS ETF 1D	2	0.3391	32.9155	20.2618	0.0005*	0.3391	25.6755	15.8921	0.0011*
8	iShares Barclays £ Index-Linked Gilts (IE)	1	0.1852	30.6646	20.2618	0.0013*	0.1852	19.4547	15.8921	0.0132*

(*continued*)

Table 5.9-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
9	Lyxor ETF iBoxx UK Gilt Inflation-Linked G	2	0.3272	22.4253	20.2618	0.0248*	0.3272	18.2300	15.8921	0.0211*
10	db x-trackers II iBoxx Global Inflation-Linked UCITS ETF Hdg 3D	-	-	-	-	-	-	-	-	-
11	db x-trackers II iBoxx Global Inflation Linked TRI Hdg 2C	5	0.8178	35.1785	15.4947	0.0000*	0.8178	28.9404	14.2646	0.0001*
12	CS ETF (IE) on iBoxx USD Inflation Linked G	1	0.4123	28.3514	20.2618	0.0031*	0.4123	26.0492	15.8921	0.0009*
13	CS ETF (IE) on iBoxx USD Inflation Linked U	-	-	-	-	-	-	-	-	-

(*continued*)

Table 5.9-*Continued*

	Fund Name	Number of Lags	Trace Test				Maximum Eigenvalue Test			
			Eigenvalue	Trace Statistic	0.05 Critical Value	P – value	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P – value
14	db x-trackers II USD Treasuries Inflation-Linked UCITS ETF 1C	1	0.3812	32.3108	20.2618	0.0007*	0.3812	29.7624	15.8921	0.0002*
15	iShares Barclays TIPS (IE) G	2	0.1799	23.4982	20.2618	0.0173*	0.1799	18.6482	15.8921	0.0180*
16	iShares Barclays TIPS (IE) U	1	0.1964	24.7048	20.2618	0.0114*	0.1964	20.7704	15.8921	0.0079*
17	Portfolio	0.1845	22.2606	20.2618	0.0262*	0.1845	17.3412	15.8921	0.0294*	0.1845

* at least 1 cointegrating equation at 5% level

Table 5.10: Coefficient of Autocorrelation of the Residuals between Physical Gold ETF Portfolio, Inflation-Linked Bond ETF Portfolio, CPI and RPI

The value of the autocorrelations is smaller for physical gold ETF portfolio compared to the value of autocorrelations for inflation-linked bond ETF portfolio. This suggests that the physical gold ETF portfolio mimics the inflation rate better.

Portfolio	CPI	RPI
Physical Gold ETF	0.6512	0.6322
Inflation-Linked Bond ETF	0.7231	0.7252

Table 5.11: Granger Causality Tests between Physical Gold ETFs traded on the London Stock Exchange, their portfolio and CPI.

The table also shows the results of Granger Causality test on physical gold ETFs, their portfolio and CPI. All of the physical gold ETFs and their portfolio are found to be significant in the relationship, at least as a dependent that Granger caused by the CPI.

	Fund Name	Fund as Dependent Variable		CPI as Dependent Variable	
		Chi-Square	Prob.	Chi-Square	Prob.
1	db Physical Gold	9.5032	0.0086*	8.2673	0.016**
2	db Physical Gold G Hedged	16.2850	0.0003*	18.0264	0.0001*
3	db Physical Gold Hedged	13.4094	0.0012*	3.9553	0.1384
4	ETFS Gold Bullion Securities E	8.5860	0.0137**	7.4620	0.0240**

(*continued*)

Table 5.11-*Continued*

	Fund Name	Fund as Dependent Variable		CPI as Dependent Variable	
		Chi-Square	Prob.	Chi-Square	Prob.
5	ETFS Gold Bullion Securities	4.7442	0.0933***	6.8911	0.0319**
6	ETFS Physical Gold	8.4688	0.0145**	4.5444	0.1031
7	ETFS Physical Gold G	4.6992	0.0954***	6.4027	0.0407**
8	ETFS Physical Swiss Gold	6.7432	0.0343**	8.3306	0.0155**
9	iShares Physical Gold	18.0047	0.0001*	19.0065	0.0001*
10	iShares Physical Gold G	17.9516	0.0001*	19.1613	0.0001*
11	Source Physical Gold P	5.1379	0.0766***	10.7697	0.0046*
12	Source Physical Gold P G	6.8798	0.0321**	10.4380	0.0054*
13	Portfolio	7.9254	0.0190**	4.7292	0.0940***

*Granger causality at 1% level
** Granger causality at 5% level
*** Granger causality at 10% level

Table 5.12: Granger Causality Tests between Inflation-Linked Bond ETFs traded on the London Stock Exchange, their portfolio and CPI.

The table also shows the results of Granger Causality test on inflation-linked bond ETFs, their portfolio and CPI. All of the inflation-linked bond ETFs and their portfolio are found to be significant in the relationship, at least as a dependent that Granger caused by the CPI.

	Fund Name	Fund as Dependent Variable		CPI as Dependent Variable	
		Chi-Square	Prob.	Chi-Square	Prob.
1	CS ETF (IE) on iBoxx EUR Inflation Linked	6.7392	0.0344**	2.0480	0.3592
2	CS ETF (IE) on iBoxx EUR Inflation Linked GBP	6.6064	0.0368**	1.9990	0.3681
3	iShares Barclays Euro Inflation Linked Bond (IE)	4.4144	0.0356**	5.5038	0.0638***
4	iShares Barclays Global Inflation-Linked Bond (IE)	8.6997	0.0129**	5.7628	0.0561***
5	iShares Barclays Global Inflation-Linked Bond (IE) E	19.7446	0.0061*	11.5978	0.1146
6	iShares Barclays Global Inflation-Linked Bond (IE) G	10.0838	0.0729***	2.3105	0.8047
7	db x-trackers II iBoxx UK GILT Inflation-Linked UCITS ETF 1D	6.2016	0.0450**	1.2293	0.5408

(*continued*)

Table 5.12-*Continued*

	Fund Name	Fund as Dependent Variable		CPI as Dependent Variable	
		Chi-Square	Prob.		Chi-Square
8	iShares Barclays £ Index-Linked Gilts (IE)	8.3326	0.0155**	2.4018	0.3009
9	Lyxor ETF iBoxx UK Gilt Inflation-Linked G	2.0745	0.0799***	0.5804	0.7838
10	db x-trackers II iBoxx Global Inflation-Linked UCITS ETF Hdg 3D	3.1255	0.0590***	0.0373	0.9635
11	db x-trackers II iBoxx Global Inflation Linked TRI Hdg 2C	8.7167	0.0027*	3.4376	0.0515***
12	CS ETF (IE) on iBoxx USD Inflation Linked G	3.9964	0.0266**	0.1322	0.8766
13	CS ETF (IE) on iBoxx USD Inflation Linked U	2.5664	0.0551***	1.010	0.4156
14	db x-trackers II USD Treasuries Inflation-Linked UCITS ETF 1C	3.2145	0.0500**	0.7397	0.4832
15	iShares Barclays TIPS (IE) G	2.3149	0.0286**	0.5356	0.8259
16	iShares Barclays TIPS (IE) U	4.9241	0.0093*	0.6141	0.5434
17	Portfolio	4.8522	0.0884***	6.1764	0.0456**

*Granger causality at 1% level
** Granger causality at 5% level
*** Granger causality at 10% level

Table 5.13: **Granger Causality Tests between Physical Gold ETFs traded on the London Stock Exchange, their portfolio and RPI**.

The table also shows the results of Granger Causality test on physical gold ETFs, their portfolio and RPI. All of the physical gold ETFs and their portfolio are found to be significant in the relationship, at least as a dependent that Granger caused by the RPI.

	Fund Name	Fund as Dependent Variable		RPI as Dependent Variable	
		Chi-Square	Prob.	Chi-Square	Prob.
1	db Physical Gold	11.3539	0.0034*	6.1543	0.0461**
2	db Physical Gold G Hedged	19.4842	0.0001*	15.7070	0.0004*
3	db Physical Gold Hedged	19.3879	0.0001*	3.6378	0.1622
4	ETFS Gold Bullion Securities E	5.6987	0.0579***	4.4359	0.1088
5	ETFS Gold Bullion Securities	4.9661	0.0835***	3.6559	0.1607
6	ETFS Physical Gold	4.9934	0.0824***	6.1595	0.2060
7	ETFS Physical Gold G	4.9409	0.0845***	3.1711	0.2048
8	ETFS Physical Swiss Gold	7.2919	0.0261**	5.6257	0.0600***

(*continued*)

Table 5.13-*Continued*

	Fund Name	Fund as Dependent Variable		RPI as Dependent Variable	
		Chi-Square	Prob.		Chi-Square
9	iShares Physical Gold	20.0497	0.0000*	15.5829	0.0004*
10	iShares Physical Gold G	19.9804	0.0000*	15.7503	0.0004*
11	Source Physical Gold P	6.7273	0.0346**	6.3746	0.0413**
12	Source Physical Gold P G	7.3628	0.0252**	5.9413	0.0513***
13	Portfolio	7.4313	0.0243**	7.3341	0.0256**

*Granger causality at 1% level
** Granger causality at 5% level
*** Granger causality at 10% level

Table 5.14: **Granger Causality Tests between Inflation-Linked Bond ETFs traded on the London Stock Exchange, their portfolio and RPI**.

The table also shows the results of Granger Causality test on inflation-linked bond ETFs, their portfolio and RPI. All of the inflation-linked bond ETFs and their portfolio are found to be significant in the relationship, at least as a dependent that Granger caused by the RPI.

	Fund Name	Fund as Dependent Variable		RPI as Dependent Variable	
		Chi-Square	Prob.	Chi-Square	Prob.
1	CS ETF (IE) on iBoxx EUR Inflation Linked	7.3542	0.0253**	2.8766	0.2373
2	CS ETF (IE) on iBoxx EUR Inflation Linked GBP	6.2326	0.0443**	2.6420	0.2669
3	iShares Barclays Euro Inflation Linked Bond (IE)	2.5833	0.0805***	1.7385	0.1810
4	iShares Barclays Global Inflation-Linked Bond (IE)	4.8117	0.0902***	12.9746	0.0015*
5	iShares Barclays Global Inflation-Linked Bond (IE) E	2.7465	0.0097*	0.8136	0.6170
6	iShares Barclays Global Inflation-Linked Bond (IE) G	3.0462	0.0048*	0.8075	0.6225
7	db x-trackers II iBoxx UK GILT Inflation-Linked UCITS ETF 1D	7.1751	0.0277**	1.3173	0.5176
8	iShares Barclays £ Index-Linked Gilts (IE)	8.8027	0.0123**	6.8242	0.0330**

(*continued*)

Table 5.14-*Continued*

	Fund Name	Fund as Dependent Variable		RPI as Dependent Variable	
		Chi-Square	Prob.		Chi-Square
9	Lyxor ETF iBoxx UK Gilt Inflation-Linked G	2.2498	0.0950***	0.8444	0.6138
10	db x-trackers II iBoxx Global Inflation-Linked UCITS ETF Hdg 3D	5.9222	0.0848***	0.6346	0.7491
11	db x-trackers II iBoxx Global Inflation Linked TRI Hdg 2C	10.0940	0.0011*	1.7849	0.1996
12	CS ETF (IE) on iBoxx USD Inflation Linked G	3.3001	0.0766***	0.2062	0.6522
13	CS ETF (IE) on iBoxx USD Inflation Linked U	94.4221	0.0105**	4.2558	0.2066
14	db x-trackers II USD Treasuries Inflation-Linked UCITS ETF 1C	3.2045	0.0800***	0.2910	0.5923
15	iShares Barclays TIPS (IE) G	2.1828	0.0534***	1.0866	0.3779
16	iShares Barclays TIPS (IE) U	7.5840	0.0071*	0.0006	0.9812
17	Portfolio	5.0453	0.0802***	3.0261	0.2202

*Granger causality at 1% level
** Granger causality at 5% level
*** Granger causality at 10% level

CHAPTER 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

The aim of this thesis is to assess the tracking properties of gold ETFs, the co-existence of gold ETF and gold mutual funds and the inflation-hedging feature of gold ETF in the UK. In other words, we try to answer the following questions:

- Do physical gold ETFs track the return of physical gold prices well in the UK?
- Does the introduction of gold ETFs affect the returns and trading volume of gold mutual funds in the UK?
- Are physical gold ETFs and inflation-linked bond ETFs capable of hedging inflation risk in the UK?

These research questions have been addressed in the context of the UK market. The remainder of this chapter presents the summary, conclusions and recommendations for further research on the basis of the findings of the empirical results from this thesis. Although our conclusions are based on the experience in the UK alone, we believe that our findings may be important and applicable to the understanding of the use of gold ETF as an investment vehicle in other country markets as well. Since the motivation for the investment in gold ETF comes from a variety of factors, such as lower transaction costs, liquidity and lower storage cost, it is crucial for investors to understand and master this

financial innovation, especially regarding their tracking error, return and inflation hedging. In addition, understanding the hedging capability of gold ETFs is important because they provide insights into which ETF should be considered, especially in a world where various financial instruments are widespread.

In this chapter, we summarise the main findings of our research. These findings are presented in ways that show how they meet the objectives and hypotheses that we proposed at the beginning of the thesis. The conclusions are then proposed based on the findings. Finally, some proposals for further research are suggested.

6.2 Summary and Conclusions from the Empirical Investigations

The main findings of the research have been presented in the following which represents our three research studies.

6.2.1 The Tracking Performance and Profitability of Gold ETFs Relative to Some Other Instruments in the UK

This study examines the tracking error of gold ETFs and gold mutual funds relative to physical gold prices. It also analyses the risk and return characteristics of those funds relative to gold prices. This study empirically examines the tracking error by using four methods: average daily tracking error, standard errors from regression analysis, standard deviation of differences between returns and coefficients of the autocorrelation of the residuals from the cointegrating equation.

The evidence from the tracking error analyses shows that, on average, the mean return from physical gold ETFs is quite similar to gold prices return, although not absolutely similar. The risk, which is based on standard deviation, of physical gold ETFs are also higher than gold mutual funds and physical gold prices. The minimum (best) tracking errors come from a product of physical gold ETF, compared to synthetic gold ETF, inverse gold ETF, leveraged gold ETF, sector equity gold ETF and gold mutual funds. Thus, this study report contrasting findings to Johnson et al. (2012) and Meinhardt et al. (2012). However it reports similar findings to Guedj et al. (2011), Jagerson and Hansen (2011), Plamondon and Luft (2012) and Chu (2016). That is, the ETF that uses the tracked asset as its underlying asset performs better than the ETF that uses synthetic underlying asset.

Further, we also found that ETFs do differ individually in terms of tracking performance although they share similar underlying assets. Similar findings have also been reported by previous studies (Kostovetsky, 2003; Milonas and Rompotis, 2006; Murphy and Wright, 2010; Ivanov, 2011; Drenovak et al., 2012; Oztekin, 2016; Vandermarliere et al., 2017 among others), although they investigate different type of ETFs. The reason behind that is beyond the scope of this study. We can only speculate that the management of the ETFs do serve as the main factor in the results.

The limitations of the study lie with the methods used in the study. That is, the results only limited to the methods used. There are other approaches can be used to measure the tracking errors, for example multiple regression analysis and vector autoregressive method or any other approach that might be thought of in the future. Also, the analyses are only based on the data during the period of study. In the future, the pattern

of the data might change because of some events and new analyses would be needed. Anyway, we have used the widely accepted techniques in measuring the tracking error and used all of the available data throughout the period of study, by taking into consideration the resource and time limits.

6.2.2 Are Gold ETFs Substitutes for Gold Mutual Funds?

The second study of this thesis examines the impact of gold ETF introduction in the UK market on gold mutual funds. The most important contribution concerns whether the gold ETF inception would decrease the market activity of gold mutual funds. This study finds that there is no effect of gold ETFs introduction to gold mutual funds in terms of return performance. However, there are significant changes in the amount of volume traded of the gold mutual funds during before and after the introduction of gold ETFs. Results from regression analysis indicate that the changes in the return of the newly introduced gold ETFs do not influence the variation of the abnormal returns and abnormal volume of gold mutual funds. Hence, the substitutional assumption that was raised during the early part of the study is rejected.

It is the first study that examines the impact of gold ETFs on gold mutual funds. Hence, there is no comparison can be done to the results of the study. The only results that we have is the results from index ETFs and index mutual funds which has been reported by Boney et al. (2007), Guedj and Huang (2009), Barnhart and Rosenstein (2010) and Agapova (2010 and 2011) and Romero-Perez (2010). That is, they found either index ETFs are substitutes or complementaries to the index mutual funds. In our case, we find there is no relationship between gold ETFs and gold mutual funds in terms

of returns and volume during the introduction of gold ETFs. The possible explanation for this is that gold ETFs and gold mutual funds attract different type of investors according to their needs, as in the case of index ETFs and index mutual funds as reported by Guedj and Huang (2009). This suggestion is also supported by Broman and Shum (2015).

The limitations of the study also lie with the methods and data used in the study. We can find many other event study analyses instead of 3 parametric tests and 2 nonparametric tests used in the study. We chose those tests as they are most suitable according to our opinion and is supported by previous literatures. Also, because of the availability of gold ETFs in the UK, we only consider the events of 13 gold ETFs introduction that can be matched to the gold mutual funds. In the future, there should be more of such events, based on the pattern of gold ETF's inception in the UK. Hence, more data should be available and they may result in different outcomes than what this study has reported.

6.2.3 Do Gold ETFs Provide a More Effective Hedge Against Inflation than Inflation-Linked Bond ETFs?

This study analysed whether gold ETF and inflation-linked bond ETF can be used for inflation hedging in the UK, specifically against CPI and RPI. To the best of our knowledge, this is the first study to compare the abilities of gold ETFs and inflation-linked bond ETFs to hedge against inflation risk. The findings suggest that gold ETFs, especially, move similarly to the movement of cost of living, which is represented by the CPI and RPI although not perfectly. The gold ETFs have higher correlations with the CPI and RPI compared to inflation-linked bond ETF. This can be seen from the results of

cointegration and Granger causality tests. The possible explanation is the benchmark itself, which is gold prices. The majority of previous researchers conclude that physical gold prices can be used to hedge against and influence inflation risk (Omag, 2012; Reboredo, 2013; Beckman and Czudaj, 2013 and Bampinas and Panagiotidis, 2015, among others). Hence, gold ETFs, as they track gold prices with fairly good tracking performance as reported in Chapter 2, are also catching up well with the ups and downs of inflation rates.

It is well known that the inflation-linked bond cointegrates with inflation. This is because the inflation rate, specifically the RPI, is used to determine the return of the bond. In this study, majority of the inflation-linked bond ETFs have been shown to move well with inflation, either in the cointegration analysis or Granger causality test. However, two of them cannot be proven to be cointegrated with inflation as they did not conform to the prerequisite of the cointegration analysis. Furthermore, we find that the gold ETF portfolio hedges inflation risk better than the inflation-linked bond ETF portfolio.

The limitations of this study also lie with the methods and data used in the study. There are many other methods can be used in measuring the movements of inflation rate and the return of the ETFs, such as vector autoregressive (VAR) and its modified versions or Markov switching multifractal model. However, as we have resource and time limits, we used only the widely accepted methods in the study.

6.3 Further Research

The main aim of our research is to provide a deep analysis of whether the use of gold ETF could expose the investor to the ups and downs of physical gold prices. We focus on the whole market of gold ETF in the UK. However, we do not consider other techniques in achieving that aim, such as using gold ETF in a different type of portfolio. More specifically, we do not investigate the magnitude of gold ETF usage, whether when combined with other gold ETF products or other asset classes, in mimicking the trend, return and risk of physical gold prices. In addition, we do not explore the diversification benefits of gold ETFs. For example, we do not examine whether a portfolio which also contains gold ETFs could beat the market or be more efficient than those which do not.

Taking a different perspective, there is a large gap between analysing the magnitude of investment in gold ETF and identifying the factors and type of investors that invest in gold ETF. We do not identify the factors and type of investors that invest in gold ETF. In our opinion, studies that try to achieve those aims would require a comprehensive survey including investors that are willing to reveal their investment preferences and strategies.

We believe that further research based on the findings of our research is necessary. For example, this research has demonstrated that there is a gap in the empirical literature since most of the empirical research on gold ETF has been conducted using samples from the US market. Currently, there are only limited studies investigating the usage of gold ETF as an investment vehicle from the non-US market. Further efforts should be made to conduct tests on the usage of gold ETF in investment on data from countries other than

the US. This is worthwhile as it might reveal the importance of alternative country-specific gold ETF factors in investment, not encountered in existing studies.

Technically, subsequent work might increase the power of our research by:

- using more data from different countries
- using more panel data from factors that influence gold ETF investing
- examining for cross-country gold ETF investment
- using different econometric/statistics methods.

This study is a preliminary effort in attempting to analyse the investment in gold ETF in the UK. There is a broad range of issues to be explored in the future. For instance, the nature, procedure and process for cross-country gold ETF investment is an important issue for further research. While extant theory predicts that this process is feasible, available tax barrier evidence gives negative indications about the effect of cross-country gold ETF investment. Further investigation of these issues is suggested as a line for future research.

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