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Have Exchange Traded Funds influenced commodity market volatility?

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ABSTRACT: Exchange Traded Funds (ETFs) have existed since the late 1980s, but were first traded on commodity markets in the early 2000s. Their inception has been linked by some market analysts with the large commodity price increases and volatility evident between 2007 and 2009. This research provides a concise literature review based on ETFs and then focuses on the role that the product has played, either as an accelerant for mispricing in international commodity markets, or as a mechanism for liquidity improvements, thereby increasing the speed of the transfer of information. This research also investigates whether the effects are more pronounced in larger or smaller sized commodity markets. The results indicate that larger market-proportional ETF holdings are associated with higher EGARCH volatility. Smaller commodity markets are found to have increased liquidity flows, indicating benefits from ETF investment. The need for further regulation of investment size and market ownership limits cannot be rejected.

Keywords: Exchange Traded Funds (ETFs), commodity markets, volatility.
JEL Classification: G12, G15.

1. Introduction

This research investigates whether Exchange Traded Funds (ETFs) have had a role in the amplification of volatility in international commodity markets, or alternatively, whether the introduction of this new investment source has increased market liquidity, therefore increasing the speed of the transfer of information. Commodity markets are also segregated by size to specifically investigate whether volatility estimates are more pronounced in larger or smaller markets.

ETFs are usually registered investment funds that track a particular index, but can also be traded with the same properties as equities. The ETF itself is a bundle comprising the individual components of a chosen group of products or investment strategy, which is decided by the provider. ETF investors have benefitted from tax-efficiency in comparison to mutual funds[1] as they simply track many of the indices in which they invest. This lends to a reduction in operating and transaction costs due to their passive-management style[2]. ETFs have evolved in recent years, becoming more complex. It is now possible to buy shares in an ETF investing strategically using leverage, differing

[1] A mutual fund is a professionally managed type of collective investment scheme that pools capital from many investors and invests typically in investment securities. The mutual fund will have a manager that trades the fund’s investment pool in accordance with the fund’s investment objective.

[2] A passive investment style is a financial strategy in which a fund manager makes as few portfolio decisions and changes as possible to minimise transaction costs.

investment stance (long or short) or indeed based on a wide variety of strategies such as market spreads. Other benefits of ETF investment have been identified through the opportunities for investors to enter markets they otherwise could not have, due to high market entry costs and required minimum margin levels. But the creators of the ETF mitigate these issues by pooling the multiple investments together and selling the shares of their chosen strategy to the investors in a secondary market.

Between 2005 and 2010, ETFs trading volume increased threefold to account for approximately thirty per cent of commodity markets trading volume. This trend has continued into 2012 and 2013 where ETFs account for approximately forty per cent of total commodity trading (Financial Times, 2013). The Investment Company Institute in 2010 believed that more than $780 billion was invested across all ETFs (Milonas and Rompotis, 2010). As of December 2013, the four largest commodity ETFs in the world controlled nearly $51 billion in assets under management. These ETFs include the SPDR Gold Trust ($32.8 billion), the iShares Gold Trust ($6.6 billion), the iShares Silver Trust ($6.3 billion) and the PowerShares DB Commodity Index Tracking Fund ($1.7 billion).

Some issues have been identified in commodity markets after the arrival of ETFs. Volatility has been identified as the primary area where ETF investment may have a direct impact (FSA, 2011) through market dominating factors, as ETFs can sometimes possess monopoly holdings within a market. The Financial Services Authority (FSA) claim that the rapid growth of the ETF markets has led to a high level of innovation in this product area. They find that this created further risks due to a lack of investor understanding, that is, investors do not understand the true differences between product types in terms of investment strategies, complexities, tax status and underlying risk. Counterparty and collateral risk is found to be mostly associated with ETFs as opposed to other investment funds, with conflicts of interest commonly uncovered due to the structure of the product. The FSA raised strong concerns based on the legal structure of ETFs, that are mostly based in the domicile state, rather than the state in which the product is being directly offered. The United States Commodity Futures Trading Commission (CFTC) chairman Gary Gensler stated in August 2009, that ‘position limits should be consistently applied and vigorously enforced’ and that ‘position limits promote market integrity by guarding against concentrated positions’. These comments were made in direct response to reports based on negative effects stemming from the size of ETF investment. The research in this paper specifically focuses on the volatility of these identified commodity markets.

Xiong and Tang (2011) found that ETFs are associated with an increase in cross-commodity market correlation because findings based on international markets are not evident in Chinese commodity markets, which are not available to foreign investment. Therefore, ETFs cannot enter Chinese markets to purchase underlying commodity components to create their funds. On a direct market impact level, from 1986 to 2004, the return correlation of soybeans and West Texas Intermediate oil was almost zero. Since commodity ETFs were first introduced in 2004 and have subsequently grown as a trading product, this correlation has increased to 0.6. Similarly, from near zero correlation, the arrival of ETFs has been linked with increased correlation in the markets for oil and cotton (0.5), oil and live cattle (0.4) and oil and copper (0.6). These correlation increases have been directly linked to mixed commodity ETFs, where an increase in demand creates greater investment into the underlying components simultaneously, therefore providing a mechanism for commodity market correlations to synchronise. As ETFs grow, this correlation increase will also continue to grow.

This research focuses specifically on volatility changes in commodity markets after the arrival of significant ETF investment in 2004. EGARCH methodologies are used to identify specific volatility changes in the periods before and after the arrival of ETF investment. These same volatility estimates are then analysed in terms of the size of the commodity market in which the ETF has invested to identify volatility differences based on market size.

From a policy perspective, it is vital to understand the effects that ETFs have had on the volatility of commodity markets. If it is the case that ETFs are found to have directly influenced volatility, it may be necessary for regulatory bodies to implement regulatory changes to mitigate any potential effects. For example, if it is found that ETFs are negatively impacting market functionality, then policy response must focus on position limits, short-selling limits and margin limits for ETFs.

The rest of this paper is organised as follows: section two presents an overview of the identified issues with ETFs as a trading product, while presenting the associated previous literature. Section three describes the data, methodology and structure of the models used in the analysis while section four describes the results. Section five concludes.

2. Previous literature on ETFs

Though ETFs are still in their relative youth, a number of significant issues have already been identified. ETF investing is associated with more frequent trading, which has been found to reduce overall market returns (Jares and Lavin, 2007, Gastineau, 2008). John Bogle, the founder of the Vanguard Group[3] has argued that ETFs are the source of short-term speculative strategies. While ETFS can be a good long-term investment, they may not be suitable for short-term speculative strategies as trading commissions significantly reduce returns.

There is also evidence that ETFs are capable of manipulating market prices, particularly 'short' or 'inverse' ETFs[4] (Jing, 2006). In some cases, it has been argued that the strategy that had been offered by the ETF provider may be misrepresented. Though the fund may be based on a particular sector of the economy or market, it is at the discretion of the ETF creator to determine which individual components are included in the fund. Higher market volatility is associated with a tracking error[5] between the returns of the ETF and the returns of the market. In most cases, ETFs have a low tracking error. But in markets with a substantial reduction in market liquidity, there are significant issues with the ability of ETFs to buy and sell fund components at a fair market price, therefore passing on the costs of illiquidity to ETF investors (Robinson et al., 2010, Kosev and Williams, 2011). The effects of contango[6] and backwardation[7] are also substantial when a commodity ETF is created on constituents formed from commodity futures.

The main benefits of ETF investment are found through the ease of diversification, low expense ratios and tax efficiency. This is combined with all the standard trading structure of equities with options, short selling, stop losses and limit orders all available. Some ETFs have lower costs due to their passive management style, whereby ETF managers do not have to regularly buy and sell the individual components of the ETF. ETFs can be bought and sold at any time during the trading day, in comparison to mutual funds that can only be sold at the end of the day when their net asset value (NAV) is calculated. One of the major volatility linked issues associated with managed-ETFs is the

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[3] The Vanguard Group is an American investment management company that manages approximately $2.5 trillion in assets and is based on Malvern, Pennsylvania. It offers mutual funds and other financial products and services to individual and institutional investors in the United States and abroad.

[4] A 'short' or 'inverse' ETF, or also known as an inverse ETF is constructed by using various derivatives for the purpose of profiting from a decline in value of an underlying benchmark. Investing in this style of ETF is similar to holding various short positions, or using a combination of advanced investment strategies to profit from falling prices.

[5] Tracking error is a measure of how closely a portfolio follows the index to which it is benchmarked.

[6] Contango refers to the market condition wherein the price of a forward or futures contract is trading above the expected spot price at contract maturity. The resulting futures or forward curve would typically be upward sloping ('normal') since contracts for further dates would typically trade at even higher prices.

[7] Backwardation refers to the market condition wherein the price of a forward or futures contract is trading below the present spot price. The resulting futures or forwards contract would typically be downward sloping ('inverted') since contracts for further dates would typically trade at even lower prices.

rebalancing trades that occur at the end of the day. For ETFs to meet their investment mandates, it is necessary for them to rebalance their portfolios as market movements require. Previous research has found that this rebalancing process may cause excess volatility (Rompotis, 2008, Humphries, 2010). It has also been found that ETF rebalancing due to the unwillingness and reticence to hold positions overnight is boosting late-day volume. Some estimates of this last-hour trading accredited to ETFs are in the range of twenty to thirty per cent (Avellaneda and Zhang, 2009, Knain-Little, 2010).

Rompotis (2009) investigated the dynamics of various investment styles and found that active ETFs underperform their corresponding passive ETFs and the market indices. The results also indicate that the percentage correlation between the trading price of the ETF and the underlying index range between 0.2 per cent and 39.1 per cent. This finding is echoed by Gastineau (2004) and Lu and Wang (2009). A 'herd effect' has been identified by identified in associated ETF research (Miffre, 2007). This effect is found to have been amplified by current global uncertainties, as investors are less willing to hold overnight positions due to the increased risk of off-market-hours price fluctuations. Trainor (2010) investigated the link between leveraged ETFs and equity market volatility. Of the one hundred and fifty leveraged and inverse ETFs with assets of more than $30 billion in 2010, intra-day volatility since the year 2000 was not found to be associated with the rebalancing process of ETF fund managers. This result was also found to hold during periods of extreme intra-day volatility such as during the United States subprime crisis. Cheng and Madhaven (2009) found that leveraged ETFs have a large effect on market-on-close[8] volumes (MOC). Large moves in price could be further exacerbated by the rebalancing process of ETFs at the end of the day. Cherry (2004) found that ETFs are on average, seventeen per cent more volatile than their underlying components and seventy per cent of this volatility can be explained by transaction and holding costs. Madura and Richie (2004) found substantial overreaction of ETFs during normal trading hours and after hours, presenting opportunities for feedback traders.

Hughen (2003) investigated the arbitrage mechanism on premiums and discounts showing how critical the arbitrage mechanism is towards the pricing of ETFs. Kalaycioglu (2006) investigated the flow-return relationship in ETFs and fails to reject the hypothesis of no-price-pressure on market returns originating from ETF flows. Harper et al. (2006) found that between 1996 and 2001, ETFs showed higher mean returns and Sharpe ratios[9] than foreign closed-end funds. Modura and Ngo (2008) found that in response to the inception of ETFs, there are positive and significant valuation effects on the dominant component stocks of the ETF investigated.

There are two further channels of previous literature that also aid research into the effects of ETFs on commodity market volatility. The first is based on the view that derivative products increased volatility, as they are instruments primarily used by speculators to increase their exposure to an asset, thereby amplifying risk. Some research has found destabilising effects evident in markets as speculative trading originates from uninformed investors (Chathrath et al., 1995). Stein (1987) claimed that futures markets attracted uninformed traders because of their high degree of leverage,

[8] This is an order entered during the day that grants discretionary power to the trader, so that, as near as possible to the end of the trading day, a market order will be executed. Market-on-close (MOC) orders are sometimes used as a limit order qualifier, making the limit order a MOC order if the limit was not reached earlier in the day. In addition, MOC orders allow investors to buy or sell a stock that might move drastically before the next morning's open – perhaps as the result of a known after-hours earnings announcement or news story.

[9] The Sharpe ratio tells us whether a portfolio's asset returns are due to smart investment decisions, or as a result of excess risk. This measurement is very useful because although one portfolio or fund can reap higher returns than its peers, it is only a good investment if those higher returns do not come with too much additional risk. The greater a portfolio's Sharpe ratio, the better its risk adjusted performance has been. A negative Sharpe ratio indicates that risk-less assets would perform better than the security being analysed.

which can reduce the information content of prices and can cause destabilising market volatility. Other research supporting the view that derivatives increases volatility includes Antoniou and Holmes (2003). Pok and Poshakwale (2004) found similar volatility increases, but also noted greater sensitivity of spot market prices to new information, combined with efficiency improvements through the faster transfer of information.

The second view is based on the hypotheses that derivative products reduce spot market volatility and in fact stabilise the market. Derivatives are viewed as an efficient medium of price discovery. Other noted benefits include improved market depth, a reduction in market asymmetries and less cash market volatility as found by Kumar et al. (1995) and Antoniou et al. (1998). Other research that found volatility reductions after the inclusion of their investigated derivative products include Pilar and Rafael (2002), Bologna and Cavallo (2002) and Drimbetas et al. (2007).

3. Data, methodology and structure of the models

The primary research question is to quantify the impact that ETFs have had on the volatility of a broad range of United States commodity markets. This is investigated through the use of EGARCH models testing dynamic changes in the structure of volatility in the periods before and after the introduction of commodity ETFs in 2004. The data used spans from January 1998 to December 2011. Forty-four ETFs across seventeen commodity markets were investigated. Though over eighty international ETFs were initially included, some had to be excluded from the analysis due to reasons including a lack of data, illiquidity or the ETF being introduced too late in the sampling period. Though some ETFs invest in the commodity futures markets, spot commodity market prices were used in the analysis. This method was selected to minimise the effects of backwardation and contango in futures markets. It also minimised volatility stemming from rolling over futures contracts, a process which involves selling the commodity when a contract expires and re-buying the commodity at the start of the next contract.

In table one, we can see the size of the market for international ETFs for all types of investment products. The United States, Germany, France, Canada and Japan are among the largest jurisdictions where ETFs are based in terms of domestic assets under management (AUM) in United States Dollars ($) as of December 2013.

Table 1: ETF estimated assets under management (AUM$) as of January 2013

Country	AUM Billion$	Country	AUM Billion$
Australia	5.747	Malaysia	0.195
Austria	0.275	Mexico	5.334
Belgium	0.099	Netherlands	0.700
Brazil	2.235	New Zealand	0.312
Canada	22.335	Norway	0.376
China	2.867	Singapore	1.945
Finland	0.182	Slovenia	0.003
France	5.648	South Africa	1.958
Germany	35.251	South Korea	3.701
Greece	0.106	Spain	0.693
Hong Kong	15.205	Sweden	2.017
Hungary	0.030	Switzerland	7.791
Iceland	0.071	Taiwan	1.151
India	1.860	Thailand	0.101
Indonesia	0.009	Turkey	0.185
Ireland	0.059	United Kingdom	12.255
Italy	1.912	United States	58.285
Japan	59.275		

Note: Data taken from Deutsche Bank statistics released in January 2013. The above table represents the estimated assets under management (AUM) in billions of US Dollars ($) as of December 2010 for all styles of ETF investment (bond, equity, currency, commodity etc.).

Table two lists the underlying commodity markets analysed in this investigation, while table three lists the total sample of forty-four international ETFs across seventeen markets. The data used in this analysis is based on the ETFs found in table three. The daily return is calculated as $R_t = (P_t - P_{t-1}/P_{t-1})$. The dataset[10] is based on the daily returns of spot market commodity prices. The EGARCH(1,1) model used in this analysis includes a dummy variable to signal the inception of the commodity ETF as a trading product, denoted as zero prior to the arrival of ETFs and one thereafter. The model also includes the Dow Jones Industrial Average (DJIA) as a proxy for equity market performance[11]. As commodity markets are significantly affected by exchange rate movements, the model includes a trade-weighted basket comprised of the United States dollar ($) against numerous international exchange rates. The specification of the model is outlined in equation one below.

Table 2: Commodity markets under investigation after ETF introduction

Sector	Commodity	Ticker Symbol	Main Exchange	Contract Size
Energy	West Texas Intermediate Crude Oil	CL / WTI	NYMEX / ICE	1000 barrels
	Brent Crude	B	ICE	1000 barrels
	Natural Gas	NG	NYMEX	10,000 mmBTU
	RBOB Gasoline	RB	NYMEX	1000 barrels
Precious Metals	Gold	GC	CBOT	troy ounce
	Platinum	PL	NYMEX	troy ounce
	Palladium	PA	NYMEX	troy ounce
	Silver	SI	CBOT	troy ounce
Industrial Metals	Copper	HG	LME	Metric Tonne
	Zinc	Z	LME	Metric Tonne
	Aluminium	AL	LME	Metric Tonne
Livestock	Lean Hogs	LH	CME	20 tonnes
	Live Cattle	LC	CME	20 tonnes
	Feeder Cattle	FC	CME	25 tonnes
Agricultural	Corn	C / EMA	CBOT / EURONEXT	5,000 bushels
	Oats	O	CBOT	5,000 bushels
	Soybeans	S	CBOT	5,000 bushels
	Wheat	W	CBOT	5,000 bushels
	Cocoa	CC	NYBOT	10 tonnes
	Coffee	KC	NYBOT	37,500lb
	Cotton	CT	NYBOT	50,000lb
	Sugar (No.11 / No.14)	SB / SE	NYBOT	112,000lb

Note: The above table contains the spot and future commodity markets under investigation in this chapter for effects after the introduction of Exchange Traded Funds (ETFs).

[10] All data in this research is provided by Thomson Reuters DataStream

[11] An intercept and a deterministic trend were included in the Augmented Dickey Fuller (ADF) and Phillip Perron (PP) models. The trend was included to capture the reduction in average volatility that took place during the period prior to the inclusion of ETFs. The ADF model tests whether the commodity market series used contain a unit root in order to correct for serial correlation. PP tests employ a non-parametric estimator of the variance-covariance matrix with d truncation lags. The models test down by sequentially removing the last lag until a significant lag is reached, giving the order of augmentation for the ADF test that minimised the Akaike information criterion. The results indicated rejection of the null-unit root hypotheses at a minimum of the five per cent level of significance. The EGARCH (1,1) was selected as the most suitable model to test the hypotheses established in this paper.

Table 3: Commodity ETFs under investigation and their associated components

Name	Inception Date	Ticker	Assets under Control (Approximate)
SPDR Gold Trust	18/11/2004	GLD	100% Spot Gold (Long)
iShares Silver Trust	28/4/2006	SLV	100% Spot Silver (Long)
iShares COMEX Gold Trust	28/1/2005	IAU	100% Spot Gold (Long)
United States Oil Fund	10/4/2006	USO	100% Long West Texas Intermediate Oil (WTI)
ETFS Physical Swiss Gold Shares	9/9/2009	SGOL	100% Spot Gold (Long)
ETFS Physical Platinum Shares	8/1/2010	PPLT	100% Spot Platinum (Long)
ETFS Physical Palladium Shares	8/1/2010	PALL	100% Spot Palladium (Long)
ETFS Silver Trust	24/7/2009	SIVR	100% Spot Silver (Long)
Proshares Ultra Gold	3/12/2008	UGL	100% Spot Gold (Long - Leveraged x2)
Proshares Ultra Silver	3/12/2008	AGQ	100% Spot Silver (Long – Leveraged x2)
Proshares Ultra-short Gold	3/12/2008	GLL	100% Spot Gold (Short – Leveraged x2)
Proshares Ultra-short Silver)	3/12/2008	ZSL	100% Spot Silver (Short – Leveraged x2)
United States Oil Fund	24/9/2009	DNO	100% Short West Texas Intermediate Oil (WTI)
Powershares DB Base Metal Fund	5/1/2007	DBB	35% Copper Futures, 35% Aluminium Futures, 30% Zinc Futures (Long)
RICI Agriculture ETN	18/10/2007	RJA	20% Wheat, 13.5% Corn, 11.5% Cotton, 8.5% Soybeans, 6% Live Cattle, 6% Sugar, 6% Coffee, 6% Soybean Oil, 3% Lumber,3% Lean Hogs (All Long Futures)
Powershares DB Precious Metals Fund	5/1/2007	DBP	80% Gold, 20% Silver (Long Futures)
Powershares DB Gold Fund	5/1/2007	DGL	100% Gold Futures (Long)
Powershares DB Energy Fund	5/1/2007	DBE	23% Gasoline RBOB, 22.5% Heating Oil, 22.5% Brent Crude Oil, 22% West Texas Intermediate, 10% Natural Gas (Long Futures)
United States 12 Month Oil Fund	6/12/2007	USL	100% West Texas Intermediate Oil (Long Futures)
iPath Dow Jones – UBS Grain ETN	23/10/2007	JJG	45% Soybeans, 30% Wheat, 25% Corn (Long Futures)
iPath Dow Jones – UBS Natural Gas ETN	23/10/2007	GAZ	100% Natural Gas (Long)
iPath Dow Jones – UBS Copper ETN	23/10/2007	JJC	100% Copper (Long)
Powershares DB Commodity Index Tracking Fund	3/2/2006	DBC	12.5% WTI, 12.5% Brent Crude, 12.5% Heating Oil, 12.5% RBOB, 5.5% Natural Gas, 8% Gold, 2% Silver, 4% Aluminium, 4% Zinc, 4% Copper, 5.5% Corn, 5.5% Wheat, 5.5% Soybeans, 5.5% Sugar.
iPath Dow Jones – UBS Commodity ETN	6/6/2006	DJP	20% Industrial Metals, 25% Energy, 13% Precious Metals, 6% Livestock, 30% Agriculture
Powershares DB Agriculture Fund	5/1/2007	DBA	14% Live Cattle, 13% Coffee, 13% Soybeans, 12% Corn, 12% Wheat, 11% Cocoa, 10% Lean Hogs, 10% Sugar, 5% Feeder Cattle, 3% Cotton (Long Futures)
iShares GSCI Commodity Index	21/7/2006	GSC	71% Energy, 13% Agriculture, 7% Industrial Metals, 4.5% Livestock, 3.5% Precious Metals
iPath S&P GSCI Crude Oil Index ETN	15/8/2006	OIL	100% Futures West Texas Intermediate (Long)
Powershares DB Oil Fund	5/1/2007	DBO	100% Futures West Texas Intermediate (Long)
Powershares DB Gold Double Long ETN	28/2/2008	DGP	100% Gold Futures (Long)
Proshares Ultra DJ-UBS Crude Oil	25/1//2008	UCO	100% Futures West Texas Intermediate (Long)
E-TRACS UBS Bloomberg CMCI Gold ETN	1/4/2008	UCI	100% Gold Futures (Long)
Powershares DB Silver Fund	5/1/2007	DBS	100% Silver Futures (Long)
iPath Dow Jones – UBS Platinum ETN	25/6/2008	PGM	100% Platinum Futures (Long)
United States Natural Gas Fund	18/4/2007	UNG	100% Natural Gas (Long Futures)
Powershares DB Gold Double Short ETN	28/2/2008	DZZ	100% Gold Futures (Short)
iPath Dow Jones – UBS Sugar ETN	25/6/2008	SGG	100% Sugar Futures (Long)
iPath Dow Jones – UBS Livestock ETN	24/10/2007	COW	69% Live Cattle, 31% Lean Hogs (Long Futures)
Powershares DB Crude Oil Double Short	17/6/2008	DTO	100% Crude Oil Futures (Short – Leveraged x2)
E-TRACS UBS Bloomberg CMCITR Long Platinum ETN	9/5/2008	PTM	100% Platinum Futures (Long)
Powershares DB Base Metal Double Long ETN	18/6/2008	BDD	33% Aluminium, 33% Zinc, 34% Copper (Grade A)
iPath Dow Jones – UBS Coffee ETN	25/6/2008	JO	100% Coffee Futures (Long)
Proshares Ultra-Short DJ-UBS Crude Oil	25/11/2008	SCO	100% West Texas Intermediate Oil (Short – leveraged x2)
United States 12 Month Natural Gas Fund	18/11/2009	UNL	100% Natural Gas Futures (Long)
Powershares DB Gold Short ETN	29/2/2008	DGZ	100% Gold Futures (Short)

The Exponential GARCH model (EGARCH) was first developed by Nelson (1991). The ARCH(p) and GARCH(p,q) models impose symmetry on the conditional variance structure, which may not be appropriate for modelling and forecasting stock return volatility. EGARCH models capture the most important stylise features of return volatility, namely time-series clustering negative correlations with returns, log-normality and with other certain specifications, long memory (Brandt and Jones, 2006). Nelson (1991) proposed the EGARCH model as opposed to the GARCH model to deal with these issues. Under the EGARCH(1,1) framework, the conditional log variance is calculated as:

$$R_t = bx_t + \varepsilon_t$$

$$\text{where } \varepsilon_t|\Omega_{t-1} \sim N(0, h_t)$$

$$\log(h_t) = \omega + \alpha\left[\frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}}\right] + \beta\log(h_{t-1}) + \delta\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \quad (1)$$

The parameters ω, α, β and δ are constant. The EGARCH model has two advantages over the GARCH model. First, the logarithm construction of the conditional variance equation ensures that the estimated conditional variance is strictly positive, thus the non-negativity constraints used in the estimation of the ARCH and GARCH models are not necessary. Also, the parameter δ typically enters the conditional variance equation with a negative sign, thus bad news, $\varepsilon_t < 0$ generates more volatility than good news. In the EGARCH model used, the dependent and independent variables remain similar to those used in the GARCH analysis:

$$R_t = b_0 + b_1R_{t-1} + b_2R_{USD_t} + b_3R_{DJIA_t} + \varepsilon_t$$

$$\text{where } \varepsilon_t|\Omega_{t-1} \sim N(0, h_t)$$

but the specification of the conditional variance equation now becomes:

$$\log(h_t) = \omega + \alpha\left[\left|\frac{\varepsilon_{t-j}}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}}\right|\right] + \beta\log(h_{t-1}) + \delta\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \gamma D_{ETF_t} \quad (2)$$

h_t is known at the beginning of time t. Ω_{t-1} is the information set at the end of time period t-1 which makes the leverage effect exponential instead of quadratic and therefore, estimates of the conditional variance are guaranteed to be non-negative. In the mean equation, R_t represents the daily return of the individual commodity investigated, R_{t-1} represents the lagged one day before return and R_{USD_t} represents the daily return of the United States weighted exchange rate basket included. R_{DJIA_t} represents the daily return of the Dow Jones Industrial Average as a measure of equity market performance. D_{ETF_t} is included in the variance equation of both equation one and two as a representation of the dummy variable included in the EGARCH models denoting the arrival of CFDs.

The EGARCH model allows for the testing of asymmetries, which are picked up in the β term. When $\beta = 0$, the model is symmetric, but when β <0, then positive shocks generate less volatility that negative shocks. The model captures the asymmetric features of the dataset, which occur when an unexpected drop in price due to bad news increases volatility more than an unexpected increase in price because of good news of a similar magnitude. The model expresses the conditional variance of the variables as a non-linear function of its own past standard innovations. The EGARCH model is found to be the most optimal methodology to investigate volatility changes between periods. The inclusion of the international financial variables to adapt the model for 'international effects' is also found to be beneficial when attempting to segregate and investigate commodity market volatility behaviour before and after the arrival of ETFs.

4. Results

A four moment analysis shows some interesting dynamic shifts in commodity markets from the pre-ETF to post-ETF period. The four moments (mean, variance, skewness and excess kurtosis) are compared between the two periods in table four. Mean return falls in fourteen of the twenty commodity exchanges investigated in the period after the arrival of ETFs. The largest fall is in the market for cotton, which is a deeply illiquid market when compared to highly liquid exchanges such as oil and gold. Fifteen exchanges experience increased variance and twelve experienced more positive skewness. Fifteen exchanges also experience a decrease in kurtosis. The market for cotton again shows a dramatic increase in kurtosis in the period after the arrival of ETFs.

Table 4: Four moment analysis statistics of the commodity markets investigated

	Mean		Variance		Skewness		Excess kurtosis	
Exchange	**Pre-ETF**	**Post-ETF**	**Pre-ETF**	**Post-ETF**	**Pre-ETF**	**Post-ETF**	**Pre-ETF**	**Post-ETF**
Silver (L)	-0.039	-0.017	0.024	0.058	2.422	1.374	31.817	8.652
Gold (H)	-0.029	-0.051	0.001	0.019	-0.358	0.279	4.771	4.741
Aluminium (L)	0.003	-0.032	0.012	0.033	-0.629	-0.269	5.115	0.877
Brent Crude (H)	0.029	-0.019	0.057	0.076	-0.793	-0.106	4.133	4.403
Coffee (L)	-0.006	-0.001	0.052	0.029	-0.297	-0.673	7.142	3.081
Copper (L)	0.035	-0.071	0.016	0.056	-0.454	-0.186	5.597	1.779
Corn (H)	-0.043	0.031	0.050	0.052	-0.396	-1.001	3.551	7.241
Cotton (L)	-0.015	-0.351	0.049	0.026	-0.925	-2.568	25.897	91.893
Feeder Cattle (L)	0.011	0.014	0.005	0.006	-0.989	-0.532	11.664	2.501
Gas. RBOB (H)	0.059	-0.019	0.091	0.083	-0.442	-0.147	7.331	2.447
Lean Hogs (L)	0.034	0.001	0.014	0.017	-0.475	-0.181	3.296	2.095
Live Cattle (H)	0.011	0.014	0.005	0.006	-0.989	-0.532	11.664	2.501
Natural Gas (H)	0.122	-0.079	0.011	0.018	0.002	-0.076	1.697	1.462
Palladium (L)	-0.027	0.134	0.051	0.049	-0.582	-1.046	5.037	2.819
Platinum (L)	0.035	0.022	0.025	0.015	-0.668	-1.097	5.691	3.809
Soybeans (H)	0.006	0.005	0.025	0.038	-0.751	-0.488	14.819	2.074
Sugar (H)	0.012	-0.002	0.039	0.054	-0.289	-0.353	1.482	1.405
Wheat (H)	0.025	-0.043	0.034	0.086	0.295	-0.344	2.087	2.386
WTI (H)	0.032	-0.023	0.057	0.076	-0.787	-0.106	4.116	4.467
Zinc (L)	-0.012	-0.053	0.015	0.063	-0.402	-0.189	3.763	1.219

Note: The above table reports the findings of the four moment analysis comparing volatility dynamics in the period prior and post-ETF introduction. The reported coefficients are based on the average introduction, across all ETFs introduced, by commodity market investigated.

The inclusion of a dummy variable in the volatility equation, equal to zero in the period before ETF introduction and one thereafter, provides a coefficient denoted as gamma (γ) which measures the volatility change between the periods before and after ETF introduction. External sources of volatility stemming from currency and equity markets are controlled by the inclusion of an equity term (DJIA) and a currency term (US$) in the mean equation of the EGARCH model, providing results as closely associated to commodity market dynamics as possible.

To segregate the results by market size, the estimated market capitalisation of the commodity market is used (Bloomberg, 2012). Larger commodity markets are usually more liquid, therefore more capable of absorbing the new large-scale investment. These markets are found to remain relatively unaffected from large scale investment associated with ETFs. But the hypothesis being tested is based on the presence of 'noise traders[12]' using ETFs as a platform to enter and exit commodity markets quickly and cheaply with their presence influencing commodity market volatility dynamics. Table five displays the estimated gamma coefficients based on the EGARCH investigations for each of the included ETFs. The associated commodity market is also included, and in situations where there are

[12] A noise trader is described as a trader whose decisions to buy, sell or hold are irrational and erratic. The presence of noise traders in financial markets can then cause prices and risk levels to diverge from expected levels, even if all other traders are rational. In finance, noise obtained a formal definition in a 1986 paper by Fischer Black: 'Noise in the sense of a large number of small events is often a cause factor much more powerful than a small number of large events can be'.

multiple commodity investments for a single ETF, the date of fund initiation is deemed the appropriate date to use the dummy variable in the EGARCH methodology.

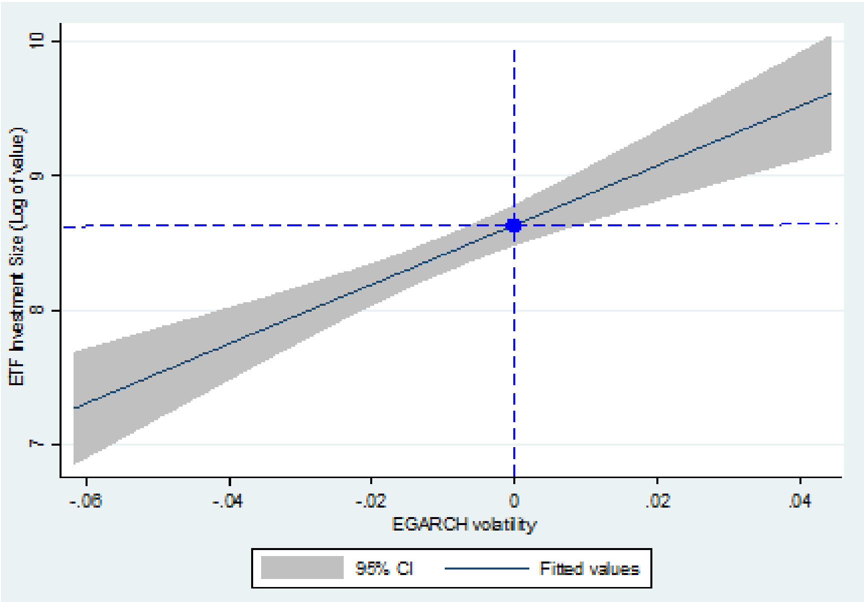
Table 5: EGARCH(1,1) results for individual commodity ETFs under investigation

ETF Ticker - Commodity	γ coefficient	ETF Ticker – Commodity	γ coefficient
SLV – Silver	0.001	JJG – Wheat	0.029*
SIVR – Silver	-0.006***	JJG – Corn	0.019*
AGQ – Silver	-0.007*	DBC – WTI	-0.007*
ZSL – Silver	-0.007*	DBC – Crude Oil	-0.008*
DBS – Silver	0.004	DBC – Gold	0.012*
GLD – Gold	0.003***	DJP – Corn	0.025*
IAU – Gold	0.004***	DBC – Corn	0.019*
SGOL – Gold	-0.008*	DBC – Natural Gas	-0.005
UGL – Gold	-0.009*	DJP – Natural Gas	-0.001
GLL – Gold	-0.009*	DBE – Gasoline RBOB	-0.005
DBP – Gold	0.003***	BDG – Aluminium	0.014
DGL – Gold	0.004***	DBE – Crude Oil	-0.005**
DGP – Gold	0.005***	DBE – WTI	-0.006**
UCI – Gold	-0.002***	DBC – Gasoline RBOB	-0.007
DZZ – Gold	0.005***	BDG – Zinc	0.006***
DGZ – Gold	0.005***	DBC – Soybeans	-0.001
PGM – Platinum	0.021*	DBC –Wheat	0.019*
PTM – Platinum	0.020*	DJP – WTI	-0.007*
PPLT – Platinum	-0.011	DJP – Soybeans	0.001
PALL – Platinum	-0.004	DJP – Gold	0.012*
USO – WTI	-0.008*	DJP – Copper	0.001
DNO – WTI	-0.020*	DJP – Live Cattle	-0.029*
USL – WTI	-0.004	DJP – Wheat	0.021*
DBO – WTI	-0.006**	UGA – Gasoline RBOB	0.003***
OIL – Crude Oil	-0.006*	DBA – Live Cattle	-0.033*
UCO – Crude Oil	-0.009*	DBA – Coffee	0.013*
DTO – Crude Oil	-0.005***	DBA – Soybeans	0.002***
SCO – Crude Oil	-0.010*	DBA – Corn	0.021*
RJN – WTI	-0.004	DBA – Wheat	0.022*
DBP – Silver	0.004	DBA – Cocoa	0.013**
JJC – Copper	-0.001	DBA – Lean Hogs	0.013*
DBB – Aluminium	0.006***	DBA – Sugar	-0.008*
GAZ – Natural Gas	-0.002	DBA – Feeder Cattle	-0.033*
UNG - Natural Gas	-0.005	DBA – Cotton	-0.001
UNL - Natural Gas	-0.024*	BDG – Copper	0.001
JO – Coffee	-0.048*	RJA – Wheat	0.029*
SGG – Sugar	-0.003	RJA – Corn	0.019*
COW – Live Cattle	-0.016*	RJA – Soybeans	0.002***
COW – Lean Hogs	0.012*	JJG – Soybean	0.002***
RJA – Cotton	0.002		

Note: The above table gives the estimated γ coefficients for each investigated commodity market after the introduction of a new Exchange Traded Fund (ETF) based primarily on the investigated commodity market using the discussed EGARCH(1,1) methodology to investigate changes in volatility dynamics after ETF introduction. In the cases of multiple commodity investments for each ETF, the associated ticker and the commodity market invested are listed above. Robust standard errors for each result are marked in parentheses, where ***p<0.01, **p<0.05 and *p<0.10. The full associated EGARCH statistics are found in the appendices.

Figure 1 shows the relationship between EGARCH volatility and the size of the total ETF investment in their chosen commodity market. There is a clear positive relationship between EGARCH volatility and the size of the total ETF investment in the specific commodity market. It is also of significant interest that we can clearly segregate ETF investment and market size based on volatility increases and decreases. In this situation, markets with a value of ETF investment under $2.15 billion are associated with decreased EGARCH volatility post-ETF introduction based on the calculated gamma coefficients. This indicates that large funds have increased the volatility of the commodity markets they have invested in, with the daily rebalancing process identified in previous literature as potentially problematic. The CFTC (2011) also raised concerns about large ETF investments possessing the capabilities of dominating commodity markets through size effects. The results in this investigation support these concerns.

Figure 1: EGARCH volatility estimates and ETF investment size



Note: The above figure shows the relationship between the EGARCH volatility estimates by commodity market investigated and the relative size of the total investment by the ETF. The shaded grey areas represent the 95% confidence intervals of the observations fitted values. We can clearly see a positive relationship (correlation coefficient of +0.63). The dashed blue lines represent the point at which EGARCH volatility switches from positive to negative, which occurs at a total ETF investment size of $2.15 billion. Thus markets under this value are associated with decreased volatility stemming from liquidity benefits from ETF investment, whereas those markets above this value are associated with increased EGARCH volatility.

ETFs have provided a medium for all investors to easily and cheaply enter and exit commodity markets. Before the introduction of ETFs, these investors would have been unable to enter these same markets due to the high entry costs and margin levels involved. The results in this analysis indicate that smaller commodity markets have benefitted from the new inflow of investment capital stemming from ETFs. The reduced EGARCH volatility found in smaller commodity markets can be attributed to increased liquidity, which increases the flow of information in these markets. Alternatively, larger markets have obtained substantial ETF investment, which in some cases has reached levels close to fifty per cent of the total market size. This monopolistic style dominance stemming from these high ownership levels appears to have increased the volatility of the commodity markets in which these large ETFs invest.

5. Conclusions

Exchange Traded Funds (ETFs) have grown in recent years to become one of the most commonly used investment techniques across international financial markets. The diversification, leverage and ease of use have attracted numerous international investors. This paper specifically investigates whether ETFs amplified or influenced volatility in the period after their introduction.

The findings indicate large differences in volatility between large and small commodity markets in the period after ETF introduction. Larger ETF investments are found to be associated with increased EGARCH volatility. This supports numerous regulatory views (FSA, CFTC, among others) that large ETFs are having dominant effects on the markets in which they have invested. The dummy variable used in the EGARCH model appears significantly positive (representing a volatility increase) in 55 per cent of the ETF introduction scenarios investigated in this research. 28 per cent of the ETFs investigated show significantly negative EGARCH volatility, whereas 17 per cent of the results were positive but insignificant. Larger commodity markets appear to have been directly influenced by the market dominating effects of extremely large ETF holdings. Alternatively, smaller commodity markets appear to have benefitted from ETF investment, as the increased liquidity has improved the transfer of information. Overall, it appears that ETFs have made commodity markets more efficient through new trading counterparties, but this same benefit is associated with more EGARCH volatility. The potential negative market-dominating impacts associated with large ETF investments and their rebalancing processes cannot be rejected.

These findings support calls for more intense regulation of the ETF industry and more investigation into the investment practices and rebalancing processes of the funds in question. The need for regulation of investment size and the imposition of market ownership caps cannot be rejected.

References

Avellaneda, M., Zhang, S.J., 2009. 'Path-dependence of leveraged ETF returns, SIAM Journal of Financial Mathematics, 1(1), pp.586-603.

Antoniou, A., Holmes, P., 1995. 'Futures trading, information and spot price volatility: evidence for the FTSE-100 stock index futures contract using GARCH', Journal of Banking and Finance, 19(1), 117-29.

Antoniou, A., Holmes, P., Priestley, R., 1998. 'The Effects of Stock Index Futures Trading on stock index volatility: An Analysis of the Asymmetric Response of Volatility to News?' The Journal of Futures Markets, 18(2), 151-166.

Black, F., 1985. 'Noise', Journal of Finance, 41(3), pp.529-543.

Bologna, P., Cavallo, L., 2002, Does the Introduction of Stock Index Futures Effectively Reduce Stock Market Volatility? Is the 'Futures Effect' Immediate? Evidence from the Italian stock exchange using GARCH, Applied Financial Economics, 12(3), pp.183-192.

Brandt, M.W., Jones, C.S., 2006, Volatility forecasting with range-based EGARCH models, Journal of Business and Economic Statistics, 24(4), pp.470-486.

Chatrath, A., Ramchander, S., Song, F., 1995, Does Options Trading Lead to Greater Cash Market Volatility? Journal of Futures Markets, 15(7), pp.785-803.

Cheng, M. and Madhavan, A., 2009, The Dynamics of Leveraged and Inverse Exchange-Traded Funds, Journal of Investment Management, 7(4), pp. 43-62.

Cherry, J., 2004, The limits of arbitrage: Evidence from Exchange Traded Funds, Working Paper Series, University of California, Berkley, CA.

Drimbetas, E., Sariannidisb, N., Porfiris, N., 2007, The effect of derivatives trading on volatility of the underlying asset: evidence from the Greek stock market, Applied Financial Economics, 17(2), pp.139–148.

Financial Services Authority, United Kingdom, 2011. 'Retail Conduct Risk Outlook 2011', November, pp.1-96.

Gastineau, G., 2004, The benchmark index ETF performance problem, A simple solution, Journal of Portfolio Management, 30(2), pp.96-103.

Gastineau, G., 2008. 'Exchange Traded Funds', John Wiley and Sons, ISBN:9780470404324.

Harper, J.T., Madura, J., and Schnusenberg, O., 2006, Performance comparison between exchange-traded funds and closed-end country funds, Journal of International Financial Markets, Institutions and Money, 16 (2), pp.104-122.

Hughen, J.C., 2003, How Effective is Arbitrage of Foreign Stocks? The Case of the Malaysia Exchange-Traded Fund, Multinational Business Review, 11(2), pp.17-27.

Humphries, W.M., 2010, Leveraged ETFs: The Trojan horse has passed the margin-rule gates, The Seattle University Law Review, Fall.

Jares, T.E., Lavin, A.M., 2004. 'Japan and Hong Kong Exchange Traded Funds (ETFs): Discounts,

Returns and Trading Strategies', Journal of Financial Services Research, 25(1), pp.57-69.
Kosev, M., Williams, T., 2011. 'Exchange Traded Funds, Reserve Bank of Australia Bulletin, March, pp.51-60.
Kalaycioglu, S., 2006, Exchange Traded Fund Flows, Working Paper Series, Simon Graduate School of Business, University of Rochester, February.
Knain-Little, P., 2010, Inverse and leveraged ETFs: Not your father's ETF, The journal of index investing, 1(1), pp.83-89.
Kumar, R., Atulya S., Kuldeep S., 1995, The Impact of the Listing of Index Options on the Underlying Stocks, Pacific-Basin Finance Journal, 3(1), pp.303-317.
Jing, W., 2006. 'Empirical study on the impact of the SHSE 50 ETF component stocks', Security Market Herald, 2006-05.
Lu, L., Wang, J., Zhang, G., 2009, Long-term performance of leveraged ETFs, Working Paper Series, Baruch College, August.
Madura, J., Ngo, T., 2008, Impact of ETF inception on the valuation and trading of component stocks, Applied Financial Economics, 18(12), pp.995-1007.
Madura, J., Richie, N., 2004, Overreaction of Exchange Traded Funds during the bubble of 1998-2002', Journal of Behavioural Finance, 5(2), pp.91-104.
Miffre, J., 2007, Country-specific ETFs: an efficient approach to global asset allocation, Journal of asset management, 8(1), pp.112-122.
Milonas, N.T., Rompostis, G.G., 2006, Investigating European ETFs: the case of the Swiss Exchange traded Funds, presented at the 2006 Conference of HFAA in Thessaloniki, Greece.
Nelson, D.B., 1991, Conditional heteroskedasticity in asset returns: a new approach, Econometrica, 59(2), pp.347-370.
Pilar, C., Rafael, S., 2002, Does Derivatives Trading Destabilize the Underlying Assets? Evidence from the Spanish Stock Market, Applied Economics Letters, 9(2), pp.107-10.
Pok, W. C., Poshakwale, S., 2004, The impact of the introduction of futures contracts on the spot market volatility: the case of Kuala Lumpur stock exchange, Applied Financial Economics, 14(1), pp.143–54.
Robinson, P., Loder, A., Bjerga, A., 2010. 'ETFs imperil investors as contango, pre-roll conspire', July 23rd, Bloomberg News.
Rompotis, G.G., 2008. 'Performance and trading characteristics of German passively managed ETFs, International Journal of Finance and Economics, 15(1), pp.210-223.
Rompotis, G.G., 2009. 'Active vs. Passive Management: New evidence from Exchange Traded Funds, National and Kapodistrian University of Athens, Greece, Working Paper Series, February.
Stein, J.C., 1987. 'Information Externalities and Welfare Reducing Speculation', Journal of Political Economy, 95(1), pp.1123-45.
Tang, K. Xiong, W. 2009. Index investing and the financialization of commodities. Working Paper, Princeton University, Princeton NJ.
Trainor, W.J., 2010. 'Do leveraged ETFs increase volatility?', Technology and Investment, 1(1), pp.215-220.