Master Thesis - MSc. Financial Economics

The effect of OPEC announcements on precious metal futures.

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ABSTRACT

Since the 2000s the financialization of commodities have increased the correlations among energy and metals, notably to non-energy commodities. The OPEC cartel commands a large presence across global markets, with its influence during their scheduled announcements. Their decision to cut, maintain or increase the quota of oil production can send signals affecting the short-term volatility and price action of energy and non-energy commodities. Gold is known to exhibit a positive relationship with oil especially in times of uncertainty and times of crisis. A link was established between the metals' futures' prices through the lens of oil supply news examining the volatility and Cumulative Average Abnormal Returns (CAARs)s of 5 precious metals using an event study around the week of an OPEC announcement. This event-study explores a connection between commodity markets and oil supply news. My results showed Gold having positive CAARs for decisions to cut and increase, with Silver, Copper and Palladium contrasting with negative CAARs over the event window.

Keywords: OPEC, Oil price, Gold, Silver, Copper, Platinum, Palladium, VIX, OVX, GVZ, DXY, Commodities, Futures, Precious Metals, USD, Event-Study

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CHAPTER 1 Introduction

Energy and commodities power the world economy, with oil and gold center stage (BP Statistical Review of World Energy, 2022). Petroleum is a critical input for modern economies with its use stretching from fuel for transport and heating to plastic and chemicals manufacturing. Oil supply shocks can therefore affect many industries, as too sharp of an increase in energy can strain profit margins. This research paper will focus on the effects of OPEC and their regular announcements regarding their supply of oil on the precious metals futures markets. The inspiration behind the motivation to choose this topic of analysis was Tang and Xiong's (2012) journal article *Index Investment and the Financialization of Commodities,* in which they analyzed the increase in correlations of energy commodities that were included in a GSCI commodity index versus those that weren't during the early 2000s. The rise in the prices of commodities over the 2000s has been termed the 'financialization of commodities.' In this period coinciding with the great financial crisis, the price of oil hit its hit nominal high in US Dollars at $145 which caused a massive decrease in demand. Other commodities such as gold and silver began to be traded alongside oil as a speculative investment and hedge. This increased the correlations between oil and other non-energy commodities. Even agricultural commodities such as soybeans or corn became more linked to oil because of its substitutive use with ethanol. An influx of 185 billion dollars (Tang & Xiong 2012), from 2003-2008 by mutual funds, hedge funds and institutional investors was a large catalyst we cannot forget to mention. During this period, commodities prices and volatilities increased substantially. This caught the attention of the public and politicians, leading to calls for governmental regulation to address the commodity bubble, and deflate its effects. Nonetheless this was before the US became an energy exporter and so was more reliant on oil as an import, and so OPEC's power was stronger in the oil market. Since then, the US introduced a low-cost method of extraction through shale, ultimately giving the US energy independence. This benefitted the US and Dollar traders with oil prices above $120 in 2008 not seen again until after 14 years later in 2022.

Gold, seen as an inflation hedge and safe haven during times of elevated volatility has shown to be used to hedge supply disruptions in the oil industry. Positive correlations between oil and gold and between gold and other metals is evidenced to be positive, especially during times of heightened volatility (Capie et al., 2005; Pukthuanthong and Roll, 2011; Reboredo, 2013) This leads to my main research question:

Are OPEC announcement decisions a driver of returns and volatilities across the precious and industrial metals markets?

This analysis was performed in two dimensions: returns and volatility. The returns portion was answered via an event-study approach that studied the effects of OPEC decisions on 5 commodity futures: Gold, Silver, Copper, Platinum and Palladium. Volatility was examined through a regression analysis against five prominent macroeconomic indicators: the three implied volatility indicators for the US equity, oil and gold markets respectively being the VIX, OVX and GVZ, as well as the Dollar Exchange Index (DXY), a strength barometer for the US Dollar against a basket of six major currencies, and the Producers Price Index (PPI), a gauge for inflation among prices for wholesalers.

The price per barrel of oil has been quite volatile over the past fifty years due to economic and technological progress, supply-side volatility due to geopolitical conflicts, and pushback from electorates regarding climate change emissions in the midst of this the current wave of globalisation and communication but with supply and demand being the cornerstones. The older generations know all too well about the oil crises in the 1970s and 1980s during which the price of oil spiked due to wars in the Middle East and the US Dollar decoupling from the price of gold, forcing Western countries to ration their consumption and find alternative energy sources to not be so reliant on oil as an import. The fact of the matter is that modern life as we know it would be impossible without this commodity (Penrose, 1979). Oil plays a key role in daily life such as in energy generation, transport and as an input for an enormous amount of plastic manufacturing. OPEC, the Organisation of Petroleum Exporting Countries, lead by international energy ministers has always grabbed my attention due to their powerful influence on the supply of oil and emotions of Western government ministers. Most oil reserves and production in the world occurs in OPEC countries, especially in the Gulf Region. Their actions regarding the variations in their own supply, when acting in cooperation with other OPEC members influence the world price of oil for consumers. The effects of OPEC's decisions on prices of oil futures have been widely documented in literature. Previous studies relied solely on conventional wisdom to formulate their expectations about the effects of OPEC decisions on price movements of oil (Draper, 1984; Loderer, 1985; Deaves & Krinsky, 1992; Guidi et al., 2006; Bina & Vo, 2007; Demirer & Kutan, 2010; Kanzig, 2021). Much of the research indicates that a decrease in oil output produces positive abnormal returns in the oil market, since the decrease in supply leads to a price increase; an increase in oil output induces negative abnormal returns due to an increase in supply, and "normal" returns when the decision is to maintain oil output. To do so, these papers had to assume that the investor's expectation of oil demand remained constant around the event-window. For the consumer, oil's finished products seem to have a relatively inelastic demand. Over the long run, consumers and producers can switch their energy inputs with more flexibility, such as using renewable energy with Tesla automobiles instead of petrol and gasoline powered cars, or gathering energy from solar panels or wind turbines. However, in the short to medium term, consumers have been known to suffer either higher oil prices or a lower standard of living. Despite this, consumers do not set the price of oil. Oil traders and speculators are behind the daily volatile price movements. With OPEC meeting dates known months beforehand, traders have an advantage if they can predict the outcome of the meeting. However, decisions to cut, increase or maintain the production of oil do not always transfer to prices linearly. The decision can be affected by many factors such as the current and future outlook for the supply and demand of the oil market, geopolitical tensions and the strength of the Dollar as mentioned. The price action of oil is also influenced by these factors before, during and outside the event window of the OPEC meeting. OPEC claims to be an independent intergovernmental organisation however their actions can be seen to be more political than economical.

Following on from our discussion about ‘black gold’ aka oil, yellow gold constitutes another one of the most highly traded commodities and one of humans’ oldest stores of wealth. While not used as an energy input, it is the most strategic asset available to governments, individuals and institutional traders. Its popularity in jewellery across civilizations goes back millennia. Now the nonphysical version, its ticker, gold and the futures and options traded on them, is also considered a haven during times of uncertainty and can act as a hedge to increases in the oil price. Gold, the most highly traded metal also shares a link to the other metals markets. As papers below show, gold is positively correlated with the other precious metals and base metals. Exploring the price reaction and volatility of these precious metals to varying OPEC announcements is paramount to me in this paper. Since the release of Al Gore’s *An Inconvenient Truth* in 2006, there has been a serious push in the West from climate lobbyists on their governments to reduce the amount of harmful byproducts emitted from the use of fossil fuels – notably coal and oil. This has led to the invention of hybrid and electric cars. These electric cars, like smartphones that have become ubiquitous, require batteries to store their energy. These batteries contain the metals copper and lithium. Coupled with the economic progress of highly populated countries such as India and China, the overall demand for these metals has increased a lot. Also, gold is mined and extracted from other metals such as silver and copper so the supply of many can increase or decrease at the same time. Unlike oil and other energy commodities, the same equipment to mine can be used for different metals.

This thesis will add to the body of literature linking the energy and commodities markets by exploring a new channel, oil supply news, using an event-study approach. With OPEC controlling 44% of the global oil production (OPEC), they are a major source of news to the oil market. Hence this thesis will focus on those scheduled supply shocks to the commodity markets. It is common for oil prices to rise before a recession or for a recession to be caused by high oil prices. This paper’s results are significant for traders, central bankers and producers as a rise in commodity prices or their future implied volatility ratios could be seen to be a pre-warning indicator for a recession or possible inflation. My topic is unique as while past research has also examined past OPEC event-study meetings, oil and gold’s relationship, gold and other metals positive correlations, none of these interlace these connections and analyze the metals futures market during the period of an OPEC meeting.

As I conduct my research in 2024, currently OPEC and OPEC + have agreed to production cuts this year. In addition, tensions in the Middle East and Black Sea, both of which have some of the world’s leading oil reserves have created concerns about supply disruptions in the short term, keeping oil prices elevated. Similarly, gold has been on a ferocious ascent with it rising from $1,800 before the October 7th 2023 Hamas attack on Israel, to present day August 2024, with gold hovering just below $2,500 an ounce. With heightened geopolitical risk, and commodities such as gold and copper at all-time nominal highs, there is not a better time to examine this relationship.

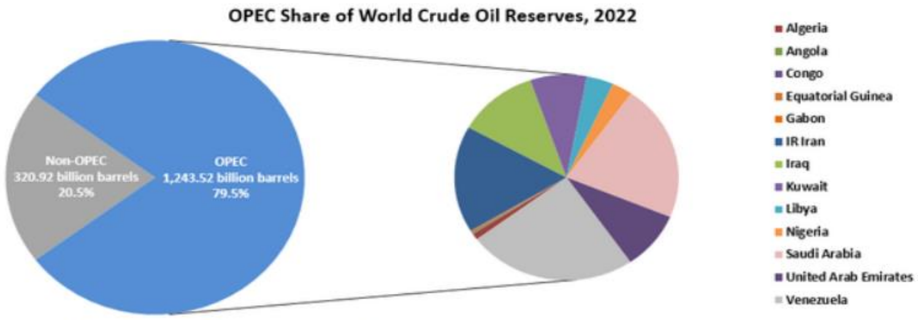
The remainder of this paper is structured as follows. Section 2 discusses relevant literature and previous research. Section 3 introduces the dataset used for the analysis. Section 4 discusses the methodology used. Section 5 presents the main results of the study, including a test of the proposed hypotheses. Section 6 discusses the main findings and provides a conclusion and summary of the research. Additional supportive materials and descriptive statistics are provided in the Appendix.

CHAPTER 2 Literature Review

2.1 OPEC

Up until the 1970s, the Seven Sisters, a group of 7 multinational oil companies based in the US dominated global petroleum production. Colgan (2021) states that these 7 companies in the 1960s reduced the price of oil for Venezuela and Middle Eastern producers, provoking anger among oil-producing governments, which led to the formation of OPEC, the Organisation of Petroleum Exporting Countries. An intergovernmental organisation founded in 1960 by 5 oil producing nations (Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela), their initial goal was to wrest control from the Seven Sisters which it succeeded in doing in the early 1970s. As early as 1972, the Seven Sisters agreed to give OPEC members a 25 percent equity share in their private oil companies, and over the course of the 1970s, most OPEC members nationalized their oil companies, leading to the reduction of power of these private companies. In 1973, OPEC produced 58 percent of the world's crude oil, but by 1985 this share had sunk to 28 percent, with OPEC's share of world oil exports falling from 71 percent in 1980 to 48 percent in 1985. The decline was partially caused by political events, such as the Iran-Iraq War in 1980. But the largest factor was the attempt to keep prices high (Kemp and Van Doren 2023).

The organisation members have varied minimally over the years: Qatar (1961), Indonesia (1962), Libya (1962), the United Arab Emirates (1967), Algeria (1969), Nigeria (1971), Ecuador (1973), Gabon (1975), Angola (2007), Equatorial Guinea (2017) and Congo (2018). According to OPEC's website 79.5% (1,243.52 billion barrels) of the world's proven oil reserves are located in OPEC Member Countries, with the bulk of OPEC oil reserves in the Middle East, amounting to 67.2% of the OPEC total. OPEC's role is unique because it aspires to reduce price volatility directly - by acting as a swing producer that offsets physical shocks to supply and demand rather than simply mitigating the cost of price shocks after they have occurred. Through their desired control of volatility in the oil market, they establish individual quotas for their members. If abided, these production quotas are an attempt to limit the supply and push the price of oil in their favoured direction. With most oil reserves under the control of governments particularly those of OPEC member nations through national oil companies, this limits the power of private companies who own little in the way of reserves. They might have access to reserves by contract, but since most contracts are with governments, even those can be eliminated instantly. For example, ExxonMobil and ConocoPhillips investments in Venezuela were abandoned without compensation in 2007 after the government demanded a doubling of its share in the projects (Morriss & Meiners 2013).



OPEC proven crude oil reserves, at end 2022 (billion barrels, OPEC share)

Venezuela	303.22	24.4%	United Arab Emirates	113.00	9.1%	Algeria	12.20	1.0%	Equatorial Guinea	1.10	0.1%
Saudi Arabia	267.19	21.5%	Kuwait	101.50	8.2%	Angola	2.55	0.2%			
IR Iran	208.60	16.8%	Libya	48.36	3.9%	Gabon	2.00	0.2%			
Iraq	145.02	11.7%	Nigeria	36.97	3.0%	Congo	1.81	0.1%			

Source: OPEC Annual Statistical Bulletin 2023

[1]OPEC's decisions are known to be economical as well as political (Kanzig 2021). Colgan (2020) argues that OPEC is in fact not a cartel nor has economic influence but that it does have influence on market prices of oil in the short term. He attributes this to OPEC statements regarding fundamentals such as production levels affecting market psychology affecting oil prices. He labels their perceived market power as a 'rational myth' - an idea that is illusory or false but persists in part because some actors have incentives to sustain it (McNamara, 2002). This supports the organisation's true principal function, which is to act as a political club generating benefits for its members. That its cartel reputation is an integral source of political strength for the organization. This myth can be known by non-OPEC actors to be incorrect, but few of them have strong incentives to contradict it. Western media and politicians are more than willing to scapegoat the institution with antitrust lawsuits such as the No Oil Producing Exporting Cartels (NOPEC) Act in 2004 attempted to punish and blame the cartel but were not carried through. Other NOPEC bills have been introduced at least 15 times since 1999, though to date none have passed (Verrastro et al., 2011). As of June 2024, 23 US Democrats seek probe of allegations between the oil industry and the OPEC.[2] The lack of enforcement and frequent cheating on OPEC quotas by members suggests that it is more a political club than an effective oil cartel. Members exceed their quota frequently as there are no incentives to comply especially if other countries are violating the quota or not releasing output statistics. OPEC nations are highly reliant on oil revenues so producing and selling more oil at a higher price would allow them to earn more revenue. Angola, in December 2023, decided to leave the organisation because of too deep a cut they had to make individually. [3] Colgan (2020) also shows that countries regularly exceed their quota, with the average among OPEC-9 members; Algeria, Iran, (no Iraq), Kuwait, Libya, Nigeria,

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[1] https://www.opec.org/opec_web/en/data_graphs/330.htm
[2] https://www.reuters.com/markets/commodities/schumer-asks-doj-investigate-ftc-claim-oil-exec-colluded-with-opec-2024-05-30/
[3] https://www.reuters.com/business/energy/angola-quit-opec-reducing-membership-12-countries-2023-12-22/

Qatar, Saudi Arabia, UAE and Venezuela exceeded their production quota 96% of the months from 1982 to 2009.

Traders likely understand that OPEC is not a cartel, but they do not care. They still pay attention to OPEC because of how loud a voice they demand in oil and energy markets. An increase in volatility in oil markets is known to occur around their scheduled announcements (Kanzig 2021). Thus, its rational to observe OPEC even if they believe that the organization itself does not alter market fundamentals as not paying attention to one of the most significant events in energy markets could have serious consequences for one's portfolio. Colgan (2020) compares this to the way observers pay attention to the White House press secretary for clues about the president's thinking, even though the press secretary has no real power of their own. Instead, they are principally interested in OPEC as shorthand for 'the members of OPEC' (Colgan 2020). Saudi Arabia appears to wield significant market power: it claims to have substantial spare capacity as it depletes its oil reserves quite slowly, likely well below its marginal cost of production and it makes major, observable adjustments to its oil production levels that somewhat correlate with its statements about intentions to either loosen or tighten the global oil supply (Colgan 2020). The Kingdom's breakeven price was originally for an average to be kept above $80 reported in May 2023. However, by February 2024, Bloomberg has raised SA's oil price target to above $90 to balance their budget.[4] Thus, the country's economy is still highly dependent on petrodollars to fuel their economy.

Over the last two decades OPEC and the world has had to respond to four unanticipated steep oil supply shocks, including the 2007–2008 Global Financial Crisis, the 2014 oil price collapse, the COVID pandemic, and the June 2021–August 2022 energy crisis caused by the war in Ukraine. The price of a barrel of WTI oil has had some ferocious increases as well as steep drop offs. From a low of $17 in 2001 to a peak of $144 in July 2008 before decreasing to a trough of $35 to December 2008. In 2008, the consistent decline in US oil and natural gas production flipped with the introduction of horizontal drilling combined with fracking producing the so-called shale gas and tight oil revolution. This introduction of low-cost oil clouded OPEC producers plans leading to the formation of OPEC+ in December 2016. This was a signal event in the history of the world oil market, establishing for the first time in OPEC's sixty-year history an agreement by which non-members would cooperate with OPEC in the effort to stabilize the price of oil. This expanded their market share to include influential exporters like Russia and Mexico. Adding Russia's supply and cooperation with OPEC through OPEC+ strategically enhances the cartel's market share and power. Recent shocks to the global economy with the Covid-19 pandemic shutdown forced OPEC to cut their oil production. In March

[4] https://www.bloomberg.com/news/articles/2024-02-05/saudi-oil-needs-go-up-as-fitch-says-budget-balances-at-over-90

2020 with transport and trade heavily disrupted by the governmental reactions to the coronavirus, authorities raced to shut down their economies in attempting to reduce the spread. With travel bans implemented and demand forcibly decreased, the outlook for oil was not bullish. Oil traders, noticing the large unused supply had been shorting the commodity well before the social restrictions were implemented. Not until April 2020, after one of OPEC's decisions to reduce oil output in these times of crises were they able to stabilize the price of oil temporarily. This came after US oil futures prices turned negative due to a shortage of storage but later recovered with some assistance claimed by OPEC. Therefore, in this instance OPEC achieved its mission of stabilizing the price of oil. Thus, it can be argued that OPEC meetings can be a positive force across markets during times of crisis. However not all crises are the same. Other recent significant events such as the aftermath of the Russian invasion in 2022 caused major volatility in the energy markets when the price per barrel spiked to over $120 during the European energy crisis. Kemp and Van Doren (2023 2) suggest that OPEC nations appear to use oil production as an international bargaining chip to provide the regimes with domestic legitimacy. That the benefits of OPEC membership are only conferred as long as the West acts as if OPEC has power. Recently, in 2022, OPEC+ angered U.S. politicians amid the war in Ukraine when oil rose to more than $120 per barrel, their highest inflation-adjusted price in nearly a decade, despite large increases in OPEC+ production targets during the first half of the year. Western leaders urged further production increases. Instead, OPEC+ announced a two million barrel per day reduction in members' targeted production levels as prices fell to a little more than $90 per barrel in October 2022. The move was seen as a snub to the United States and President Biden and a decision by Saudi Arabia to align with Russia.

Thus, it is not solely a cartel among companies, but a diplomatic organisation. Many of the member countries operate their oil producing as a semi-state or full nationalized company, such as Saudi Aramco, the National Iranian Oil Company, Rosneft, and the CNPC. While China is not an OPEC+ member, their actions in Asian and geopolitics since the Russian invasion, suggest their support not as much for OPEC and its actions, but for OPEC members individually. These countries when zoomed out form the BRICS. Brazil, with Petrobras' has one of the largest oil reserves in the world have shown interest in becoming a member of OPEC+ as recently as 2023. India who abstained from a vote at the UN General Assembly in March 2022 to compel Russia to end its offensive in Ukraine has since quadrupled its oil imports from Russia (Schneider 2022, Luce 2022). Among developed nations, India is projected to grow the most from now until 2050 and will become the most populated country and with that a much larger demand for energy, specifically oil. From an estimated 259m tonnes of oil equivalent in 2023, India's oil demand in 2033 to rise to 372mtoe, making it the largest contributor to the world's oil demand growth over the next ten years.[5] In no other industry, internationally, is there a

[5] https://www.eiu.com/n/india-will-replace-china-as-the-driver-of-oil-demand-growth/#:~:text=We%20expect%20India's%20oil%20demand,over%20the%20next%20ten%20years

functioning legal cartel of this size with this much power. Its market also happens to be among the most traded commodities in the world, oil, whether it be Brent, West Texas Intermediate (WTI) or the OPEC Reference Basket (ORB), a weighted average of oil prices from various oil blends produced by OPEC members, all prices are almost perfectly positively correlated, and arbitrage is not possible. OPEC's market power comes into the limelight during their regularly scheduled meetings.

2.2 OPEC Event Window

At these regularly occurring meetings between member diplomats, announcements are made, culminating into OPEC's most significant press releases. These announcements come after OPEC discusses amongst individual energy minister what their individual and overall quotas are to be over the following weeks and months. These events are scheduled months beforehand and so are significant events across energy markets which are worthy of analysis. Previous research has analysed these exact event windows I wish to study. Much of the research has focused on the reaction to the oil futures, specifically WTI and Brent during the days prior to the meetings and even months after the announcements. This research is labelled event studies, during which the price action is measured across the prior few days and several days after, to analyse if there are any abnormal returns or spillover effects. Below is a meta table with the most significant OPEC event study research papers.

Author(s)	Event-Window	Period of Analysis	Variables/Emphasis/ Mode of Analysis	Results
MacKinlay (1998)	(-20,20)	Groundbreaking Initial Event Study.	Earnings disclosures. Categorized to one of three categories: good news, no news, or bad news.	Higher-than-expected earnings linked with increases in value of the equity and lower than expected earnings with decreases.
Hyndman (2008)	(-20,20)	52 meeting 1986-2002.	Quota agreements on WTI price.	Positive CAR of up to 5% when OPEC reduce their quota.
Demirer and Kutan (2010)	(-20,20)	62 meetings from 1982-2008	SPR prices proxied with the Dow Jones AIG commodity index. CAR used with Market model, ARCH model and Fama-French model.	For cut decisions, significant positive returns during the post event period window were found. No significant reaction to increase decisions. Evidence of return persistence on the downside for maintain decisions.
Lin and Tamvakis (2010)	(-10,+10)	87 meetings from 1982-2008	16 Different grades of Crude. Categorised into three price bands. CAR event methodology used.	Cut decisions produce significant and positive returns. Asymmetric reactions to OPEC decisions with cuts at

				relatively low prices giving negative and significant returns.
Jonsson and Lin (2011)	(-2,2)	2005 to 2007	Stockholm Stock Market specifically, the Energy, Telecommunications and Financial sectors. CAAR event methodology used.	No significant reaction to OPEC decisions in the Stockholm stock market.
Ji and Guo (2015)	(-5,5)	34 Meetings from 2004-2012	WTI prices to oil related shocks (supply-side), the global financial crisis (aggregate demand) and the Libyan war and OPEC conferences (precautionary demand). CAR, AR-GARCH models used.	Increases in oil production resulted in no significant impact on spot prices, while maintaining and reducing oil production resulted in a significant positive impact on the oil price.
Elias (2016)	(-5,5) (-20,20)	90 meetings from 1987-2016	5 sectors: Oil & Gas, Utilities, Basic Materials, Industrials and Technology. CAR model used with market model and constant mean return model.	Industries which are more related to the oil price (Oil & Gas and Utilities) have the biggest difference between the two scenarios in the longer run (-20,20). Industries which are more closely related to the oil price are more affected by OPEC decisions and thus are more likely to display abnormal returns. Over a shorter event window (-5,5), a larger difference was seen, with the high volatility scenarios having a much greater abnormal return than low volatility scenarios.
Loutia et al (2016)	(-5,5)	83 meetings from 1991-2015.	OPEC decisions on WTI and Brent crude oil prices against BCI and S&P GSCI Index. CAR event-study methodology used.	OPEC's announcements on oil prices (i)evolves over time and among decisions, (ii) is more significant for production cut and maintain, (iii) is different for WTI and Brent prices, and (iv) is sensitive to the benchmark index.
Spencer and Bredin (2019)		91 meetings	OPEC decisions on term structure variables (level,	Agreements to increase (decrease) production are positively (negatively)

		from 1991-2017	slope and curvature) for WTI crude oil futures. Market model used with GARCH in CAR model.	associated with changes in oil price levels in futures markets.
Kanzig (2021)	(-6, 105)	119 meetings from 1983-2017	6 variables: the real price of oil, world oil production, world oil inventories, world industrial production, US industrial production, and the US consumer price index (CPI). Vector Auto Regressive model used.	Negative news about supply increases oil prices immediately and leads to a gradual fall in oil production. At their peak, an oil supply news shock raising the oil price by 10 percent today decreases future oil production by −0.7 percent, increases inventories by 1.2 percent, decreases world and US industrial production by −0.6 and −1 percent, respectively, and increases US consumer prices by 0.4 percent. Also lead to a significant fall in industrial production and a temporary depreciation of the dollar that tends to reverse after about 1.5 years.
Pescatori and Nazer (2022)	(-10,10) (-5,5)	101 meetings from 1989-2020	Parkinson, Garmin-Klass, Rogers and Satchell volatility estimators for WTI futures.	Volatility is higher by 2.2-3.1 percentage points the day after an OPEC meeting. Moving through the event window, the reduction in volatility substantially decreases from above the 75 percentiles to below the 25th percentile.
Silva (2023)	(-5,5)	20 meetings from 2007 to 2022	5 grades crude oil + S&P Global Clean Energy Index. The growth of the US economy(S&P 500 returns), and the strength of the dollar (DXY) CAAR raw returns + market model.	OPEC increase and decrease decisions are dependent on the stage of the economic cycle. Increase decisions led to significant positive CAARs for oil futures during crisis periods and negative CAARs during non-crisis periods. Evidence of volatility compression during decision days.

Table 1: OPEC Meta Table of notable past event study research papers

Gathered from this meta table, it's evident that OPEC's decision can affect energy markets more in the short-term depending on many factors. MacKinlay's initial event study measures the impact of earnings disclosures on the value of a firm. His premise being that with rationality in an efficient marketplace, the effects of an event will be reflected immediately in security prices. Thus, a measure of the event's economic impact can be constructed using security prices observed over a relatively short time. According to Silva’s (2023) results, OPEC decisions to cut, sustain or increase production are all met with different average reactions in the WTI price depending on whether the ordinary OPEC meeting was held during a labelled crisis period with elevated volatility. OPEC attempts to portray that they do not allow all crises to affect the oil market by projecting their independence, market power and internal cooperation, however some crises such as the pandemic shutdown might warrant a contrarian consensus decision to cut or increase, affecting the consumer negatively in a crisis period. Decisions to sustain or even cut production during crises periods can be a surprise to traders and governments. This lead up to an OPEC announcement can be met with heightened volatility in the oil market which can spillover across other asset and commodity markets.

2.3 The Oil-Gold-Metals Nexus

Another highly traded commodity, and vital asset to the world is gold. Its continued use as a store of value, safe-haven and inflation hedge means that is undoubtedly linked with the price of oil. Gold has served as a hedge against inflation and as a safe haven during financial turmoil (Cai et al., 2001; Batten et al., 2010; Daskalaki & Skiadopoulos, 2011; Baur & Mcdermott, 2016; Chkili, 2016, 2017, Kanjilal & Ghosh 2017). Other researchers documented that gold serves as a hedge against fluctuations in the U.S foreign exchange rates (Capie et al., 2005; Pukthuanthong and Roll, 2011; Reboredo, 2013; Ciner et al., 2013). Sindhu (2013) found an inverse relationship between gold and the USD, and that crude oil has an impact on the gold prices. Thus, it is clear that all three assets share a place in the economy, and this becomes more significant during times of crises, or heightened volatility. A powerful consequence of this “financialization of commodities” was an increase in correlation between and within different asset classes, specifically from 2000 onwards. In their popular paper, Kilian & Murphy (2014) concluded that that those price increases over that time period were more due to an increase in global energy demand. In support of this theoretical claim, Silvennoinen & Thorp (2013) find that higher implied volatility from 2003 to 2008, increased commodity returns correlation with equity returns. Sockin and Xiong (2015) argue that at the beginning of 2008, goods producers mistakenly interpreted high commodity prices as a sign of increased global demand, when the opposite was true. After 2008, volatility remained high, indicating that these informational misconceptions persisted in the following years. It has been suggested that the substantial capital influx from investors undermined the fundamental factors of commodities, becoming the primary driver of commodity price fluctuations and volatility during that period. The slightly negative correlation of commodities to equities gives the impression that this will lower one’s portfolio volatility if included. However, as with most other investable assets, once speculators and traders get involved, this raises the volatility of the asset.

My research develops from an established age-long relationship between crude oil and gold (Soytas et al., 2009; Narayan et al., 2010; Zhang & Wei, 2010; Ewing & Malik, 2013; Bildirici & Sonustun, 2018) as the two biggest, commonly traded assets in global financial markets. The findings from these studies are controversial. Some research indicates a positive relationship between the two commodities, suggesting that gold is an effective hedge against oil market risks. However, other studies present conflicting results. For instance, Zhang & Wei (2010) found no nonlinearity between oil and gold prices, whereas Bildirici & Turkmen (2015) discovered significant strong linkages between oil, gold, and silver prices using nonlinear tests. Other research finds that the threat of rising inflation, caused by higher prices for a crucial economic input like oil, prompts investors to shift their investments from oil to gold to hedge against the anticipated decline in oil investments (Jaffe, 1989). This increased demand for gold can drive up its price, further validating gold's role as a hedge. Consequently, a positive relationship between the two commodities is observed. However, since both assets are traded in US dollars (Reboredo, 2013), the depreciation of the dollar will increase oil prices but result in losses for investors trading in the US dollar. Narayan et al. (2010) studied the long-run relationship between gold and oil futures prices at different levels of maturity and found co-integration relationships existing for all pairs of spot and futures gold and oil prices. The findings suggest oil prices can be used to predict gold prices; thus, the two markets are jointly inefficient.

One of the leading papers in the subject, Youssef and Mokni (2021) explores this relationship between the two commodities using a MRS-QR Model. As variables they used daily global oil production, the oil price, the VIX index and the gold price between 2000 to 2019 and find that during a low-volatility regime supply shocks have a negative impact on gold returns. But that this was positive in high-volatility regimes. Thus, the reaction of the metal depends on the volatility exhibited across the equity, oil and gold markets. Their findings support the previous conclusions of Salisu et al. (2021), who identified a strong hedging role for gold during the COVID-19 pandemic when other asset classes were less effective. In Salisu's paper, he included other precious metals such as palladium, platinum and silver and found them exhibiting similar features as gold, but at smaller magnitudes. This was in rebuke of Salisu's own study, (Salisu 2020) a year earlier in which he disagreed and stated that gold cannot be used to hedge against oil market risks, and that investors should look elsewhere other than gold in their portfolio choices during periods of sharp oil price fluctuations.

Therefore its clear that a positive relationship can exist between oil and gold especially in periods of high volatility. Gold, the leading metal can affect prices of the other metals and vice versa. For instance, the gold-silver connection has been investigated for millennia to as far back as 2500 BC (Ross & Bettenay 2023). Bimetallism had been flirted with for centuries with both metals playing an important role in ensuring coins had their appropriate value and didn't fully disappear in the U.S. until the 1896 Presidential election with William Jennings Bryan's loss. Long before the gold-to-silver ratio was allowed to float freely, it was fixed by empires and governments to control the value of their currency and coinage. Since 1994 the Gold Silver ratio has shown to revert to its mean in the medium to long term. The EIA, the department of energy in the US keeps track of the correlations between daily future price changes of crude oil to other commodities, and have noticed an increase in recent years, notably in gold, silver and copper [6]. Mokni (2018) investigated the co-movements between returns, volatilities and market risks among oil and precious metals markets over the period 2000-2016 and found evidence of a positive, non-linear, and asymmetric relationship between oil and precious metals. Turhan et al. (2014) using daily data, found a positive correlation between gold and oil prices that increases significantly after the onset of the GFC. Mensi et al. (2021) examined the short, intermediate and long-run volatility spillover between developed and emerging stock markets and strategic commodities (Oil and Gold), and found evidence of time-varying spillovers, which is intensified under major events. Major events are likely to increase volatility across markets. Increases in volatility can force some traders to seek a less risky return with these vital commodities. Gold is not the only commodity that has shown to be an inflation hedge with oil.

Some notable papers that have examined the reaction of soft and hard commodities to changes in the oil price are discussed below. Bayaa and Qadan (2024) decomposed the US yield curve by level, slope and curvature against the prices of oil, coal, copper, ethanol, natural gas, platinum, silver and zinc over the period 1986-2021 using ETFs such as USO, GLD, PALL. Their results show that a positive shock to long-term expectations about inflation predict positive changes in oil as well as other industrial raw materials. That increases in inflation expectations are not caused by increases in oil prices but that oil prices increase in tandem with inflation expectations is significant. Ciner's (2020) article's results claim that over the period 1994-2016 non-ferrous metals receive large volatility spillovers across the metals markets, and that their behaviour is similar to other conventional asset classes like equities, justifying the position that metals have become an investment class. Bhar And Hammoudeh (2011) used a VAR model in a changing regime and find evidence of a regime-dependent relationship between precious metals and three commodity sensitive variables, the three-month T-bill, the exchange rate being the Dollar Exchange Index (DXY), and the MSCI. Their results show that oil is found to have a more pronounced impact on precious metals returns - Gold, Silver and Copper, in a high-volatility regime. Similarly, Balcilar et al. (2015) using a VEC model found that oil price shocks have a positive impact on precious metal prices, particularly in a high-volatility regime. Returning to more of Salisu’s work (2019) in which he compared the hedging properties of both gold and palladium in OECD countries from 1987-2018 and found that palladium provides a good hedge against inflation and better than gold in twelve out of the thirty-two OECD countries considered. McCown and Shaw (2017) echo this claim, that palladium appears to have shown better ability to track both US consumer

[6] https://www.eia.gov/finance/markets/crudeoil/financial_markets.php

and wholesale prices than has gold and may be a better choice for investors seeking an inflation hedge. According to Gold.org's[7], over their longest timeframe, May 31st 2018-May 31st 2024, gold's daily, weekly and monthly correlation to the S&P GSCI precious metals for the US market has been 0.759, 0.922 and 0.963 respectively. LBMA Silver shares a positive relationship as well to Gold, with respective correlations 0.52, 0.74 and 0.697. Platinum's daily, weekly, monthly correlations are found to be 0.45, 0.563 and 0.342. Also worth noting, is that for the US market, Gold's correlation to WTI is 0.08 and 0.109 on the daily and weekly before reversing to -0.111 on the monthly. This is evidence of there being linkages among the energy and commodity markets in the short term but that the correlation between gold and oil in dollars is not as positive at longer timeframes.

When oil prices rise, all consumers of oil and related products are negatively impacted, as they have less money to spend on other goods and services. This is particularly significant because the demand for oil is quite inelastic in the short run. As in, specifically for consumers, an increase in the price of the finished good, petrol, would require a significant jump before consumers cut back their consumption or switch to a non-combustible vehicle for example. Additionally, as the relative price of oil increases compared to other inputs, resources are reallocated across all industries. Conversely, when oil prices fall, the price effect is positive, giving consumers more disposable income to spend on non-energy goods. However, the effects of oil price changes are asymmetric; the economic damage from an oil price increase is greater than the economic benefit from an oil price decrease. Perifanis & Dagoumas (2019) in their analysis found that if OPEC increases production by 1% then oil prices will decrease by 1.32%. I gather that the financialization of the commodity markets seems to have also increased the degree of integration between energy and agricultural commodities. According to Nazlioglu et al. (2013) in analyzing the volatility transmission of oil to wheat, cotton, soybeans and sugar over the period 1986-2011, the introduction of biofuels, notably ethanol, a partial substitute for oil, produced from corn, linked agricultural and energy markets which led to the food price crisis in 2006. That a volatility shock in oil returns triggers an immediate positive response in the volatility of corn and soybeans returns within the week of the shock with this positive effect persisting for up to three weeks. Other papers such as Gilbert (2010) and Zhang et al. (2010) argue the contrary, that there is no direct causal relationship between oil and agricultural prices and the correlation between oil and agricultural prices is due to demand growth and monetary and financial developments. Kocaaslan's (2023) findings are in contrast with Gilbert and Zhang, that prices of corn and soybeans over the period 1974-2022 were negative due to a positive oil supply shock. He attributes this to a higher supply of crude oil decreasing the price and this decreasing agricultural commodity prices. This decrease in agricultural prices because of the price falling is likely due to the higher supply. This leads me to hypothesize that since oil is cheaper, more energy will be used, more agriculture will happen,

[7] https://www.gold.org/goldhub/data/gold-correlation

increasing the supply of crops which will decrease the price of agricultural commodities too. This position will now be argued for precious metals.

Putting this all together my hypotheses are formulated based on two arguments.
Argument 1: When OPEC announces an increase in oil production, producers of metals or miners expect a lower price of oil in the future due to the increase in oil supply hence they will delay their oil-future consumption. This decreased demand will consequentially lower real-time oil-future prices. Decreases in oil as energy and as an input to business processes will mean that more oil will be purchased which will lead to more business activity. This increase in business activity will cause more metals to be mined which will increase the supply which will lead to the lower metal prices.
By contrast, a decrease in oil production will make miners expect a higher price in the near future, hence they will increase demand for oil-futures, as a consequence, real-time oil future prices will increase. This increase in demand for oil as an input will decrease the supply of metals leading to higher metal prices. In Nkomo's paper (2006) they analyzed the impact of higher oil prices on Southern African countries, and finding that consumers and energy-using producers suffer the worst impact from oil price increases than do increases of other commodities.

Argument 2: Miners view an increase in oil production as a sign for higher oil demand in the future. Expecting higher oil prices in the future, they will anticipate their oil consumption, consequentially, oil futures prices will increase. An increase in oil futures will make oil and inputs to mining more expensive, but this will be offset by the expected higher demand for all commodities. If OPEC are signalling to markets that global oil demand is expected to increase this could signal an increase in overall energy demand which could spillover to an increase in precious and base metals. This increase in demand will cause the price to rise in this situation. Conversely, a decrease in oil output could be viewed as a decrease in future oil demand, lowering real-time oil futures prices. A decrease in the outlook in the energy market could lead to a decrease in global business sentiment, activity and demand, causing decreases in prices across the metal markets.

Based on argument 1 and argument 2, the following hypotheses were formulated:
Hypothesis 1: During non-crisis periods, an oil production output decrease by OPEC will generate positive abnormal returns among metals around the announcement. By contrast, a production output increase will generate negative abnormal returns. If oil production output is sustained, there will not be any abnormal returns.
Hypothesis 2: During crisis periods, an oil production output decrease will decrease the price of oil futures, and thus metal futures, consequentially generating negative abnormal returns around the

announcement. Conversely, a production output increase in crisis periods will result in positive abnormal returns among the metals market.

If oil production is sustained, investors will not change their expectations of high oil demand. Thus, oil futures prices will remain constant. Although this argument does not rely on the assumption that oil demand is constant around the OPEC decision, the event-window still needs to be wide enough to account for the market expectations. An influential study with high frequency data conducted by Kanzig (2021), found significant abnormal returns in oil futures markets in a tight event window, which is in accordance with the formulated hypotheses. My hypotheses will expand the analysis of OPEC's influence outside the oil market, which other studies failed to do. Previously mentioned research has focused on either OPEC event windows, the relationship of oil to gold and other commodities but not both together. In Silva's (2023) analysis of oil futures and clean energy around OPEC meetings, his results guided him toward the belief that the investors' reaction depend on the state of the economy at the time of the meeting. This is a reason why I wish to discriminate between crisis and non-crisis periods. His "crisis-periods" are characterized by high volatility, in which investors rely on demand signals, instead of oil price fundamentals. Crisis periods are characterized by high uncertainty, increasing the likelihood of increased demand for gold and a slow-down of economic activity, which lowers oil demand. Thus, investors will expect OPEC to make more economically driven decisions to minimize the crisis effects on oil-markets. I believe that during crisis periods, investors will predict an increase or a cut in oil production and so will place trades before the announcement. In contrast, following the announcement of a sustain decisions, investors will reverse their position or hedge in order to correct their market position, lowering the prices.

2.4 GOD: Gold-Oil-Dollar connection

Linking oil and gold to each other is the world's reserve currency, currently the US Dollar. The majority of international trade in homogenous goods like commodities with the most liquid and largest markets by volume listed in USD. According to Gold.org, gold has the second largest average daily trading volumes of various major assets in US dollars, behind only the S&P 500.[8] Since both assets are traded in the dollars, the volatility of the US dollar may cause fluctuations of international crude oil and gold price in the same or different directions. Speculation and hedging activities arise when there is a rise or a drop in any of those two.

Previously the British Pound held this title until the actions taken by the US Federal Government to create the Federal Reserve in 1913. Later as World War II was ending and America's economic and political strength was high, countries gathered at the Bretton Woods Conference and agreed to peg

[8] https://www.gold.org/goldhub/data/gold-trading-volumes

their currencies to the US Dollar. Initially it was convertible to gold at a fixed rate of $35 per ounce to ensure economic stability and prevent another global depression. Now with the US holding a significant portion of the world's gold, this made Europe and the world dependent on the Dollar to conduct transactions. As expected this strengthened the greenback highly against other world currencies, culminating in the Plaza Accord in 1985 whereby the G-5 nations—France, Germany, the US, the UK, and Japan—agreed to manipulate exchange rates by depreciating the U.S. dollar relative to the Yen and the Deutsche mark. President Nixon in 1971 fully axed any legal relationship to Gold leading to a financially backed system based on money creation, debt and credit. This severance of the link to physical money and admission of non-credibility of defending a gold standard let gold free, with its price doubling within a year and later a rise of over 5000% over the period 1971-2024. With both oil and gold are being traded in the USD, the volatility of the USD may then cause fluctuations across both commodities. Speculation and hedging activities arise when there is a rise or a drop in any of those two. This sets up a so called 'impossible trinity' situation in which all assets, the USD, oil, and gold rely on and trade off each other in the short and long term. With this trinity the only thing guaranteed is volatility. Foreign speculators and governments correctly predicted the US government would not hold up their end of the bargain if called upon by Dollar holders in their redemption for gold in the 1960s and 1970s, and so Nixon severed the link.

In the long run we are all dead, and so we don't know what technologies have not been discovered yet. For example, the invention of fracking technology expanded the supply and reserves across the US in the 21st century. Since we don't know what the future holds, these assets, gold and oil and their supply are considered finite and rare, giving them value. Previously with the Dollar on the Gold Standard, this limited the US government's eagerness to spend discretionarily, by forcing them to maintain their gold supply. While gold is not redeemable by dollar holders anymore, dollars are held as a medium of exchange for its liquidity, ease of wealth transfer and even a safe haven when compared to other fiat currencies. Gold prices and currency inflation rates are also dependent and positive correlation exists between them. Only in recent human history have we experimented with full fiat currency and excessive modern monetary theory. Before the first World War, many countries still abided by a gold standard in which their currency was redeemable for physical gold.

With the establishment of the petrodollar system, this generated large trade and current account surpluses for oil exporting countries. Consequently, countries and central banks must maintain substantial reserves in US dollars for conducting oil transactions, establishing a robust connection between the currency's value and oil prices. When the US dollar strengthens, it typically leads to a decrease in oil demand, causing lower oil prices as a consequence of reduced demand for oil (Haughton, 1989; Akram, 2009). Particularly during periods of turmoil, the US dollar becomes prominent as a secure instrument, due to its status as a reserve currency (Maggiori, 2017). Previous studies identify the US dollar as a key determinant of oil prices, emphasizing its safe-haven role and forecasting power during periods of turbulence in the oil market (Zhang et al., 2010 ; Peersman, 2022). Some notable studies demonstrate a significant negative link between the US dollar and oil prices (Coudert & Mignon, 2016; Mo & Nie 2017; Akram, 2009), with others furthering the analysis of oil price shocks with rising inflationary pressures (Zhang & Wei, 2010; Aguilera & Radetzki, 2017). Lizardo & Mollick's (2010) paper found that increases in real oil prices lead to a significant depreciation of the USD against net oil exporter currencies, such as Canada, Mexico, and Russia. While the currencies of oil importers, such as the Euro and Japan, depreciate relative to the USD when the real oil price goes up. Kocaarslan (2024) states that the USD is the most influential factor affecting oil market uncertainty. That increased levels of the USD are significantly associated with higher levels of oil market uncertainty, and furthermore that the USD exhibits the highest level of interaction with gold market uncertainty. In Sindhu's 2013 paper examining the effects of exchange rate, crude oil, repo rate and inflation on the price of gold, he found an inverse relationship between the US$ and Gold. That crude oil has an impact on gold prices, and that a positive correlation exists between gold prices and inflation rates. If oil and gold are believed to be positively correlated, and if they actually are correlated especially in times of crisis or heightened volatility and if gold is positively correlated to precious metals, then increases in the oil price, could increase prices of precious metals in the short term.

Thus, here I introduce, the US Dollar Index, the DXY, a ratio measuring the strength or weakness of the Dollar against a basket of 6 major currencies (Euro, Yen, Pound, Canadian Dollar, Swedish Krona, and Swiss Franc). When the DXY increases, it means the U.S. dollar is gaining value against those currencies. Conversely, it also means those other currencies are losing value against the U.S. dollar. It is a widely regarded index and is seen on the opening page of daily watchlists beside highly traded assets such as the S&P 500, the USD/EUR and the WTI. The ratio dates back to the 70s but since 1990 the ratio has fluctuated in between extremes of 120 and 70, with a current value of 104 as of August 2024. This index will be used as a proxy and control variable in measuring the strength of the USD.

The dollar is currently still the reserve currency of the world, which means that it is used in pricing and transacting homogenous products. This gives America and the $ more power. America is fortunate that they can export their inflation to non-dollar using countries. Depending on whether the dollar is appreciating/depreciating or strong/weak vs other currencies has indicated in the past who will be more at risk of an oil price increase. Recent threats and pacts by world governments, to phase out the use of the dollar has garnered a lot of attention such as Russia and Iran's partnership. Some currencies such as the Canadian Dollar, are strongly negatively correlated with the USD solely because of the amount of oil traded. These petrocurrencies (Russia, Norway, Canada) export so much oil, that their currencies are highly dependent on the price of oil. Historically, at least up until the pandemic, it was assumed oil prices were inversely related to the strength of the US dollar. For net oil importing countries, it provides a kind of partial compensatory effect that can reduce the cost of oil imports. This inverse relationship occurs because from 1980 to 2020 the US had been a net oil importer. Rising oil prices increase the value of oil imports so that the US had to increase the circulation of dollars in the world, thereby weakening the dollar. In 2022 with the Russian invasion this became a double whammy for developing countries which are net importers of food and energy. Not only did prices of commodities increase but also the US dollar strengthened, which led to a rise in the cost of imports in domestic currencies. According to Energy Intelligence[9], the relationship between the USD and oil has varied over the past few decades. They found that from 2009-2016, a 10% increase in the Brent price would generally lead to a 1.6% decline in the dollar's exchange rate. However, the relationship has reversed. From 2021 to 2023 a 10% increase in Brent lead to roughly a 2.5% increase in the exchange rate. Taken together, this shift represents a roughly four-percentage-point change in the exchange rate for every $10 fluctuation in oil prices, illustrating the significant impact of the US transition from a major oil and natural gas importer to an energy exporter. Therefore, the previously assumed theory of negative correlation between the Dollar and oil doesn't hold up anymore.

2.5 Inflation

Expanding on the consequences of a depreciating currency, a relative decrease in the purchasing power of one's currency can be exacerbated or be caused by inflation. Less goods are able to be purchased in that weaker currency. As discussed, hedging against inflation is a key reason why traders seek a positive return in commodities. Inflation in the US is released monthly through the CPI, the Consumer Price Index and the PPI, the Producers Price Index. Formerly known as the wholesale price index, the PPI measures the direction and degree of price fluctuations of the manufacturing industry, so it mainly reflects the price fluctuations of industrial products. Usually, prices increase first for producers who later pass these on to the consumer to maintain their profit margin. Therefore, I see the PPI as an earlier indicator of inflation compared to the CPI. The CPI is a better measure for valuing the increase in prices of finished goods for the consumer. Thus, in keeping with our analysis on the price action of commodities, I focus on the PPI.

A great amount of research has been carried out on the relationship between CPI, PPI and exchange rates. In Husaini & Lean (2021), they explored the asymmetric impact of oil price and the exchange rate on inflation. Their results suggest that an increase in oil price gives greater impact on PPI than CPI, and that an increase in the exchange rate is significant to cause an increase in both PPI and CPI. As mentioned previously, both gauges are likely to be affected by steep or unexpected increases in the main input of energy – oil. In Husaini & Lean (2021) analysis of exchange rates, and CPI and PPI

[9] https://www.energyintel.com/00000184-566e-dc1b-a9a4-d66e06950000

across Southeast Asia, they found an asymmetric relationship between the exchange rate and inflation. That for Malaysia and Indonesia, only a depreciation in the exchange rate will cause a higher PPI in Indonesia and CPI in Malaysia. However, a decrease will not have any impact on these indicators. Also, they found that the M2 money supply indicator has a positive relationship with CPI and PPI in the countries examined. This is in line with the monetary theory that an increase in M2, will push the inflation rate up as the demand for goods rapidly increased more than the growth rate (Friedman 1989). Second, Malaysia's results indicates that an increase in the oil price has a bigger impact on PPI than a decrease in the oil price. Third, an increase in the oil price has a bigger impact on both CPI and PPI than a decrease in the oil price in Thailand. They also noted that the PPI is more oil-intensive than the CPI. In Ghosh's (2014) analysis of 137 countries, he found that currency depreciation significantly increases the inflation rate in advanced economies, emerging markets, and low-income countries. On the other hand, Salisu et al. (2017) used a dataset of net oil-exporting and oil-importing countries and found that in net oil-importing countries, an increase in oil prices has a stronger impact on inflation compared to a decrease in oil prices, demonstrating an asymmetric effect. In net oil-exporting countries, the pass-through impact of oil prices on inflation is incomplete, with only oil price increases significantly causing inflation. Kim et al. (2024) concluded that the pass-through impact of oil prices on inflation is complete in both advanced and developing economies, with increases in oil prices having a greater impact on inflation than decreases. Ferrucci et al. (2012) analyze the pass-through of food commodity prices to final consumer prices across Europe and find that commodity prices are the main determinant of the increase in CPI and PPI. Rodríguez (2022) analysis of 18 developed and 19 developing countries country-specific commodity export price indexes found that energy and metals show the most relevant pass-through to producer prices for all countries.

Therefore, since the PPI's data reflects past information on prices it is not a forward-looking indicator. However, as researched in the above papers, CPI data is influenced by PPI data. Releases of the monthly CPI are heavily scrutinized as it can give traders a prediction on whether inflation is too high or too low. Too high or a surprise reading can incentivize the Federal Reserve to raise short-term interest rates to control and decrease the inflation. By them raising the Federal Funds rate to defend the Dollar from inflation, they have increased the minimum expected return on short term debt. With more market participants noticing the US raising rates, if their respective central bank doesn't raise in lockstep, they will exchange their other fiat currencies for dollars, and the Dollar will appreciate. This is particular to the Dollar, as in the past, other central banks have attempted to defend their currency in the same way, by raising rates but have not succeeded. An example is the Bank of England's attempt to defend the Pound against the Deutshcmark in the 1992 with the Treasury eager to hold onto a peg it had with the Deutschmark. The Bank raised rates to defend the currency attack but traders such as George Soros predicted that the peg couldn't be held because of the excess trade with and strength of the Deutschmark. This led to the British government removing the peg, letting the Pound float and subsequently a large depreciation of the currency. At the time, the Pound was one of the most used currencies but not the reserve currency. Increasing oil prices reminds consumers, producers and central bankers of the threats higher prices will do to inflation. The correlation of oil prices to inflation has decreased since OPEC's prime in the '70s and '80s primarily due to Western economies weaning off of the use of the input or the US improving its terms of trade as an importing nation there is still a pass-through channel by which higher oil prices increase overall prices in the economy, as seen with the increase in core and non-core inflation from the Russian invasion. While oil might not be used as a primary input across the whole economy, petroleum and its other semi-finished products in the manufacturing and chemicals industries are affected by volatility jumps in energy prices. Milton Friedman once regarded inflation as increase in the money supply, however 60 years later we now regard it as an increase in prices. Nonetheless, the threat of increases in either prompts investors to maintain their purchasing power and flee to safer havens such as gold. A rise in gold is technically a depreciation of all currencies specifically the Dollar. (Pukthuanthong and Roll 2011).

World markets are still feeling the effects of the supply-chain disruptions from the Covid-19 pandemic, with energy and commodity prices still relatively high. These supply risks have plagued markets concurrently with large and unwanted increases in US PPI and CPI signalling that there have been increases in prices and thus, the overall price level. Gold has held up as its reputation as an inflation hedge, with the large-scale increases in the money supply from the US Government and Federal Reserve in Quantitative Easing programs, and bailout crises such as the Great Financial Crisis and the Covid shutdowns. Typically, currencies experiencing inflation lose value against other currencies. Since 2021, like the US, the EU have experienced their own respective elevated inflation. Decisions by EU members to refuse purchasing Russian gas due to the Ukraine invasion, spiked prices in natural gas markets. While the invasion affected non-energy assets as well such as the wheat market, this 100% increase in the average monthly electricity wholesale prices in selected countries in the European Union (EU) during 2022, carried spillover price increases for the consumer with the shock triggering record-breaking inflation of 8.6% figure in June, together with a gradual slowdown in economic activity[10]. This ultimately led to the Euro depreciating to parity with the Dollar for the first time in twenty years. "In the past, rising oil prices were associated with a decline in the dollar's exchange rate. The rate decrease would cushion world consumers from rising prices. That relationship is now broken. Today, rising oil prices are associated with an increase in the dollar's value. Thus, for countries that import oil and natural gas, the impact of a rise in the dollar price of oil and gas is magnified in their currencies"[11]. It was believed in the period pre-great financial crisis (Kocaarslan 2024) that a strong dollar would have a negative relationship with oil. As in when oil prices would

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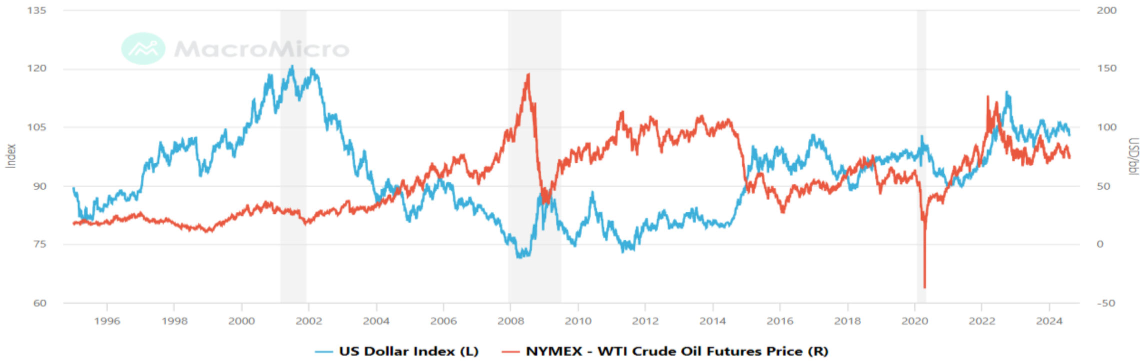
[10] https://www.euronews.com/business/2022/07/01/inflation-in-the-eurozone-reaches-new-record-high-of-86#:~:text=Soaring%20energy%20prices%20have%20pushed,high%20of%208.6%25%20in%20June
[11] https://www.energyintel.com/00000184-566e-dc1b-a9a4-d66e06950000

increase, it was presumed by non-dollar denominated economies that this wouldn't happen at the same time the dollar was exhibiting strength relative to other currencies. However, since 2019, we've seen a decoupling of this relationship as now, a high dollar index and high commodity prices are the norm. Since June 1, 2021, the Brent crude oil price has increased by 59% in U.S. dollars and by 86% in euros.[12] Countries and governments are realizing that their currency is not a solid hedge against the Dollar during inflationary times. In recent years this has accelerated the cooperation among sanctioned nations to conduct large-scale commodity transactions in non-dollar currencies.



[13]Some countries such as Saudi Arabia avoid this, by having a tighter peg against the Dollar but are then subject to mirroring the US' monetary policy. One Dollar has been worth 3.74-3.76 Riyal for the past few decades. Other economies whose incomes depends more on exports of commodities such as the Canadian Dollar has an almost perfectly negative correlation to WTI over the past twenty years. In recent months, the USD/CHF has had a positive correlation with Gold, showing the Swiss Franc's and Gold's status as more of a haven than the Dollar. Given that crude oil is priced in US dollars, it may be possible to hedge an appreciation in oil prices by holding a position in a currency strengthening against the US dollar or Gold. These three assets, the dollar, gold and oil are inextricably linked but are not entirely dependent on each other. Oil price increases could cause depreciations or appreciations of the dollar or the other way around, that appreciations or depreciations of the dollar could then affect the price of oil. Or that fluctuations in the gold market can spillover into oil and dollar markets. Kanzig (2021) found that oil supply news shocks lead to a significant depreciation of the dollar. This depreciation appears to be temporary and appears to reverse after 1 and a half years. Thus, the significance and strength of the Dollar is a major variable in commodity trading.

2.6 Volatility

Regarding volatility across the oil market, it is heavily debated if OPEC has achieved their mission of price stability. They claim to be a positive force in the oil market regarding its mission to reduce volatility. This has been supported by Pescatori and Nazer (2022) who find that volatility is higher by

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[12] https://www.eia.gov/todayinenergy/detail.php?id=52399
[13] https://en.macromicro.me/collections/19/mm-oil-price/185/oil-usd

2.2-3.1 percentage points the day after an OPEC announcement, suggesting that OPEC has been a stabilizing force for the oil market. Their results show the volatility of oil return in the days before non-regular meetings is almost twice as high as the typical median volatility. And as we move through the event window, the reduction in volatility substantially decreases from above the 75th percentile to below the 25th percentile. I believe this oil-gold connection to exhibit a more positive relationship during crisis periods because if volatility increases uncertainty in markets, this increases the threat of a larger downward move and so incentivizes wealth preservation through gold acting as store-of-value and hedge. The volatility across markets in the days preceding an announcement can therefore affect price action during and following the meeting. Kanzig (2021) found the variance on announcement days is over 3 times higher than on control dates. Horan et al. (2004) examined the implied volatility from options on crude oil futures surrounding OPEC meetings. His results state that volatility drifts upward as the meeting approaches and drops by 3% following the day of the meeting.

Another goal of this thesis is to see if there is reactions across volatility indicators over the event window surrounding the OPEC meetings. This will be achieved by incorporating three volatility indicators into my analysis, namely the VIX, the OVX, and the GVZ. Firstly, the VIX, known as the 'fear-gauge' in the financial world, measures a constant, 30-day expected volatility of the U.S. stock market, calculated by the Chicago Board Options Exchange, derived from real-time, mid-quote prices of S&P 500® Index (SPX) call and put options and represents the market's expectations for the relative strength of near-term price changes of the S&P 500 equity index. Like the OVX and GVZ volatility gauges, the VIX is also a forward-looking indicator. While other indexes such as the Dow and Nasdaq have their own volatility gauges, the VIX is highly regarded as the S&P 500 is the largest index by market-cap in the world and a broad barometer of the US and Western economies. Higher VIX values indicate a higher expected level of uncertainty and vice versa. If the VIX is rising, demand for options is increasing, and therefore, becoming more expensive. If the VIX is falling, there's less demand, and options prices tend to fall. Demand for options might be increasing due to an increase in the desire to hedge a specific event or speculation. Baele et al. (2013) showed that flights-to-safety phenomena occur when the stock market volatility is high. Supporting this, Thomas (2015) reported evidence that the VIX can be a proxy for market risk by predicting flights-to-safety. In Sarwar's research (2017) he finds that increases in VIX lead to contemporaneous and delayed increases in the volatilities of T-note, gold, and silver prices. That a one percent rise in VIX is accompanied by an elevated price risk of 0.06% for T-note, 0.26% for gold, 0.59% for silver, and 0.61 for goldminers.

The OVX is another highly important indicator of volatility across the oil and energy markets, as it measures oil price implied volatility. Referred to as the oil VIX, the OVX is an estimate of the expected 30-day volatility of crude oil as priced by the United States Oil Fund (USO). Like the VIX, its calculated by interpolating between two time-weighted sums of option mid-quote values - in this case, options on the USO ETF, measuring the market's expected implied volatility of oil prices. It does not track the price of WTI oil itself, but the price traders are willing to buy and sell WTI options at for the next 30 days. The index began in 2007 and is plotted on a range from 0-100, with it usually lower than 60 over the past 5 years however it jumped above 100 and reached 500 during the March-May 2020 Covid-19 panic and lockdown. The pandemic resulted in an unprecedented oil shock, with oil prices turning negative for the first time (Corbet et al., 2020, Fernandez-Perez et al., 2023). While a lot of the focus was on the rapid depreciation of oil prices, an outcome was the elevated volatility around this time. In April 2020, the price of oil rose by more than 11.3% in six trading days. More recently, oil prices rose by more than 6.7% on five trading days after the Russian invasion (Conlon et al. 2024). Before this, during the financial crisis of 2008, the OVX index spiked up as the S&P index plummeted. In general, spikes in the OVX can correspond with downward movements within the S&P index. A rise in the OVX index shows the market's belief of higher oil price volatility in the future, which could result in an increase in uncertainty and hence could potentially make investors more risk averse. This would imply a 'flight to safety' and funds being channelled towards relatively safer liquid stocks carrying less liquidity risk. It is also consistent with the results of Qadan & Nama (2018) who find a negative correlation between the OVX and investor sentiments, implying that a rise in OVX makes investors more pessimistic towards risky assets including illiquid stocks. In Dutta's (2017) research on the OVX, they found clean energy stock market returns are highly sensitive to OVX shocks and that the magnitude of the effect of OVX is much bigger than that of the realized variance of WTI oil spot prices. They also observe that OVX and WTI oil price are inversely related indicating that an increase in OVX causes a drop in oil price. In Lv's (2018) analysis of the crude oil futures market from 2007 to 2015, she found that OVX is a statistically significantly forecasting indicator for the future volatility of the oil price. While options and futures can be traded on the VIX and OVX, many traders use them as a gauge for sentiment in the equity and oil markets. Seeing as volatility is a leading indicator this means a rise in the OVX might precede a rise in US crude oil prices. Nonetheless, like the VIX, the OVX often overpredicts 30-day future movements, as the oil market has time to react to the indicator's projections. The influence of OVX is only significant in a lagged setting within the short run as the reverting mechanism of these indices don't qualify them as solid buy and hold investments. The fact that only futures and options can be traded on them solidifies this. Similar research has analyzed OVX's relationship with the precious metals market. In Dutta's (2018) paper, he found both negative and positive OVX shocks affecting the industrial metal market returns negatively. In contrast Das et al. (2022) investigated the impacts of lagged OVX jumps on precious metals from 2007-2021 and found that gold returns are relatively less responsive acting as a weak hedge against OVX jumps, and that the four other metals don't serve as a hedge against contemporaneous OVX jumps. OVX jumps result in an increased volatility in metals with copper, platinum, palladium, and silver returns decrease when OVX increases.

Now taking our attention to gold volatility, the GVZ was created in 2008 and is the volatility index of the most famous gold ETF, the SPDR Gold Shares (GLD). Using the same methodology as the VIX and OVX, the GVZ measures the short-term fluctuation range of the gold price expected by the market. The SPDR Gold Shares ETF with the ticker GLD is an ETF with its value directly linked to price of gold through the purchase of gold bullion. A high level signals a high expected fluctuation range, while a low index level indicates a low fluctuation range. Like the other volatility indicators, while it doesn't inform traders of the direction the gold price is going in, its forward-looking implied volatility measure can be a useful indicator for traders. A high GVZ reading could mean that gold is falling, rising or moving between wide support and resistance levels, but typically when the GVZ is spiking it means gold's nominal value is going down. This makes sense as when the bullion price is falling, traders purchase put options to hedge against their risk. This causes the premiums on such options to rise, which makes the GVZ go up. Gold bull markets tend to be less severe than bear ones, so the options trading is less pronounced – meaning the volatility index doesn't rise as much.

Some notable past research include Badshah et al. (2013) who investigated the contemporaneous spillover effects among the VIX, GVZ and the exchange rate volatility (EVZ). They detect strong unidirectional spillover from VIX to GVZ and EVZ and bidirectional spillover between GVZ and EVZ. Boscaljon & Clark (2013) found that a large increase in VIX is an indicator of the market's flight-to-safety, during times of extreme market uncertainty, where investors reallocate their funds in gold and gold-mining stocks. In Andrada-Felix's paper (2018) his results point to GVZ as net receiver of volatility from VIX and EVZ but net generator of volatility to OVX, indicating a link between the equity, foreign exchange, oil and gold markets. That GVZ was a substantial generator of volatility over OVX and VIX during the period 2008–2017. This episode coincides with a fall in global inflation, and evidence of gold undermining its status as a safe haven. Later GVZ became net receiver from all other assets until November 2016, net giver until October 2017 for VIX and OVX, and net receiver from EVZ. This occurred in a context marked by the escalation of negative interest rates, the collapse and subsequent rebound in commodity prices and fluctuating stock market valuations.

Clearly there is a heavy amount of literature linking these volatility indices to each other, with these spillovers into the other markets seeming to be stronger in the short-term. This has led me to my third hypothesis:

Hypothesis 3: The volatility and price action of the precious metals over the event window, is influenced more by the OVX volatility indicator than the VIX or GVZ indicators.

CHAPTER 3 Data

Since the founding of OPEC in 1960 there have been 180 general meetings. Meetings are divided into ordinary, extraordinary and JMMC meetings. The ordinary meetings have a fixed schedule but also when pressing matters arise, such as the Covid-19 pandemic, where demand will be significantly affected, 'extraordinary' meetings occur. Regular OPEC meetings usually last two days and conference resolutions become effective after 30 days. A final decision about their production output is announced to the press at the end of each conference, thus change in future supply is a certainty. In making decisions, the conference generally operates on the principles of unanimity and one vote per member. However, the de-facto leader of the organisation is Saudi Arabia, the largest producer in the cartel and can threaten to function as a swing producer in global market. Elias (2016) notes that most meetings take place when the inflation-adjusted oil price is lower than average. This is logical as OPEC has more of an incentive to intervene during low oil prices.

Using a similar approach to MacKinlay (1997), these 96 meetings were categorised as a decision by the cartel to increase, decrease or maintain their oil production quota. To verify the categorisation of the meeting, whether it was increase, decrease or a sustaining of the quota, news articles were able to confirm OPEC's decision to the market as well as appendices of past OPEC event studies. I am using the final day of the conferences—as event day zero. Official announcement times are unavailable, and my data only focuses on the daily closing prices for all variables. As well as that, OPEC decisions sometimes get leaked before the official announcement.

Data for the period 2002 till 2024 was obtained from press releases published on the OPEC website. This period was chosen because OPEC's press releases begin on their website in 2002. Considering both ordinary and extraordinary meetings over the 23-year period, 96 press releases were collected from OPEC's website of which 50 were labelled maintain decisions, 28 cut decisions and 18 increase decisions, composed of ordinary, extraordinary, OPEC+ meetings, and JMMC meetings. Like Silva (2023) these meetings were also categorised into whether they occurred over a crisis period or not. The crisis periods encompassed 2007-2011, 2020 and 2022 accounting for the 2008 Great Recession (that lasted from 2007-2009 according to the US Bureau of Economic Research), the European Sovereign Debt crisis (that lasted from 2009 to 2011 according to the European Central Bank), the Covid-19 pandemic and the Russian Invasion of Ukraine.

Of those 50 maintain decisions, 20 for Crisis and 30 non-Crisis. Of the 28 cut decisions 7 were Crisis and 21 non-Crisis. Of the 18 increase decisions 8 were Crisis and 10 Non-Crisis. Individual meeting categorization is provided in the appendix. In other OPEC event studies, large amounts of meetings are excluded, mainly due to them being extraordinary meetings. I see these meetings as being highly important regarding the future direction OPEC chooses to go. Dropping the extraordinary meetings would decrease my sample size by 30% which is why I chose to include them in my analysis. A decision to maintain was very popular by the cartel over the period, demonstrated by the 50 out of 96 meetings analyzed.

The historical price information of five metal futures for the Gold, Silver, Copper, Platinum and Palladium futures as well as the SPGSIN benchmark and the DXY were extracted from Investing.com. These will be used to test hypotheses 1 and 2 over the period 2002-2024. Closing prices for Platinum and Palladium were only available from 2008 onwards, therefore there are less meetings analysed for these two metals. Regarding the volatility indicators – VIX, OVX and GVZ, these were extracted from YahooFinance. Monthly PPI data was gathered from the US Federal Reserve website, FRED.

Some reasons why I focused on the futures prices compared to the spot prices was that most trading, speculation and price action occurs in the futures markets. Many traders speculate on the direction of price movement and would rather not settle and own the physical commodity. Gold and Silver would be the only exceptions with investors storing some of their wealth in the physical bullion, but this cannot be arbitraged over a short period of time, such as my event window. Therefore, due to the limitations of buying a physical commodity, most trading and speculation in the physical commodity markets are done using futures in which one can buy the product and then short sell the future just before it is due. In addition to purely being beneficial to those investing in commodities, it can also apply to the large number of commodity producers to deal with unexpected price increases in the spot market is to purchase and sell a futures contract. Also, since OPEC announcements come with a lag – the decision to cut or increase isn't effective immediately and so would not affect immediate supply. Despite this the price will still move in the spot market. Spot prices are also heavily related to the futures price and vice versa. Too large of a contango spread between them will incentivize arbitrage and storing the commodity. Hamilton (2009) pointed out that, as a matter of theory, speculative trading in oil futures markets may cause a surge in the real price of oil even without any change in oil inventory holdings if the short-run price elasticity of demand for gasoline is literally zero.

Chapter 4 Methodology

4.1 Event Study Analysis

Following on from my hypotheses:

Hypothesis 1: During non-crisis periods, an oil production output decrease by OPEC will generate positive abnormal returns among metals around the announcement. By contrast, a production output increase will generate negative abnormal returns. If oil production output is sustained, there will not be any abnormal returns.

Hypothesis 2: During crisis periods, an oil production output decrease will decrease the price of oil futures, and thus metal futures, consequentially generating negative abnormal returns around the announcement. Conversely, a production output increase in crisis periods will result in positive abnormal returns among the metals market

Hypotheses 1 and 2 were tested via an event-study approach, as proposed by MacKinlay (1997). Events studies are useful and common in financial economics research. They attempt to gauge the effect of an identifiable event such as earnings, or for me OPEC meetings on a financial variable usually asset returns. They're considered tests of market efficiency as if we assume financial markets to be efficient, we should not see a significant abnormal return over the event window. In assuming the T=0 is an OPEC meeting; the return of the metal has to be measured over an event window. To account for information leakage before and after the event this study will use 5 days before (T-5) and 5 days (T+5) after the event as the event window, leading to a period of 11 days in which returns can be generated. In order to perform the event-study, it has to be assumed that demand for oil around OPEC announcements is constant (for non-crisis periods), hence a tight event-window is also advisable. However, it still needs to account for the full aggregate effect of the OPEC announcements. Hence, an event window of [−5,5] days seems to be a good compromise (as in Bina & Vo, 2007). While many papers measure OPEC's influence in these event windows, they find that OPEC's power is visible in the short term, but less certain of such pricing power in the long term. At longer time frame's the volatility after the meetings appears to fall. This is exactly why I limit my event window from five days before to the five days concluding an OPEC meeting.

Returns were characterized as the logarithmic difference between the daily prices of metal futures (F) for each return, i, at time t. The core of event study methodology is the estimation of excess or abnormal returns; this can be defined as the difference between the actual ex post return of an underlying asset deducted by the normal return. This can be defined as:

$$(1)\ AR_{i,t} = R_{i,t} - E(R_{i,t})$$

In this equation $AR_{i,t}$, abnormal return is $R_{i,t}$, the return of metal i on day t less $E(R_{i,t})$, the normal expected return for event i at time t. This thesis will consider each OPEC meeting during our time frame as an event. Returns were characterized as the logarithmic difference between the daily prices of each metal future (F) for each return, i, at time t. This was also done for the return of the variables VIX, OVX, GVZ and DXY for the volatility regression.

$$(2)\ RF_{i,t} = \ln\left(F_{i,t}\right) - \ln\left(F_{i,t-1}\right)$$

In which $RF_{i,t}$ is the daily logarithmic return of the metal and variable. Two models will be used to calculate the abnormal returns. First the market model in which returns will be judged based off the returns of a benchmark, the SPGSIN, an index with majority exposure to industrial metals.

$$(3)\ RF_{i,t} = \beta 0 + \beta 1 RM_t + \varepsilon_i$$

In equation (3), $\beta 0$ captures the coefficient of the intercept, or the return of the metal not explained by the return of the market RM. $\beta 1 RM_t$ is the slope coefficient of the index, the SPGSIN. The benchmark SPGSIN, S&P GSCI Industrial Metals, was used. This was chosen over SPGSCI, the S&P GSCI commodity index, as its return is more related to metals, then the entire basket of commodities the SPGSCI takes into account including energy. Other indexes such as the GSCI, BCI or the DJCI were also considered, however prices were not available for these for the period analyzed. Epsilon accounts for the error between the predicted return of the model and the actual return for each day. The market model will be analyzed on Gold, Silver and Copper increase, decrease and maintain decisions.

The second model considered will be solely focusing on raw returns. With a short event window of only a few days, previous research has highlighted that expected returns are of less concern and that it is acceptable to simply use the actual returns in place of abnormal returns (Schopohl 2019). An event window over a shorter period of time assumes that the expected return is equal to zero. Thus, the raw returns are equal to the abnormal returns. This approach assumes that benchmark returns were actually zero, which is common in event studies with an event window that does not overlap with other events, i.e. OPEC meetings, or account for a post estimation period (e.g. Deaves & Krinsky, 1992; Henderson et al., 2014). There will be a section focused on Day 0, as the day of the announcement usually attracts the most attention from media outlets and traders. Thus, in my raw returns model for each metal, abnormal returns (4) will be given its actual return in (2) instead of (1).

$$(4)\ AR(F)_{i,t} = R(F)_{i,t}$$

With our abnormal returns equalling the raw returns for each day, the Cumulated Abnormal Return, CAR, for each day was found using:

$$(5)\ CAR_i(t) = \sum_{t}^{n} AR\,(F)_{i,t}$$

Here in equation (5), the daily logarithmic return was found for all days across event window for each metal. The returns for each day, for example Day 0, were summed together to produce the CAR for that day. (t) stands for the specific day over the event window (-5…5).

Then to obtain the Cumulated Average Abnormal Return, I will calculate the mean abnormal returns of each metal for each day. For each day:

$$(6)\ CAAR_i(t) = \frac{1}{n}\sum CAR(F)_{i,t}$$

Here ‘n’ equals the amount of OPEC meetings that occurred on that specific day of the event window. For example, there were 28 Day 5 events for Gold for decisions to cut. Similarly, this was done for each 11-day window.

$$(7)\ CAAR_i(t1, t2) = \sum_{t1}^{t2} CAAR_{i(t)}$$

To bulletproof my results, this 11-day CAAR calculated by adding all of the individual days CAARs together, was compared against the average of the sum of the CARs, (another method of computing the CAAR) was employed which produced the same result.

$$(8)\ CAAR_i(t1, t2) = \frac{1}{11}\sum_{t1}^{t2} CAR_{i(t)}$$

Choosing an event window of 11 days means that t1 will be -5 and t2 +5. This will account for the five days before the OPEC announcement, the day of the meeting, and the following five days after. The five days before could better depict the returns before the announcement and the five days after would capture the post-meeting’s effect. Some of the meetings occurred on a weekend or non-trading day. This was remedied by comparing the event dates of each meeting to the days the futures contracts were traded on. For example, if the press release concludes the meeting on a Sunday, the previous Friday will count as Day -1 and Monday will be +1. Thus, while each OPEC meeting will have abnormal returns five days before and five days after, there will be less observations for Day 0 which is accounted for.

With these CAARs for each metal calculated, the following hypotheses will be tested for Hypothesis 1 and 2:
H0: CAARs across the event-window are equal to zero.
H1: CAARs across the event-window are different from zero.

In order to be able to assess if the null hypothesis can be rejected, a 95% confidence interval will be computed with the below equation. But first, descriptive statistics were gathered such as the mean, standard error, and number of events. The standard error was found using the equation below:

$$(9)\ SE = \frac{(Standard\ Deviation\ of\ the\ Sample)}{Number\ of\ Events}$$

In which Number of Events or the count, stands for number of meetings in the sample or the number of specific event days for the individual days. Then the T statistic was calculated by:

$$(10)\ T\ Statistic = \frac{Mean\ Return\ of\ Sample}{SE}$$

Then to compare significance, the critical T value was found at the 95% confidence level. To find the critical t-value, I used Excel's built-in function T.INV.2T. The function T.INV.2T is designed to return the critical value from two-tailed Student's t-distribution. The alpha was set at 0.05 to account for the test of 95%. The degrees of freedom were calculated by subtracting 1 from the sample, n – 1. The values for the T statistics were then compared against their Critical T Values. If the absolute value of the T statistic was found to be larger than the Critical T Values, I rejected the null hypothesis that the CAARs across the event window were equal to zero.

$$(11)\ |\mathrm{t}|\ statistic\ \geq \text{Critical T Value : Reject the Null Hypothesis}$$
$$(12)\ |\mathrm{t}|\ statistic\ < \text{Critical T Value : Accept the Null Hypothesis}$$

4.2 Volatility Regression

Regarding, *Hypothesis 3: The volatility and price action of the precious metals over the event window, is influenced more by the lagged volatility indicator OVX than the VIX or GVZ indicators*. This will be tested using a multilinear factor regression on STATA. To find out which volatility index has the largest affect, I will regress these variables against each metal and judge their significance. The GVZ began more recently than the VIX, and so this limits my period of analysis from September 2008-June 2024. 65 OPEC meetings occurred over this timeframe, with 21 cuts, 11 increase and 33 maintain.

Something to note is that while this is a 16-year period, only 11-day event windows of each meeting were taken into account. The regression will look like this:

$$(13)\ MFR = \beta 0 + \beta 1 OVX + \beta 2 GVZ + \beta 3 VIX + \beta 4 DXY + \beta 5 PPI + \epsilon$$

In which MFR stands for each metal's daily logarithmic return. All five metals will be used as MFR, the dependent variable in these regressions. β0 represents the intercept or constant term. β1, β2, β3, β4 are the regression coefficients associated with each daily logarithmic return of the independent variables (OVX returns, VIX returns, GVZ returns, DXY returns). Daily returns were calculated using equation (2). β5 is the regression coefficient for PPI returns. With PPI data released monthly its most recent reading was expanded to include all dates in that month. The regression's coefficients for each metal were tested at multiple levels of significance.

A barrage of tests were run against the regressions to test for many qualities such as collinearity, endogeneity and autocorrelation. First the Durbin Watson test was used to determine if there was autocorrelation across the residuals of the models. The Durbin Watson d statistic was found to be 1.33, 1.46, 1.15, 1.29 and 1.04 for the metals, Gold, Silver, Copper, Platinum and Palladium respectively. With all values being less than 2, this indicated some positive autocorrelation. Therefore, to correct for this first-order autocorrelation in the residuals of the regressions, the Prais-Winsten method was implemented instead of the classic 'regression' command. The regressions were also tested for heteroskedasticity. The Breusch-Pagan Test and White's General test were used on all regressions. It was found that heteroskedasticity was present among all regressions meaning that the variance of the errors or the residuals were not constant across all levels of the independent variables. If heteroskedasticity is present and not addressed, the standard errors could be biased and not reflect the coefficients of the variables as accurately and possibly lead to inaccurate conclusions. To circumvent this, "robust" was also employed in the command.

CHAPTER 5 Results

5.1 Market Model

First, the market model was implemented to assess whether each metal's abnormal return was influenced by the return of the chosen benchmark, the SPGSIN. The market model was only used for Gold, Silver and Copper as Palladium and Platinum price information was regularly not traded on the same days as the benchmark. Decisions by OPEC to increase, decrease and maintain their production quota were analyzed individually.

	GOLD			SILVER			COPPER		
Decisions	Cut	Increase	Maintain	Cut	Increase	Maintain	Cut	Increase	Maintain
Multiple R	0.239	0.341	0.376	0.322	0.385	0.431	0.865	0.641	0.849
R Square	0.057	0.116	0.142	0.104	0.148	0.186	0.749	0.411	0.721
Adj. R Sq.	0.054	0.112	0.140	0.101	0.144	0.184	0.748	0.408	0.720
St. Error	0.013	0.008	0.011	0.023	0.014	0.019	0.010	0.012	0.008
Observations	303	197	548	302	198	546	303	196	544

ANOVA GOLD

CUT	df	SS	MS	F	Significance F
Regression	1	0.003	0.003	18.227	0.000
Residual	301	0.048	0.000		
Total	302	0.051			
INC					
Regression	1	0.002	0.002	25.688	0.000
Residual	195	0.013	0.000		
Total	196	0.015			
MAINTAIN					
Regression	1	0.011	0.011	90.089	0.000
Residual	546	0.066	0.000		
Total	547	0.077			

CUT	Coefficients	St.Error	t Stat	P-value	L95%	U95%
Intercept	0.001	0.001	1.097	0.273	-0.001	0.002
SPGSIN	0.210	0.049	4.269	0.000	0.113	0.307
INC						
Intercept	0.000	0.001	0.521	0.603	-0.001	0.001
SPGSIN	0.235	0.046	5.068	0.000	0.143	0.326
MAINTAIN						
Intercept	-0.001	0.000	-1.184	0.237	-0.001	0.000
SPGSIN	0.336	0.035	9.492	0.000	0.267	0.406

ANOVA SILVER

CUT	df	SS	MS	F	Significance F
Regression	1	0.019	0.019	34.665	0.000
Residual	300	0.163	0.001		
Total	301	0.182			
INC					
Regression	1	0.007	0.007	34.023	0.000
Residual	196	0.040	0.000		
Total	197	0.047			
MAINTAIN					
Regression	1	0.044	0.044	124.158	0.000
Residual	544	0.194	0.000		
Total	545	0.238			

CUT	Coefficients	St.Error	t Stat	P-value	L 95%	U 95%
Intercept	0.000	0.001	0.162	0.871	-0.002	0.003
SPGSIN	0.530	0.090	5.888	0.000	0.353	0.707
INC						
Intercept	-0.002	0.001	-1.590	0.114	-0.004	0.000
SPGSIN	0.473	0.081	5.833	0.000	0.313	0.633
MAINT						
Intercept	0.000	0.001	-0.307	0.759	-0.002	0.001
SPGSIN	0.673	0.060	11.143	0.000	0.554	0.792

ANOVA COPPER

CUT	df	SS	MS	F	Significance F
Regression	1	0.083	0.083	896.743	0.000
Residual	301	0.028	0.000		
Total	302	0.111			
INC					
Regression	1	0.019	0.019	135.492	0.000
Residual	194	0.028	0.000		
Total	195	0.047			
MAINTAIN					
Regression	1	0.099	0.099	1399.769	0.000
Residual	542	0.038	0.000		
Total	543	0.137			

CUT	Coefficient	St. Error	t Stat	P-value	L 95%	U 95%
Intercept	-0.001	0.001	-0.949	0.344	-0.002	0.001
SPGSIN	1.120	0.037	29.946	0.000	1.047	1.194
INC						
Intercept	0.000	0.001	0.119	0.905	-0.002	0.002
SPGSIN	0.790	0.068	11.640	0.000	0.656	0.924
MAINTAIN						
Intercept	0.000	0.000	0.384	0.701	-0.001	0.001
SPGSIN	1.012	0.027	37.413	0.000	0.959	1.066

Table 2: Market Model Regression Results and Analysis of Variance for Gold, Silver, Copper against SPGSIN from 2002-2024 for all three OPEC decisions over the 11 day (-5,5) window across 96 meetings.

Across each of the three metals, we see a positive relationship with the benchmark's returns to the metals' returns as expected. All of the results are significant at the 99% confidence level for each OPEC decision. The benchmark explains Copper's returns the most, Silver the second-most and Gold the least. This makes sense as the benchmark, the SPGSIN stands for the S&P GSCI Industrial Metals Spot Index. With Copper, more popularly classified as an industrial metal, its weight across the index is likely higher than the weights assigned to the more commonly classified 'precious' metals Gold and Silver. Finding the exact components of the index was unavailable. Other indexes that might have sounded more suitable did not provide price information for the period studied.

For decisions to cut production, the index's coefficients for Gold, Silver and Copper are 0.21, 0.53 and 1.12 respectively. Thus, for every increase of 1% in the return of SPGSIN over the 11-day event windows over 22 years, Gold's return was expected to increase 0.21%, Silver 0.53% and Copper 1.12%. For decisions to increase production, the index's coefficients were 0.25, 0.47 and 0.79 for Gold, Silver and Copper. For decisions to maintain production, we see index coefficients of 0.34, 0.67 and 1.01 respectively. For Gold and Silver, decisions to maintain, exhibited the largest influence on the metals. Whereas for Copper, the benchmark's returns for decisions to increase production explains the abnormal returns much less, 20-30% less than decisions to cut or maintain production.

5.2 Raw Returns Model

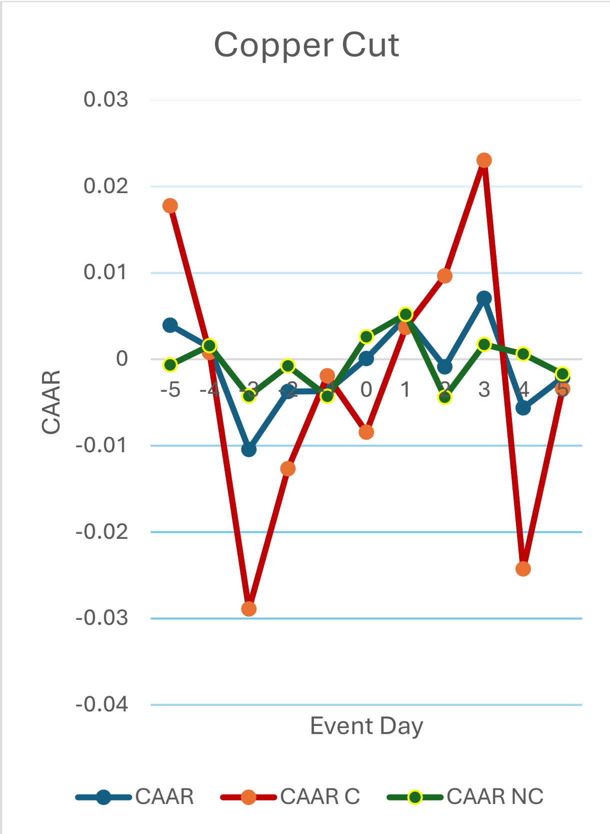
The raw returns were the main focus of my thesis - and how I will test for hypotheses 1 and 2. With each OPEC meeting categorised as either increase, decrease or maintain production, the CAARs were gathered for each day of each meeting for each metal. The CAAR were also found for the entire 11-day event window for each metal of each meeting. The CAARs were divided into three categories: CAAR which encompasses all periods, CAAR C which accounts for meetings during the crisis period, and CAAR NC accounting for meetings occurring not during the crisis period.

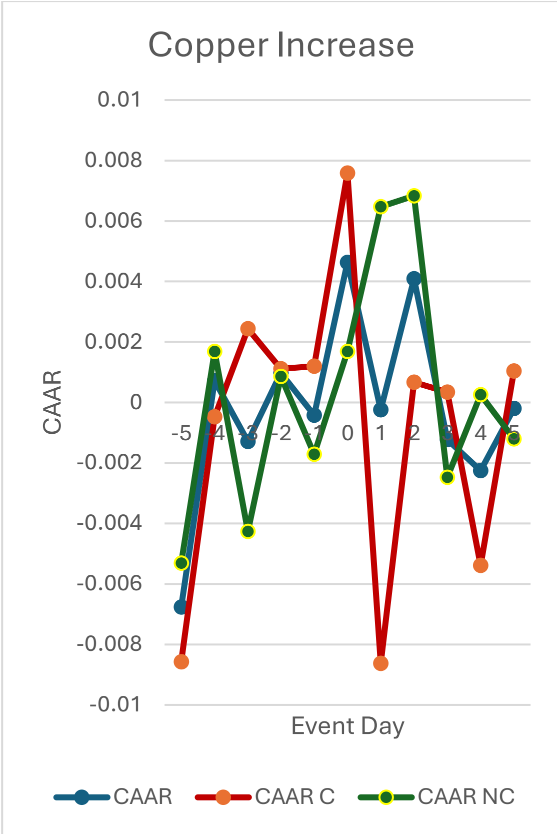
Below are the descriptive statistics for each metal over the 11-day (-5,5) event window discriminating between the three periods. The graphs of each metals CAAR are also presented below. The blue line accounts for the entire period 2002-2024. The red line designates the CAARs calculated over the crisis period: 2007-2011, 2020, 2022. The green line represents the CAARs over the non-crisis period: 2002-2006, 2011-2019, 2021, 2023-2024.

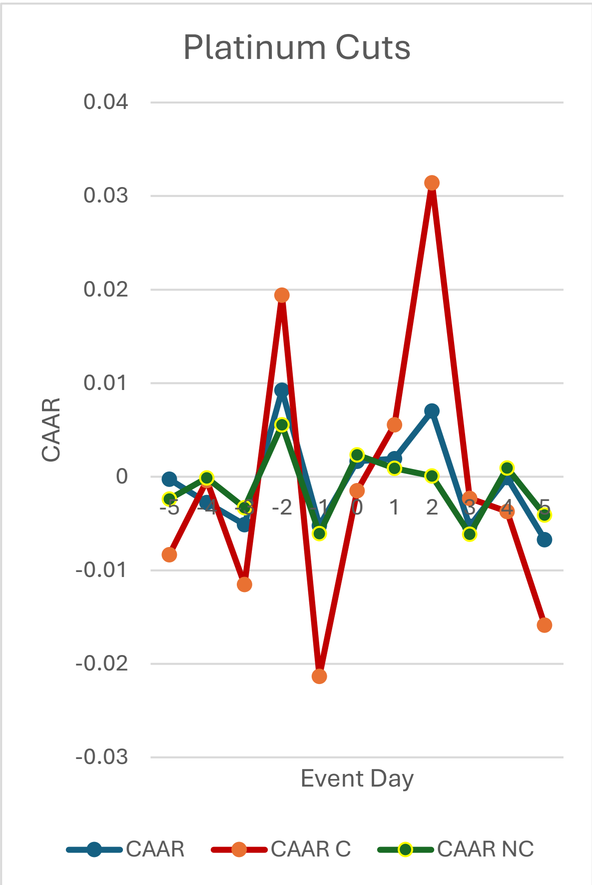
	Max	Min	Mean	Median	St.D	Skew	Kurt	Count	T statistic	Critical T Value	95% Sig
Gold 11 Day Cuts	0.086	-0.044	0.001	0.001	0.013	0.601	6.713	302	0.949	1.968	No
C Cuts	0.086	-0.044	0.001	-0.001	0.020	0.992	3.644	75	0.350	1.993	No
NC Cuts	0.027	-0.042	0.001	0.001	0.010	-0.788	2.158	227	1.043	1.971	No
Gold Inc	0.029	-0.025	0.000	0.000	0.009	-0.103	0.788	196	0.386	1.972	No
C Inc	0.029	-0.025	0.001	0.001	0.010	-0.150	0.664	88	0.484	1.988	No
NC Inc	0.020	-0.023	0.000	0.000	0.008	-0.073	0.711	108	0.036	1.982	No
Gold M	0.075	-0.055	0.000	0.001	0.012	-0.338	4.786	544	-0.635	1.964	No
C M	0.075	-0.047	0.000	0.001	0.013	0.258	5.749	217	0.023	1.971	No
NC M	0.036	-0.055	0.000	0.000	0.011	-0.885	2.844	327	-0.825	1.967	No
Silver 11 Day Cuts	0.109	-0.101	0.000	0.001	0.024	-0.051	4.141	302	-0.003	1.968	No
C Cuts	0.109	-0.073	0.001	-0.006	0.035	0.707	0.943	75	0.169	1.993	No
NC Cuts	0.044	-0.101	0.000	0.001	0.019	-1.612	6.527	227	-0.185	1.971	No
Silver Inc	0.066	-0.046	-0.002	-0.001	0.016	0.349	3.089	196	-1.584	1.972	No
C Inc	0.066	-0.043	-0.001	0.002	0.018	0.790	3.114	88	-0.411	1.988	No
NC Inc	0.029	-0.046	-0.003	-0.002	0.013	-0.688	1.065	108	-1.990	1.982	Yes
Silver M	0.125	-0.107	0.000	0.002	0.021	-0.309	5.263	544	0.191	1.964	No
C M	0.125	-0.107	0.001	0.004	0.026	-0.069	4.144	217	0.568	1.971	No
NC M	0.071	-0.090	0.000	0.001	0.017	-0.881	4.451	327	-0.384	1.967	No
Copper 11 Day Cuts	0.116	-0.097	-0.001	0.001	0.019	-0.151	7.637	302	-0.797	1.968	No
C Cuts	0.116	-0.097	-0.002	0.001	0.031	0.043	3.318	75	-0.599	1.993	No
NC Cuts	0.045	-0.048	0.000	0.001	0.013	-0.375	1.402	227	-0.520	1.971	No
Copper Inc	0.050	-0.060	0.000	-0.001	0.015	-0.333	1.922	196	-0.344	1.972	No
C Inc	0.050	-0.051	-0.001	-0.001	0.015	-0.094	2.070	88	-0.680	1.988	No
NC Inc	0.038	-0.060	0.000	-0.001	0.015	-0.539	2.033	108	0.157	1.982	No
Copper M	0.056	-0.066	0.001	0.000	0.016	-0.049	1.544	544	1.097	1.964	No
C M	0.056	-0.048	0.003	0.002	0.018	0.212	0.407	217	2.205	1.971	Yes
NC M	0.050	-0.066	-0.001	0.000	0.015	-0.465	2.583	327	-0.619	1.967	No
Palladium 11 Day Cuts	0.102	-0.049	0.000	0.001	0.019	0.708	4.166	193	-0.084	1.972	No
C Cuts	0.060	-0.046	0.001	0.000	0.022	0.483	0.768	43	0.252	2.018	No
NC Cuts	0.102	-0.049	0.000	0.001	0.018	0.800	6.012	150	-0.266	1.976	No
Palladium Inc	0.053	-0.078	-0.003	-0.001	0.025	-0.558	0.678	121	-1.354	1.980	No
C Inc	0.053	-0.078	-0.003	-0.002	0.027	-0.412	0.449	77	-1.060	1.992	No
NC Inc	0.024	-0.060	-0.003	0.001	0.021	-1.066	1.055	44	-0.861	2.017	No
Palladium M	0.077	-0.107	0.000	0.000	0.020	-0.240	3.371	348	-0.225	1.967	No
C M	0.077	-0.107	0.000	0.001	0.022	-0.400	3.773	162	0.048	1.975	No
NC M	0.061	-0.055	-0.001	-0.001	0.017	0.033	1.523	186	-0.407	1.973	No
Platinum 11 Day Cuts	0.083	-0.049	0.000	-0.001	0.017	0.511	2.845	197	-0.383	1.972	No
C Cuts	0.083	-0.045	0.002	-0.001	0.023	0.905	2.421	43	0.460	2.018	No
NC Cuts	0.044	-0.049	-0.001	0.000	0.015	-0.111	0.930	154	-0.877	1.976	No
Platinum Inc	0.044	-0.042	0.000	0.001	0.017	0.143	-0.022	121	0.260	1.980	No
C Inc	0.044	-0.042	0.001	0.000	0.017	0.412	0.003	77	0.550	1.992	No
NC Inc	0.026	-0.039	-0.001	0.001	0.017	-0.437	-0.241	44	-0.320	2.017	No
Platinum M	0.072	-0.124	-0.001	0.000	0.016	-1.136	11.192	328	-0.582	1.967	No
C M	0.072	-0.124	-0.002	-0.001	0.019	-1.673	13.037	142	-0.954	1.977	No
NC M	0.045	-0.052	0.000	0.000	0.014	0.094	2.293	186	0.230	1.973	No

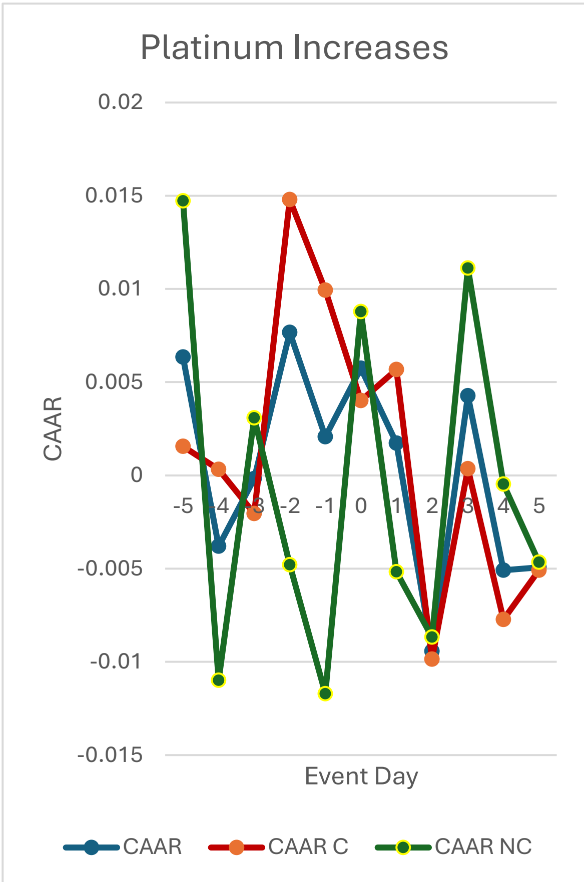
Table 3: Descriptive Statistics for the 5 metals for the 3 OPEC decisions over the 3 periods over the event window (-5,5). Yellow shading indicates CAAR (-5,5) significance at the 95% level.

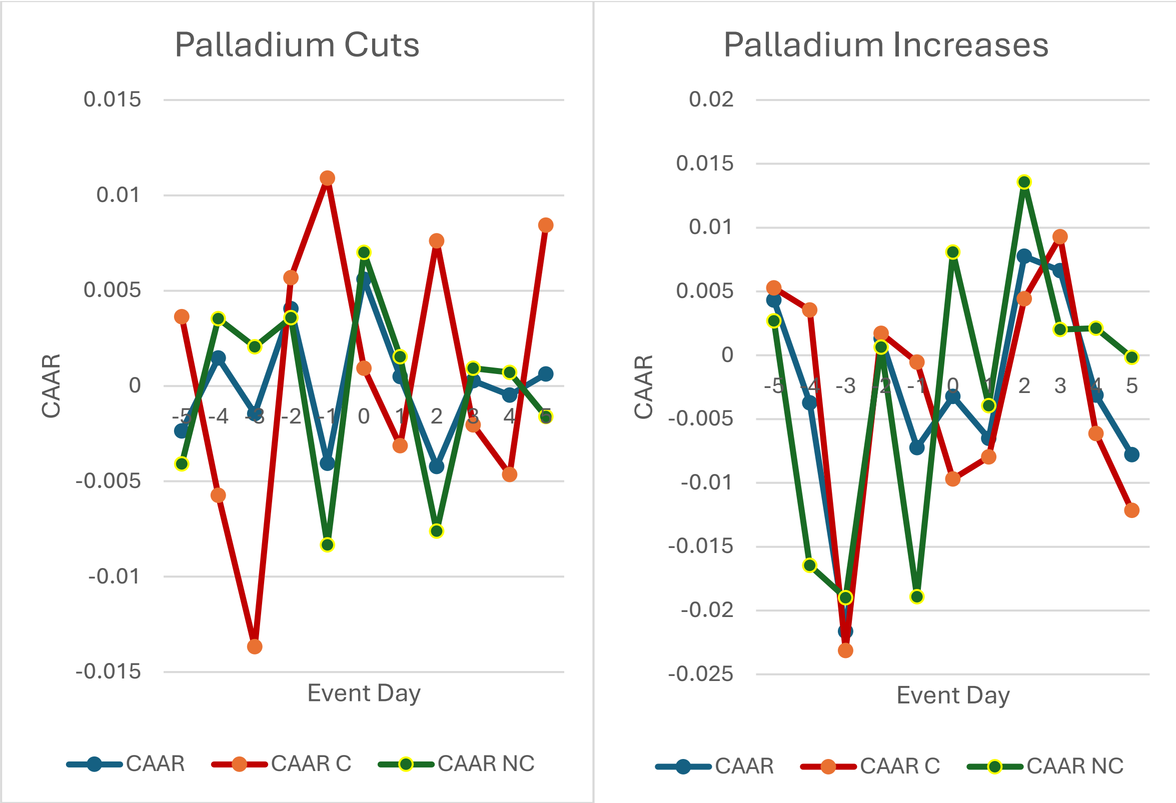

Gold Cuts
0.008
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
-0.01
CAAR
Event Day
CAAR
CAAR C
CAAR NC
Gold Increase
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
CAAR
Event Day
CAAR
CAAR C
CAAR NC
Silver Cuts
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
CAAR
Event Day
CAAR
CAAR C
CAAR NC
Silver Increase
0.008
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
-0.01
-0.012
-0.014
CAAR
Event Day
CAAR
CAAR C
CAAR NC


Copper Cut
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
CAAR
-5 -4 -3 -2 -1 0 1 2 3 4 5
Event Day
CAAR
CAAR C
CAAR NC


Copper Increase
0.01
0.008
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
-0.01
CAAR
-5 -4 -3 -2 -1 0 1 2 3 4 5
Event Day
CAAR
CAAR C
CAAR NC


Platinum Cuts
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
CAAR
-5 -4 -3 -2 -1 0 1 2 3 4 5
Event Day
CAAR
CAAR C
CAAR NC


Platinum Increases
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
CAAR
-5 -4 -3 -2 -1 0 1 2 3 4 5
Event Day
CAAR
CAAR C
CAAR NC



Graph Set 1: Presents the CAARs for each day for each metal for OPEC increase and decrease decisions, for all three periods.

I will now discuss the CAAR's observed for each day over the event window. First for Gold cuts, CAAR is only negative on Day -3 and Day 2. CAAR crisis is broadly positive but there is a large drop-off of -0.009 on Day -3. For CAAR NC we see positive CAARs up until the second day after the meeting in which it drops off, rising again for Day 3 and 4 before falling negative for Day 5. For Gold increases, we see positive CAAR values for Day -4 to 0. Negative CAARs are seen for the following days after the meeting except Day 4. For CAAR C, positive values are seen in the days leading up to the announcement, negative for Day 1, 2,3 and positive for Day 4 and 5. For CAAR NC the results are more mixed. Initially on Day -5, the CAAR is negative on Day -5, but produces mainly positive values up until Day 3. For Silver cut decisions, CAAR is mainly positive in the days leading up to the meeting and negative in the following days. CAAR crises are more volatile but similar in that the days before the meeting produce positive CAAR and mainly negative following the meeting. Some large Crisis CAARs include -0.011 on Day 0, and 0.012 on Day 4. For CAAR NC initially we have positive CAARs for Days -5, -4, -3 before going negative for -2 and -1, positive on the day of the meeting Day 0, and then mainly negative following it. For Silver increase decisions, the only positive CAAR values fall on days -2, 0 and 4. For CAAR crisis, we see different results. CAARs are positive in the lead-up to the meeting, negative the day before Day -1, positive Day 0 and then mainly negative following the meeting. An interesting takeaway is the difference between the large negative CAAR C value on Day 2 to a large positive CAAR the following day. For CAAR NC, we see negative CAARs before the meeting with these values increasing towards 0 as we move to Day 0. The CAARs on the days after provide mixed results with some positive and some negative. Regarding Copper, CAARs for the entire period and for non-crisis periods for cut decisions were mixed with most CAARs hovering around 0. For CAAR C we see a more volatile CAAR line with the CAAR going negative on Day -3 before slowly increasing the negative CAARs until after the meeting on Day 1. Days 1 to 3 produce positive CAARs before turning negative on Day 4 and 5. For CAAR C, some large CAARs were found, such as -0.029 on Day -3, 0.023 on Day 3, and -0.024 on day 4. For increase decisions, CAARs are negative except for Day -4, 0 and 2 with the largest being 0.0046. For CAAR C we see increased volatility with larger negative values and larger positive values. Starting off at Day -5 with a negative CAAR, the CAARs increase positively until we reach Day 1 when the CAAR spikes down. Now bringing our attention to Platinum, for decisions to cut we see negative CAARs less than 0.012% of all three periods in the first 3 days with the crisis being the lowest. From Day -2 to 2 the total period CAAR are positive, negative, positive, positive, positive with double the amount during crisis periods. Days 3 to 5 are negative for all periods except for non-crisis. Day 2 for Platinum Cut decisions produced the largest CAAR across the entire sample with a value of 0.031 however the low sample of 4 meetings explains this. Turning to the CAARs for OPEC decisions to increase production we see CAARs for the total period to be positive from Day -3 to 2. Then we see three out of the remaining four days to have negative CAARs for increase decisions in the total period. Turning to Palladium, for cut decisions we see low CAARs initially and then an increase in the range of CAARs for period (-2,2). Also, the crisis period's CAARs are much larger for both positive and negative values, but a low sample of 4 out of 11 account for this. For Palladium increases, we see CAARs ranging from (0.008 to -0.22) over the entire period. These individual days of the event window were tested at 95% level of significance. Many of the days results turned out to be insignificant however Copper, Platinum and Palladium all showed multiple days with significant CAARs across the meetings and periods. The descriptive statistics of all days and for the event window for all metals are provided in the Appendix.

Now I turn my attention to the CAAR (-5,5) of the event window. Focusing on Gold first, we mainly see positive results. For decisions to cut and increase, we see positive CAARs for the entire 11 days for the entire period, crisis and non-crisis periods. For Silver, the 11-day CAARs are negative for all periods for cut and increase decisions. For maintain decisions, CAARs were positive for the entire period and the crisis period but negative for the non-crisis period. Similarly, none of these Gold and Silver CAARs were significant at the 95% level of confidence except for Silver's negative CAAR of -0.0027 exhibited during the non-crisis period for increase decisions. For Copper, a cut decision produced a negative CAAR for all periods. For increase decisions, the CAARs were negative, negative and positive for the entire period, crisis period and non-crisis period respectively. For maintain decisions, all CAARs were negative. Once again, only one of the nine distinctions were significant– the negative CAAR (-1E-05) for maintain decisions during crisis periods. For Platinum, CAARs (-5,5) were negative during all periods for cut decisions. For increase decisions, CAARs were positive for the entire period and for the crisis period, but negative for the non-crisis period. Regarding Palladium, decisions to cut yielded a negative CAAR for the total period and for non-crisis but a positive CAAR for the crisis period. Finally, increase decisions by OPEC produced a negative CAAR for all periods.

Looking at the graphs, we see that the CAAR during crisis periods is more volatile exhibiting higher positive values and lower negative values. This was expected as mentioned earlier, during crisis periods there is an increase in uncertainty. Increases in uncertainty can incentivize risk aversion and so this could lead to the metals being used as a hedge more. With an increase in trading volume volatility is likely to increase too. Focusing on Day 0, the announcement day, for cut and increase decisions, for the designated periods (C + NC) I report positive CAARs for all metals, except Silver, Copper and Platinum Cuts Crises, and Palladium Increase Crisis. We see a spike in Day 0 in the graphs for Gold, Copper and Platinum Increases for the entire period CAAR. Many of the graphs show a drop in CAAR as we go from Day -2 to Day 1 before an increase for Day 0. For 5 of the 10 graphs shown, the blue line CAAR encompassing all periods, its Day 0 contains the largest positive spike over the event window. Summarizing, for Gold for all three decisions, CAARs were broadly positive in the lead-up to the meeting, and mainly negative in the 5 days after. Gold CAARs were notably less in magnitude than the volatility exhibited in the Copper and Platinum returns. For cut decisions, Gold, Silver and Copper all had positive CAARs on Day 3, with a spike of double the magnitude for CAAR C. Silver CAARS for the three decisions appear to be less influenced over the event window. Copper especially for increase decisions appears to react positively to the OPEC event window meeting.

5.3 Volatility Analysis

The Variance Inflation Factor, VIF, was employed to test for multicollinearity across the regressions. If multicollinearity is present, this would mean that two or more of the independent variables are highly correlated with each other. For the metals, Gold, Silver, Copper, Platinum and Palladium, the mean VIF was found to be 1.17, 1.17, 1.17, 1.20 and 1.18 respectively. With values close to 1 this suggests that multicollinearity is minimal among the variables and that the results of the regression are unlikely to be affected by severe multicollinearity and so this was recognised.

	Gold	Silver	Copper	Platinum	Palladium
OVX	0.0015	-0.0213	-0.0333**	-0.0068	-0.0139
	-0.0072	-0.0186	-0.0131	-0.0103	-0.0155
GVZ	0.0175	0.0294	0.0027	-0.0036	0.0005
	-0.0192	-0.0325	-0.0182	-0.0212	-0.0241
VIX	-0.0007	-0.0103	-0.0053	-0.0185	-0.0142
	-0.0093	-0.0174	-0.0131	-0.0125	-0.0199
DXY	-0.971***	-1.546***	-1.173***	-1.542***	-1.384***
	-0.1900	-0.3410	-0.2240	-0.1620	-0.2870
PPI	0.0238	-0.0793	0.0000	-0.0389	-0.1260
	-0.0416	-0.0698	-0.0993	-0.0623	-0.1010
Constant	0.0001	0.0010	0.0004	0.0003	0.0015
	-0.0005	-0.0009	-0.0010	-0.0008	-0.0012
Observations	469	470	473	428	451
R-squared	0.181	0.149	0.149	0.193	0.106
Adj R squ	0.1719	0.1397	0.1395	0.1839	0.0961
F Statistic	20.44	16.23	16.3	20.25	10.57

Table 4: Regression Coefficients with Standard Errors for the 5 metals over the 11-day event window of 65 OPEC announcements from 2008-2024. Standard errors in parentheses. *** p<0.01, ** p<0.05

As expected, the DXY exhibits a significant negative impact on all metals with the strongest to weakest being Silver, Platinum, Palladium, Copper and Gold in line with recent research (Kocaarslan (2024). Originally, I would have assumed that the DXY would have had the largest effect on Gold among the metals because of how important and popular the metal is compared to the others when hedging movements in oil prices and dollar strength. Maybe this is due to less liquidity and volume for the other metals. The reaction of OVX was shown to be statistically significant at the 95% level for changes in copper. That for every 1% increase in OVX returns, copper futures are expected to decrease by 0.0333 return. That an increase in the expected future implied volatility of oil futures over the event window decreases the future price of copper. An increase in OVX, usually assumes that there will be an increase in expected volatility in the oil markets. This could imply that during the 11-day event windows in the lead up and aftermath of OPEC's meetings, an increase in uncertainty and volatility could lead traders and hedgers to seek a haven in other assets. Traders with long positions in copper, seeing an increase in OVX, could seek returns in other metals that have a higher probability of a larger price movements or returns. And so, Copper might not be used as a hedge compared to the other metals as much during the event window. Something to note is the low value of the R-squared, indicating that my independent variables explain between 10.6% and 19.3% of the variance across the metals. That a large proportion of the variance in metal prices is explained by factors not included in these regressions. This was remedied with my robustness tests which I will discuss later.

Regarding Gold, the OVX and GVZ's coefficients are positive, implying that an increase in either of these increases the return on the futures contract. This is in contrast to OVX's reaction on the other metals, in which its daily change exhibits a negative relationship to the daily change of Silver, Copper, Platinum and Palladium. The GVZ as predicted, has a positive coefficient with all metals excluding Platinum. The popular VIX index exhibits a negative relationship with all five metals indicating that an increase in the return of the fear gauge or the future volatility of S&P 500 option contracts decreases the return of the metals. The PPI's coefficients for Gold and Copper are positive while negative for Silver, Platinum and Palladium.

Regarding Hypothesis 3, that OVX exhibits more of an influence than GVZ is inconclusive and so rejected as most of the regression's coefficients are not significant. Forgetting about significance for a moment, regarding the absolute values of the coefficients, for Gold and Silver we see GVZ's coefficient being larger than OVX but also having much larger standard errors. For Copper, OVX is significant, and its absolute value is larger than GVZ. For Platinum and Palladium, the absolute values of OVX are higher than GVZ. Another interesting aspect is that for Platinum, all variables contain negative coefficients, implying that an increase in the daily return of any of these will affect the daily return of the Platinum futures contract negatively. Before my analysis I had assumed that GVZ returns would influence metals prices more than the OVX index because gold is more related to other metals than oil is to other metals. However, with the reduction of trading days in which I only allowed for the 11 days surrounding the OPEC meeting instead of every available historical trading day, this brought me to the hypothesis that over a shorter period, and surrounding a notable event in the oil market, OVX could command more of a presence than the GVZ across the metals.

5.4 Robustness Tests

To account for noise in the volatility analysis the initial regressions were also ran over a shorter event window of 7 days (-3,+3). To control for omitted variable bias, I also inserted the four other metals into the regression. This strengthened the R-squared for Gold and Silver to 0.67. The results were striking and produced more results with significance at the 95% and 99% level. Gold's return is shown to influence Silver strongly with a coefficient of 1.308, and Silver, Platinum and Palladium exhibiting a positive relationship with the other four metals. Both robustness tests are located in the Appendix as Table 11 and Table 12.

CHAPTER 6 Discussion and Conclusion

The main goal of this thesis was to analyse the following research question: *Are OPEC announcement decisions a driver of returns and volatilities across the precious and industrial metals markets?*
This question was divided into three hypotheses, the first, *H1: During non-crisis periods, an oil production output decrease by OPEC will generate positive abnormal returns among metals around the announcement. By contrast, a production output increase will generate negative abnormal returns. H2: During crisis periods, an oil production output decrease will decrease the price of oil futures, and thus metal futures, consequentially generating negative abnormal returns around the announcement. Conversely, a production output increase in crisis periods will result in positive abnormal returns.*

This question was answered by looking at 5 metals futures over an event window 5 days before and 5 days after 96 meetings over the period 2002-2024. The question was answered via an event-study approach, in which the date of the press release concluding the meeting served as Day 0 in my event window. After interpreting the data, the insignificant results received means is difficult to come to an absolute conclusion regarding if the metals experienced an abnormal return over the period. Thus, with *H1* I expected during non-crisis NC periods, metals to have positive CAARs (-5,5) during cut decisions and negative CAARs for increase decisions. For cuts Gold was the only metal to have a positive CAAR NC while the remaining were negative. For increases Silver, Platinum and Palladium had negative CAAR NCs. The only significant CAAR the non-crisis period was Silver with its negative CAAR of -0.00268 for an increase decision. This leads me to reject hypothesis 1.

Regarding *H2*, I hypothesised that during crisis periods, decisions to cut would produce negative CAARs (-5,5) and decisions to increase oil production would generate positive CAARs. For OPEC cut decisions during the crisis periods, positive CAARs were seen in Gold, Platinum and Palladium, with Silver and Copper negative. For increase decisions during the crisis periods, only Gold and Platinum had positive CAARs. With none of these CAARs significant, I cannot conclusively state that OPEC's production decisions during crisis and non-crisis periods have a consistent or significant impact on the cumulative average abnormal returns of these precious metals. Therefore, I reject H1 and H2, indicating that there is insufficient evidence to support the hypothesis that OPEC's production decisions during crisis periods consistently produce the expected negative or positive CAARs for these metals. Further research is needed to explore other factors that may influence CAARs during such periods. Initially I expected the results to be in line with both of my hypothesis or at least for the other metals to move in the same direction as Gold, however I was proved wrong as it seems that the (-5,5) CAAR of the four other metals for the three periods for cut and increase decisions are mainly negative with Gold being entirely positive and Silver entirely negative. Thus, I conclude that metal traders seek return in Gold over the other metals during an OPEC event window. Silver, a more industrial metal could be shorted as traders seek a hedge in a more typical haven of Gold than a less traded metal. This aligns with my previously discussed Argument 1. That for Gold, a decision by OPEC to increase or decrease their oil supply, aligns with past papers on the movement of WTI returns surrounding an announcement, with a decrease in supply produces positive abnormal returns for Gold but negative returns for the other metals (Spencer and Bredin 2019). And that an increase in oil supply produces negative abnormal returns for Silver and Palladium, and positive for Gold.

The next hypothesis examined was the following, *H3*: *The volatility and price action of the precious metals over the event window, is influenced more by the OVX than the VIX or GVZ indicators.*

A similar event-study framework was used in examining this hypothesis. The 5 metals were regressed against 5 macroeconomic variables: VIX, OVX, GVZ, DXY and PPI. The 65 meetings to cut, increase and maintain oil production and their 11-day event windows, were aggregated over the period 2008-2024. With most of the results not being significant at the 95% confidence level, I reject my null hypothesis, that OVX influences all the metal's returns more than the VIX or the GVZ. Individually, I would fail to reject *H3* for Copper, Platinum and Palladium as OVX absolute value is larger than GVZ's in my regression analysis. In line with past research (Reboredo, 2013, Pukthuanthong and Roll, 2011) the DXY, the Dollar Exchange Index showed its negative correlation to the metals.

As this is the first study of its kind examining the price environment of metals surrounding an OPEC meeting, there are no precedents to compare these results with. There have been several studies that looked at the significance of abnormal returns around OPEC event meetings, but these have focused on other assets mainly the WTI or Brent oil price. The insignificance of the CAAR results is in line with the results of Christensen (2009) and Jonsson & Lin (2011). While other studies have examined this event window through oil prices, clean energy prices or gold's relationship with oil, this paper is the first of its kinds to examine it during the OPEC announcement meeting event window. These findings have several practical implications. Investors might use these results to help establish their expectations on the market response to a certain OPEC decision in a given stage of the economic cycle or due to heightened increase in one of my tested variables, consequentially adapting their trading strategy. This can lead to better portfolio risk management, and a better identification of trading opportunities across the precious metals and implied volatility markets.

With the US EIA expecting crude oil production to peak by 2035, OPEC, the more politically neutral organisation expects their production to continue rising through 2050. The Paris and Tokyo Accords attempted to answer the loud calls to quell the extraction and combustion of labelled 'toxic' fossil fuels such as oil and coal in Western nations. With energy demand growth being driven by the non-OECD region such as India and China over the next 20 years and energy demand for oil in OECD countries set to decline, OPEC and the BRICS nations are in a perfectly ripe situation to continue exploiting the world with their control of energy and non-energy commodities. Brazil, a large exporter of oil through Petrobras and other natural resources has flirted with OPEC+ membership. Large oil reserves in Suriname and Guyana have also ignited a race to drill between private companies. Saudi Arabia has recently decided to not renew the petrodollar agreement with the USA. Central banks in Russia and China have accelerated their purchases of gold bullion with some suggesting the end of the Dollar as a reserve currency and movement towards a digital currency backed by gold. The runaway inflation in the U.S caused by the excessive spending of the US Federal Government since 2020 has accelerated this switch. If geopolitical tensions continue rising, then as the US government did with the weaponisation of the Dollar and the SWIFT system freezing Russian assets, this could incentivize OPEC and OPEC + to weaponize prices of energy, metals and agricultural commodities against Western populations. The importance of precious metals for industrial and even military use has been highlighted in recent years with the EU recognizing copper as a strategic metal. Ghorbani et al., (2024) prophesises that an OPEC-style organisation for Green Energy-Mineral Exporting Nations be set up to prevent top-down control of the metals industry. The ongoing Russian-Ukrainian war could lead to a long period of rising commodity prices as wars tend to precede commodity booms. Both countries are important players in the energy, metals, and grains markets. There is also a resource race ongoing. Some of the most in-demand finished products such as phones and cars contain trace amounts of metals and minerals. For growth to continue, demand for these base metals will only increase. China for instance or the proxy title; Hong Kong Exchanges and Clearing (HKEX) purchased the London Mercantile Exchange in 2012 as well as heavily supporting south American governments, such as Chile, Peru and the Belt and Road Initiative across West Asian economies. India and China are some of the largest commodity importers in the world, while Russia and South Africa are among the largest suppliers of oil and gold, respectively. The rapid growth of the BRICS is a popular explanation for the recent commodity demand and price boom (Hamilton 2009; Kilian 2009; Akram et al., 2020). Nations that have significant reserves of metals such as lithium, cobalt and rare earth elements (REEs) will become more strategically important. Chile, for example, realising the strategic importance of battery metals, recently nationalised its lithium industry (Ghorbani et al., 2024).

In regards futures studies surrounding the topics researched, other macroeconomic variables such as the US T-bond, T-note and T-bill, the GPU – the geopolitical index, the Gold-Silver ratio, the Gold-Dow ratio, and other inflation gauges like the CPI, PCE and M2 could be included in the analysis. Base metals traded on the London Mercantile Exchange such as Lead, Aluminium, Nickel and Zinc as well as other benchmarks could produce varying results. Lithium, for instance is a vital metal for the green transition isn’t traded on a centralized marketplace but has become popular in recent years. Solely focusing on the continuous futures contract limits the scope of my analysis. Comparing futures contracts of varying maturity could expose larger CAARs with less liquidity among longer expiration contracts. With the open, high, low and close available for all variables, volatility estimators such as the Garmin-Klass could be employed to strengthen volatility conclusions. Also, some of the meetings occurred on the weekend, and so the reaction on Friday and Monday could be much different than occurring on a normal business day. Calendar anomalies such as day of the week could be skewing the results for the metals and especially for the VIX and other volatility indicators.

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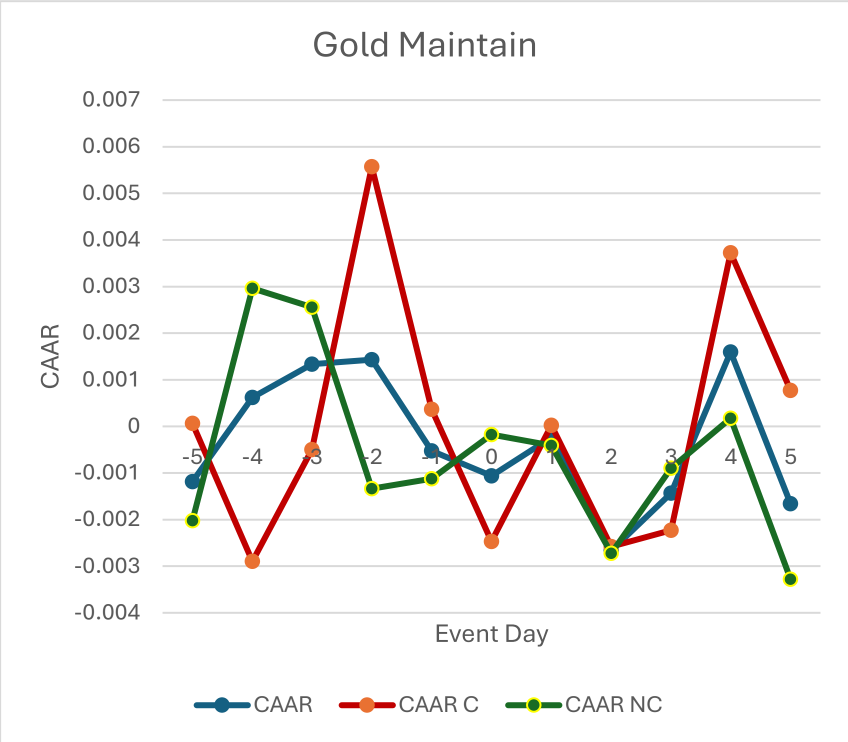
APPENDIX A

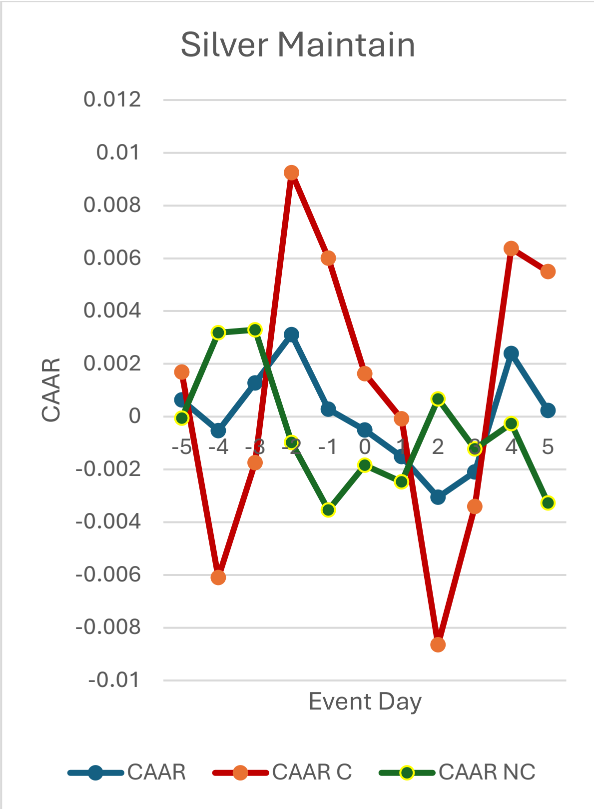
Appendix A

OPEC Meeting Dates 2002-2024

03/15/2002 M NC	10/24/2008 Cut C	08/19/2020 M C
06/26/2002 M NC	12/17/2008 Cut C	09/17/2020 M C
09/19/2002 M NC	03/15/2009 M NC	10/19/2020 M C
12/12/2002 Cut NC	05/28/2009 M NC	11/17/2020 M C
01/12/2003 Increase NC	09/10/2009 M NC	12/03/2020 Increase C
03/11/2003 M NC	12/22/2009 M NC	01/05/2021 Cut NC
04/24/2003 Cut NC	03/17/2010 M NC	03/04/2021 Cut NC
06/11/2003 M NC	10/14/2010 M NC	04/01/2021 Increase NC
07/31/2003 M NC	12/11/2010 M NC	06/01/2021 M NC
09/24/2003 Cut NC	06/08/2011 M NC	07/18/2021 Increase NC
12/04/2003 M NC	12/14/2011 M NC	09/01/2021 M NC
02/10/2004 Cut NC	06/14/2012 M NC	10/04/2021 M NC
03/31/2004 Cut NC	12/12/2012 M NC	11/04/2021 M NC
06/03/2004 Increase NC	05/31/2013 M NC	12/01/2021 Increase NC
09/15/2004 Increase NC	12/04/2013 M NC	01/04/2022 Increase C
12/10/2004 Cut NC	06/11/2014 M NC	02/02/2022 M C
01/30/2005 M NC	11/27/2014 M NC	03/31/2022 Increase C
03/16/2005 Increase NC	06/05/2015 M NC	05/05/2022 Increase C
06/15/2005 Increase NC	12/04/2015 M NC	06/02/2022 Increase C
09/20/2005 Increase NC	06/02/2016 M NC	06/30/2022 Increase C
12/12/2005 M NC	09/28/2016 Cut NC	08/03/2022 Increase C
01/31/2006 M NC	11/30/2016 Cut NC	09/05/2022 Cut C
03/08/2006 M NC	05/25/2017 Cut NC	10/05/2022 Cut C
06/01/2006 M NC	12/01/2017 Cut NC	12/04/2022 M C
09/11/2006 M NC	06/22/2018 Increase NC	02/01/2023 M NC
12/14/2006 Cut NC	12/07/2018 Cut NC	04/02/2023 Cut NC
03/15/2007 M C	06/03/2019 Cut NC	06/04/2023 Cut NC
09/11/2007 Increase C	12/05/2019 Cut NC	11/30/2023 Cut NC
12/05/2007 M C	03/05/2020 M C	02/01/2024 M NC
02/01/2008 M C	04/12/2020 Cut C	03/03/2024 Cut NC
03/05/2008 M C	06/06/2020 Cut C	04/03/2024 M NC
09/10/2008 Cut C	07/15/2020 M C	06/02/2024 Cut NC

Appendix B Maintain Decisions Graphs

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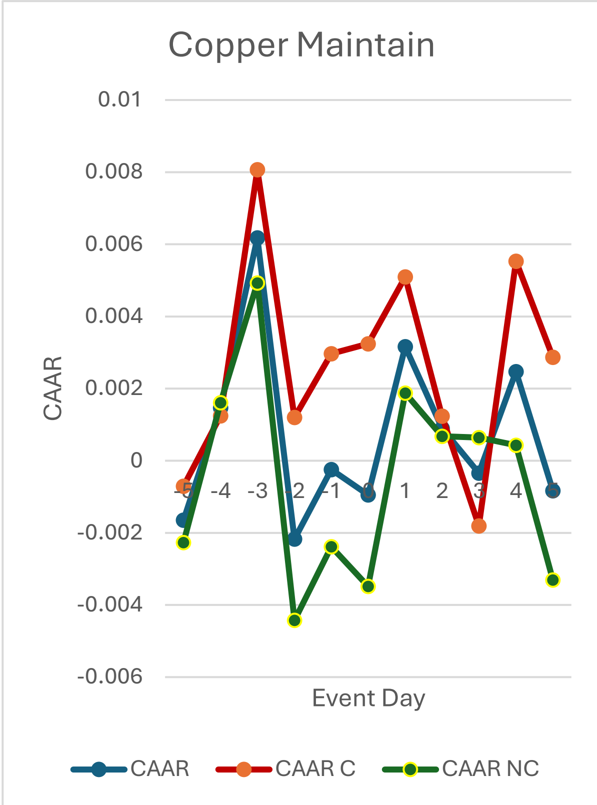
0.01
0.008
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
-0.01
CAAR
-5 -4 -3 -2 -1 0 1 2 3 4 5
Event Day
CAAR
CAAR C
CAAR NC


Copper Maintain
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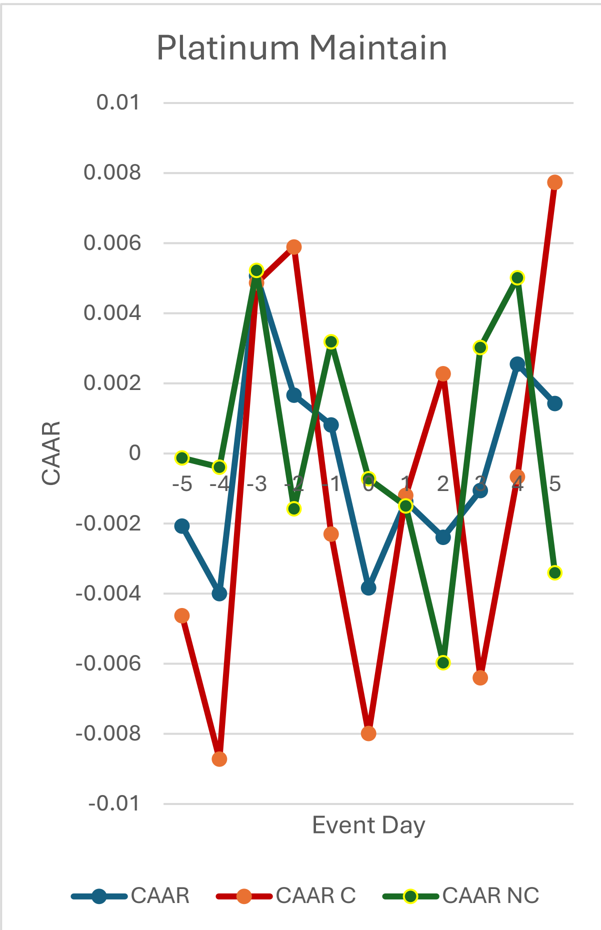
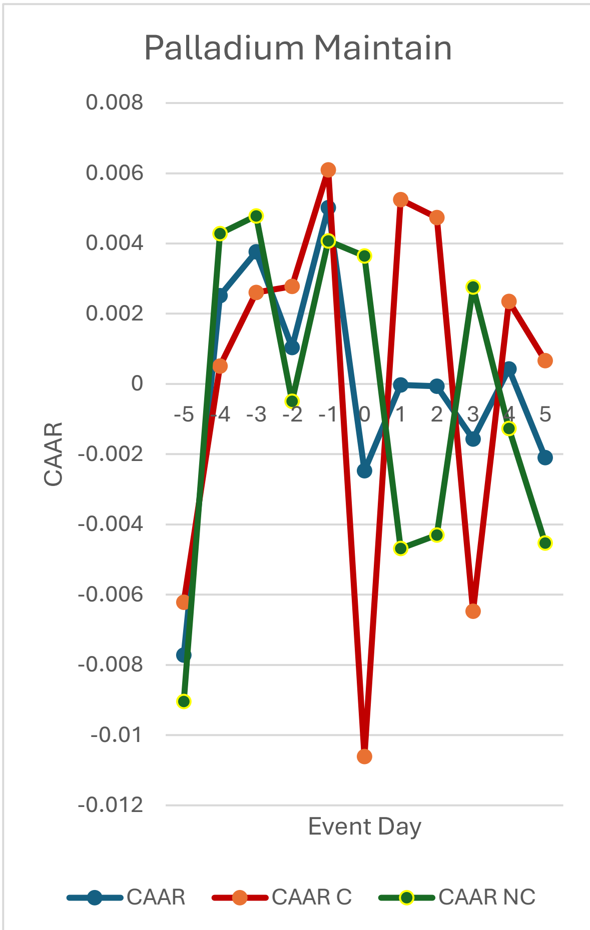
0.008
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
CAAR
-5 -4 -3 -2 -1 0 1 2 3 4 5
Event Day
CAAR
CAAR C
CAAR NC


Platinum Maintain
0.01
0.008
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
-0.01
CAAR
-5 -4 -3 -2 -1 0 1 2 3 4 5
Event Day
CAAR
CAAR C
CAAR NC


Palladium Maintain
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0.006
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
-0.01
-0.012
CAAR
-5 -4 -3 -2 -1 0 1 2 3 4 5
Event Day
CAAR
CAAR C
CAAR NC

Appendix C

GOLD Event Day	-5	-4	-3	-2	-1	0	1	2	3	4	5	Total
Gold Cuts CAR	0.0348	0.0544	-0.0252	0.0409	0.0298	0.0409	0.0222	-0.0345	0.0291	0.0125	0.0103	0.2154
Count	28	28	28	28	28	22	28	28	28	28	28	302
CAAR	0.0012	0.0019	-0.0009	0.0015	0.0011	0.0019	0.0008	-0.0012	0.0010	0.0004	0.0004	0.0007
Crisis CAR	0.0442	0.0295	-0.0630	-0.0032	0.0041	0.0025	0.0120	-0.0025	0.0264	-0.0204	0.0307	0.0604
Count	7	7	7	7	7	5	7	7	7	7	7	75
CAAR	0.0063	0.0042	-0.0090	-0.0005	0.0006	0.0005	0.0017	-0.0004	0.0038	-0.0029	0.0044	0.0008
NC CAR	-0.0094	0.0249	0.0378	0.0441	0.0257	0.0384	0.0102	-0.0320	0.0028	0.0329	-0.0204	0.1550
Count	21	21	21	21	21	17	21	21	21	21	21	227
CAAR	-0.0005	0.0012	0.0018	0.0021	0.0012	0.0023	0.0005	-0.0015	0.0001	0.0016	-0.0010	0.0007
Gold Inc CAR	-0.0240	0.0405	0.0477	0.0118	0.0182	0.0471	-0.0043	-0.0330	-0.0554	0.0285	-0.0302	0.0469
Count	18	18	18	18	18	16	18	18	18	18	18	196
CAAR	-0.0013	0.0023	0.0027	0.0007	0.0010	0.0029	-0.0002	-0.0018	-0.0031	0.0016	-0.0017	0.0002
Crisis CAR	0.0171	0.0227	-0.0031	0.0222	0.0062	0.0369	-0.0048	-0.0507	-0.0070	0.0022	0.0022	0.0440
Count	8	8	8	8	8	8	8	8	8	8	8	88
CAAR	0.0021	0.0028	-0.0004	0.0028	0.0008	0.0046	-0.0006	-0.0063	-0.0009	0.0003	0.0003	0.0005
NC CAR	-0.0411	0.0178	0.0508	-0.0105	0.0120	0.0102	0.0005	0.0177	-0.0484	0.0263	-0.0324	0.0030
Count	10	10	10	10	10	8	10	10	10	10	10	108
CAAR	-0.0041	0.0018	0.0051	-0.0011	0.0012	0.0013	0.0001	0.0018	-0.0048	0.0026	-0.0032	0.0000
Gold M CAR	-0.0594	0.0309	0.0667	0.0714	-0.0263	-0.0466	-0.0118	-0.1334	-0.0715	0.0799	-0.0830	-0.1830
Count	50	50	50	50	50	44	50	50	50	50	50	544
CAAR	-0.0012	0.0006	0.0013	0.0014	-0.0005	-0.0011	-0.0002	-0.0027	-0.0014	0.0016	-0.0017	-0.0003
Crisis CAR	0.0014	-0.0579	-0.0100	0.1114	0.0073	-0.0419	0.0004	-0.0516	-0.0446	0.0746	0.0154	0.0045
Count	20	20	20	20	20	17	20	20	20	20	20	217
CAAR	0.0001	-0.0029	-0.0005	0.0056	0.0004	-0.0025	0.0000	-0.0026	-0.0022	0.0037	0.0008	0.0000
NC CAR	-0.0607	0.0888	0.0767	-0.0400	-0.0336	-0.0047	-0.0123	-0.0818	-0.0269	0.0053	-0.0984	-0.1875
Count	30	30	30	30	30	27	30	30	30	30	30	327
CAAR	-0.0020	0.0030	0.0026	-0.0013	-0.0011	-0.0002	-0.0004	-0.0027	-0.0009	0.0002	-0.0033	-0.0006

Table 6: Gold CARs and CAARs for each Day. Yellow shading indicates significant at the 95% level.

SILVER Event Day	-5	-4	-3	-2	-1	0	1	2	3	4	5	Total
Silver Cuts CAR	0.0720	0.0742	0.0828	-0.0171	-0.0199	-0.0092	-0.1079	-0.0947	0.0121	0.0345	-0.0682	-0.0415
Count	28	28	28	28	28	22	28	28	28	28	28	302
CAAR	0.0026	0.0027	0.0030	-0.0006	-0.0007	-0.0004	-0.0039	-0.0034	0.0004	0.0012	-0.0024	-0.0001
Crisis CAR	0.0138	0.0499	-0.0301	0.0070	0.0408	-0.0553	-0.0529	-0.0251	0.0872	-0.0532	0.0161	-0.0018
Count	7	7	7	7	7	5	7	7	7	7	7	75
CAAR	0.0020	0.0071	-0.0043	0.0010	0.0058	-0.0111	-0.0076	-0.0036	0.0125	-0.0076	0.0023	0.0000
NC CAR	0.0582	0.0243	0.1129	-0.0241	-0.0608	0.0461	-0.0551	-0.0695	-0.0751	0.0877	-0.0843	-0.0397
Count	21	21	21	21	21	17	21	21	21	21	21	227
CAAR	0.0028	0.0012	0.0054	-0.0012	-0.0029	0.0027	-0.0026	-0.0033	-0.0036	0.0042	-0.0040	-0.0002
Silver Inc CAR	-0.0717	-0.0307	-0.0183	0.0190	-0.0501	0.0186	-0.0831	-0.0878	-0.0469	0.0053	-0.0204	-0.3661
Count	18	18	18	18	18	16	18	18	18	18	18	196
CAAR	-0.0040	-0.0017	-0.0010	0.0011	-0.0028	0.0012	-0.0046	-0.0049	-0.0026	0.0003	-0.0011	-0.0019
Crisis CAR	0.0155	0.0079	0.0070	0.0521	-0.0290	0.0116	-0.0556	-0.0912	0.0329	-0.0178	-0.0024	-0.0692
Count	8	8	8	8	8	8	8	8	8	8	8	88
CAAR	0.0019	0.0010	0.0009	0.0065	-0.0036	0.0014	-0.0070	-0.0114	0.0041	-0.0022	-0.0003	-0.0008
NC CAR	-0.0872	-0.0385	-0.0253	-0.0331	-0.0211	0.0070	-0.0275	0.0034	-0.0798	0.0231	-0.0180	-0.2970
Count	10	10	10	10	10	8	10	10	10	10	10	108
CAAR	-0.0087	-0.0039	-0.0025	-0.0033	-0.0021	0.0009	-0.0028	0.0003	-0.0080	0.0023	-0.0018	-0.0028
Silver M CAR	0.0319	-0.0266	0.0639	0.1557	0.0140	-0.0223	-0.0758	-0.1528	-0.1047	0.1194	0.0116	0.0144
Count	50	50	50	50	50	44	50	50	50	50	50	544
CAAR	0.0006	-0.0005	0.0013	0.0031	0.0003	-0.0005	-0.0015	-0.0031	-0.0021	0.0024	0.0002	0.0000
Crisis CAR	0.0337	-0.1221	-0.0349	0.1850	0.1202	0.0276	-0.0016	-0.1728	-0.0681	0.1273	0.1099	0.2042
Count	20	20	20	20	20	17	20	20	20	20	20	217
CAAR	0.0017	-0.0061	-0.0017	0.0092	0.0060	0.0016	-0.0001	-0.0086	-0.0034	0.0064	0.0055	0.0009
NC CAR	-0.0017	0.0955	0.0988	-0.0293	-0.1062	-0.0499	-0.0743	0.0201	-0.0365	-0.0079	-0.0983	-0.1898
Count	30	30	30	30	30	27	30	30	30	30	30	327
CAAR	-0.0001	0.0032	0.0033	-0.0010	-0.0035	-0.0019	-0.0025	0.0007	-0.0012	-0.0003	-0.0033	-0.0006

Table 7: Silver CARs and CAARs for each Day. Yellow shading indicates significant at the 95% level.

COPPER												
Event Day	-5	-4	-3	-2	-1	0	1	2	3	4	5	Total
Copper Cuts CAR	0.1107	0.0384	-0.2919	-0.1050	-0.1032	0.0020	0.1350	-0.0247	0.1973	-0.1575	-0.0594	-0.2582
Count	28	28	28	28	28	22	28	28	28	28	28	302
CAAR	0.0040	0.0014	-0.0104	-0.0038	-0.0037	0.0001	0.0048	-0.0009	0.0070	-0.0056	-0.0021	-0.0009
Crisis CAR	0.1243	0.0056	-0.2024	-0.0887	-0.0133	-0.0422	0.0258	0.0675	0.1611	-0.1699	-0.0240	-0.1563
Count	7	7	7	7	7	5	7	7	7	7	7	75
CAAR	0.0178	0.0008	-0.0289	-0.0127	-0.0019	-0.0084	0.0037	0.0096	0.0230	-0.0243	-0.0034	-0.0021
NC CAR	-0.0136	0.0328	-0.0895	-0.0163	-0.0899	0.0442	0.1092	-0.0922	0.0362	0.0124	-0.0354	-0.1020
Count	21	21	21	21	21	17	21	21	21	21	21	227
CAAR	-0.0007	0.0016	-0.0043	-0.0008	-0.0043	0.0026	0.0052	-0.0044	0.0017	0.0006	-0.0017	-0.0005
INC CAR	-0.1218	0.0130	-0.0232	0.0175	-0.0076	0.0742	-0.0043	0.0737	-0.0220	-0.0405	-0.0037	-0.0446
Count	18	18	18	18	18	16	18	18	18	18	18	196
CAAR	-0.0068	0.0007	-0.0013	0.0010	-0.0004	0.0046	-0.0002	0.0041	-0.0012	-0.0023	-0.0002	-0.0002
Crisis CAR	-0.0686	-0.0038	0.0195	0.0089	0.0096	0.0607	-0.0690	0.0054	0.0027	-0.0431	0.0084	-0.0694
Count	8	8	8	8	8	8	8	8	8	8	8	88
CAAR	-0.0086	-0.0005	0.0024	0.0011	0.0012	0.0076	-0.0086	0.0007	0.0003	-0.0054	0.0010	-0.0008
NC CAR	-0.0531	0.0168	-0.0426	0.0086	-0.0172	0.0135	0.0647	0.0683	-0.0248	0.0026	-0.0120	0.0248
Count	10	10	10	10	10	8	10	10	10	10	10	108
CAAR	-0.0053	0.0017	-0.0043	0.0009	-0.0017	0.0017	0.0065	0.0068	-0.0025	0.0003	-0.0012	0.0002
M CAR	-0.0823	0.0732	0.3092	-0.1087	-0.0121	-0.0424	0.1582	0.0451	-0.0169	0.1236	-0.0417	-0.1830
Count	50	50	50	50	50	45	50	50	50	50	50	544
CAAR	-0.0017	0.0015	0.0062	-0.0022	-0.0002	-0.0009	0.0032	0.0009	-0.0003	0.0025	-0.0008	-0.0003
Crisis CAR	-0.0142	0.0249	0.1614	0.0241	0.0594	0.0551	0.1019	0.0247	-0.0361	0.1107	0.0574	0.0045
Count	20	20	20	20	20	17	20	20	20	20	20	217
CAAR	-0.0007	0.0012	0.0081	0.0012	0.0030	0.0032	0.0051	0.0012	-0.0018	0.0055	0.0029	0.0000
NC CAR	-0.0681	0.0483	0.1478	-0.1328	-0.0714	-0.0975	0.0563	0.0203	0.0192	0.0129	-0.0991	-0.1875
Count	30	30	30	30	30	28	30	30	30	30	30	327
CAAR	-0.0023	0.0016	0.0049	-0.0044	-0.0024	-0.0035	0.0019	0.0007	0.0006	0.0004	-0.0033	-0.0006

Table 8: Copper CARs and CAARs for each Day. Yellow shading indicates significant at the 95% level.

PALLADIUM Event Day	-5	-4	-3	-2	-1	0	1	2	3	4	5	Total
Cut CAR	-0.0425	0.0265	-0.0260	0.0730	-0.0731	0.0729	0.0091	-0.0760	0.0049	-0.0087	0.0114	-0.0285
Count	18	18	18	18	18	13	18	18	18	18	18	193
CAAR	-0.0024	0.0015	-0.0014	0.0041	-0.0041	0.0056	0.0005	-0.0042	0.0003	-0.0005	0.0006	-0.0002
Crisis CAR	0.0146	-0.0229	-0.0547	0.0227	0.0436	0.0028	-0.0125	0.0304	-0.0081	-0.0186	0.0338	0.0311
Count	4	4	4	4	4	3	4	4	4	4	4	43
CAAR	0.0036	-0.0057	-0.0137	0.0057	0.0109	0.0009	-0.0031	0.0076	-0.0020	-0.0046	0.0084	0.0007
NC CAR	-0.0571	0.0494	0.0287	0.0503	-0.1167	0.0700	0.0216	-0.1064	0.0130	0.0099	-0.0223	-0.0596
Count	14	14	14	14	14	10	14	14	14	14	14	150
CAAR	-0.0041	0.0035	0.0021	0.0036	-0.0083	0.0070	0.0015	-0.0076	0.0009	0.0007	-0.0016	-0.0004
Inc CAR	0.0477	-0.0411	-0.2379	0.0145	-0.0795	-0.0356	-0.0715	0.0853	0.0731	-0.0345	-0.0857	-0.3652
Count	11	11	11	11	11	11	11	11	11	11	11	121
CAAR	0.0043	-0.0037	-0.0216	0.0013	-0.0072	-0.0032	-0.0065	0.0078	0.0066	-0.0031	-0.0078	-0.0030
Crisis CAR	0.0369	0.0248	-0.1619	0.0120	-0.0038	-0.0679	-0.0557	0.0309	0.0650	-0.0429	-0.0850	-0.2478
Count	7	7	7	7	7	7	7	7	7	7	7	77
CAAR	0.0053	0.0035	-0.0231	0.0017	-0.0005	-0.0097	-0.0080	0.0044	0.0093	-0.0061	-0.0122	-0.0032
NC CAR	0.0108	-0.0658	-0.0760	0.0026	-0.0757	0.0324	-0.0158	0.0543	0.0081	0.0084	-0.0006	-0.1174
Count	4	4	4	4	4	4	4	4	4	4	4	44
CAAR	0.0027	-0.0165	-0.0190	0.0006	-0.0189	0.0081	-0.0040	0.0136	0.0020	0.0021	-0.0002	-0.0027
M CAR	-0.2469	0.0805	0.1205	0.0332	0.1607	-0.0691	-0.0010	-0.0022	-0.0502	0.0136	-0.0671	-0.0279
Count	32	32	32	32	32	28	32	32	32	32	32	348
CAAR	-0.0077	0.0025	0.0038	0.0010	0.0050	-0.0025	0.0000	-0.0001	-0.0016	0.0004	-0.0021	-0.0001
Crisis CAR	-0.0932	0.0076	0.0391	0.0417	0.0915	-0.1274	0.0787	0.0710	-0.0971	0.0352	0.0099	0.0571
Count	15	15	15	15	15	12	15	15	15	15	15	162
CAAR	-0.0062	0.0005	0.0026	0.0028	0.0061	-0.0106	0.0052	0.0047	-0.0065	0.0023	0.0007	0.0004
NC CAR	-0.1537	0.0728	0.0814	-0.0085	0.0692	0.0583	-0.0796	-0.0732	0.0469	-0.0216	-0.0770	-0.0850
Count	17	17	17	17	17	16	17	17	17	17	17	186
CAAR	-0.0090	0.0043	0.0048	-0.0005	0.0041	0.0036	-0.0047	-0.0043	0.0028	-0.0013	-0.0045	-0.0005

Table 8: Palladium CARs and CAARs for each Day. Yellow shading indicates significant at the 95% level.

PLATINUM

Event Day	-5	-4	-3	-2	-1	0	1	2	3	4	5	Total
Cut CAR	-0.0050	-0.0498	-0.0921	0.1665	-0.0938	0.0281	0.0348	0.1266	-0.0951	-0.0019	-0.1210	-0.1028
Count	18	18	18	18	18	17	18	18	18	18	18	197
CAAR	-0.0003	-0.0028	-0.0051	0.0093	-0.0052	0.0017	0.0019	0.0070	-0.0053	-0.0001	-0.0067	-0.0005
Crisis CAR	-0.0333	-0.0015	-0.0461	0.0776	-0.0853	-0.0045	0.0223	0.1257	-0.0093	-0.0149	-0.0635	-0.0329
Count	4	4	4	4	4	3	4	4	4	4	4	43
CAAR	-0.0083	-0.0004	-0.0115	0.0194	-0.0213	-0.0015	0.0056	0.0314	-0.0023	-0.0037	-0.0159	-0.0008
NC CAR	-0.0333	-0.0015	-0.0461	0.0776	-0.0853	0.0325	0.0125	0.0009	-0.0859	0.0130	-0.0574	-0.1730
Count	14	14	14	14	14	14	14	14	14	14	14	154
CAAR	-0.0024	-0.0001	-0.0033	0.0055	-0.0061	0.0023	0.0009	0.0001	-0.0061	0.0009	-0.0041	-0.0011
Increase CAR	0.0698	-0.0417	-0.0020	0.0844	0.0227	0.0632	0.0191	-0.1037	0.0469	-0.0560	-0.0542	0.0486
Count	11	11	11	11	11	11	11	11	11	11	11	121
CAAR	0.0063	-0.0038	-0.0002	0.0077	0.0021	0.0057	0.0017	-0.0094	0.0043	-0.0051	-0.0049	0.0004
Crisis CAR	0.0109	0.0023	-0.0143	0.1036	0.0696	0.0280	0.0397	-0.0690	0.0025	-0.0541	-0.0356	0.0836
Count	7	7	7	7	7	7	7	7	7	7	7	77
CAAR	0.0016	0.0003	-0.0020	0.0148	0.0099	0.0040	0.0057	-0.0099	0.0004	-0.0077	-0.0051	0.0011
NC CAR	0.0589	-0.0440	0.0123	-0.0192	-0.0468	0.0352	-0.0207	-0.0347	0.0444	-0.0019	-0.0187	-0.0350
Count	4	4	4	4	4	4	4	4	4	4	4	44
CAAR	0.0147	-0.0110	0.0031	-0.0048	-0.0117	0.0088	-0.0052	-0.0087	0.0111	-0.0005	-0.0047	-0.0008
M CAR	-0.0622	-0.1200	0.1522	0.0499	0.0243	-0.1074	-0.0410	-0.0718	-0.0318	0.0765	0.0428	-0.0885
Count	30	30	30	30	30	28	30	30	30	30	30	328
CAAR	-0.0021	-0.0040	0.0051	0.0017	0.0008	-0.0038	-0.0014	-0.0024	-0.0011	0.0026	0.0014	-0.0003
Crisis CAR	-0.0601	-0.1133	0.0633	0.0766	-0.0299	-0.0959	-0.0155	0.0296	-0.0831	-0.0087	0.1006	-0.1363
Count	13	13	13	13	13	12	13	13	13	13	13	142
CAAR	-0.0046	-0.0087	0.0049	0.0059	-0.0023	-0.0080	-0.0012	0.0023	-0.0064	-0.0007	0.0077	-0.0010
NC CAR	-0.0021	-0.0066	0.0889	-0.0268	0.0542	-0.0115	-0.0255	-0.1015	0.0514	0.0852	-0.0579	0.0479
Count	17	17	17	17	17	16	17	17	17	17	17	186
CAAR	-0.0001	-0.0004	0.0052	-0.0016	0.0032	-0.0007	-0.0015	-0.0060	0.0030	0.0050	-0.0034	0.0003

Table 9: Platinum CARs and CAARs for each Day. Yellow shading indicates significant at the 95% level.

Appendix D

Correlation Matrix:

	Gold	Silver	Copper	Plat	Pallad	OVX	GVZ	VIX	DXY	PPI
Gold	1.000	0.801	0.260	0.564	0.389	-0.003	-0.020	-0.053	-0.430	-0.085
Silver	0.801	1.000	0.368	0.616	0.436	-0.048	0.001	-0.055	-0.373	-0.084
Copper	0.260	0.368	1.000	0.354	0.319	-0.193	-0.093	-0.135	-0.323	-0.110
Plat	0.564	0.616	0.354	1.000	0.536	-0.070	-0.063	-0.119	-0.421	-0.081
Pallad	0.389	0.436	0.319	0.536	1.000	-0.047	-0.072	-0.096	-0.282	-0.090
OVX	-0.003	-0.048	-0.193	-0.070	-0.047	1.000	0.259	0.412	0.028	-0.152
GVZ	-0.020	0.001	-0.093	-0.063	-0.072	0.259	1.000	0.440	0.022	-0.060
VIX	-0.053	-0.055	-0.135	-0.119	-0.096	0.412	0.440	1.000	0.057	0.001
DXY	-0.430	-0.373	-0.323	-0.421	-0.282	0.028	0.022	0.057	1.000	0.131
PPI	-0.085	-0.084	-0.110	-0.081	-0.090	-0.152	-0.060	0.001	0.131	1.000

Table 10: 423 Observations over the period 11 day event windows around 65 OPEC meetings over the period 2008-2024.

The correlation matrix is displayed above for all variables including metals and macroeconomic indicators. Some notable correlations include Gold's correlation of 0.8, 0.56 and -0.43 for Silver, Platinum and the DXY respectively. Silver and Platinum's largest correlation was with each other at 0.61 over the event windows. None of Copper's correlations were larger than ± 0.37. Palladium's correlations to the other metals was consistently positive at 0.39, 0.44, 0.32 and 0.54 for Gold, Silver, Copper, Platinum and Palladium. Likewise, but different, DXY exhibited moderately negative correlations to all metals. Regarding the volatility indicators, the OVX's correlation with the VIX is stronger at 0.41 than its value for the GVZ at 0.26. Surprisingly VIX's correlation to GVZ is the strongest among the three indicators over the OPEC event window's during the period September 2008-June 2024.

Robustness Regressions	Gold	Silver	Copper	Platinum	Palladium
OVX	0.00454	-0.0064	-0.0273***	-0.00153	0.00601
	-0.00381	-0.00923	-0.00762	-0.0073	-0.0137
GVZ	-0.00467	0.0165	-0.00944	-0.00426	-0.0176
	-0.00876	-0.0196	-0.0132	-0.0137	-0.0208
VIX	-0.00099	0.004	-0.00206	-0.01	-0.00384
	-0.00484	-0.00993	-0.00793	-0.0115	-0.0184
DXY	-0.341***	0.206*	-0.533***	-0.560***	-0.085
	-0.0783	-0.124	-0.126	-0.14	-0.256
PPI	-0.00252	-0.00238	-0.0830*	0.00112	-0.0509
	-0.0257	-0.0472	-0.0474	-0.0529	-0.0785
Gold		1.308***	-0.233**	0.204*	0.0959
		-0.0647	-0.0999	-0.105	-0.187
Silver	0.362***		0.194***	0.261***	0.112
	-0.0299		-0.0622	-0.0596	-0.0739
Copper	-0.0652**	0.207***		0.0692	0.202***
	-0.0278	-0.0587		-0.0479	-0.0738
Platinum	0.0436	0.234***	0.0726		0.495***
	-0.0279	-0.0553	-0.0457		-0.0834
Palladium	0.00934	0.0504*	0.0805***	0.224***	
	-0.0204	-0.028	-0.0296	-0.0335	
Constant	0.000139	-3.48E-05	0.000791	-0.00031	0.000811
	-0.00034	-0.00061	-0.00062	-0.00066	-0.00099
Observations	423	423	423	423	423
R-squared	0.673	0.701	0.247	0.509	0.324
Adj. R-sq.	0.6658	0.694	0.2306	0.4979	0.309
F (9,413)	42.27	73.91	14.25	40.94	15.56

Table 11: Robustness regression whereby other metals were included in the original regression. Period examined: (-5,+5) 11 Day OPEC event windows across 65 meetings from 2008-2024. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

In which we see the GVZ having a larger absolute value than OVX for all metals except Copper and OVX copper being signficiant at the 99% level. The coefficients of Gold, Silver and Copper returns to each other is quite positive and significant at the 99% level.

	Gold	Silver	Copper	Platinum	Palladium
OVX	-0.0062	-0.0411**	-0.0509***	-0.0167	-0.00385
	-0.00875	-0.0187	-0.0171	-0.0125	-0.0243
GVZ	-0.0118	-0.0288	0.00638	-0.0243	-0.0196
	-0.0165	-0.0313	-0.022	-0.0204	-0.0293
VIX	0.00698	0.0185	-0.00804	-0.0127	-0.0124
	-0.00873	-0.0181	-0.0144	-0.0136	-0.023
DXY	-0.723***	-1.365***	-1.051***	-1.508***	-1.124***
	-0.21	-0.43	-0.256	-0.187	-0.364
PPI	-0.022	-0.098	-0.0636	-0.0787	-0.132
	-0.0503	-0.0846	-0.108	-0.0672	-0.114
Constant	0.000216	0.000335	0.00158	0.00068	0.00141
	-0.00065	-0.00114	-0.00116	-0.00086	-0.00139
Observations	358	359	359	333	346
R-squared	0.113	0.126	0.169	0.19	0.073

Table 12: Second robustness test regression result. Period examined (-3,+3) 7 day OPEC event window across 65 meetings from 2008-2024. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix E

GOLD	Raw Returns										
		Max	Min	Mean	Median	St.D	St.Error	Count	T Stat	Critical T	MOE	95%**
Day 5	All Cut	0.0859	-0.0279	0.0004	-0.0016	0.0199	0.0038	28	0.0979	2.0518	0.0077	No
	C Cut	0.0859	-0.0279	0.0044	-0.0051	0.0382	0.0144	7	0.3038	2.4469	0.0353	No
	NC Cut	0.0110	-0.0279	-0.0010	-0.0009	0.0095	0.0021	21	-0.4690	2.0860	0.0043	No
	All Inc	0.0109	-0.0158	-0.0017	-0.0012	0.0066	0.0016	18	-1.0725	2.1098	0.0033	No
	C Inc	0.0109	-0.0158	0.0003	0.0003	0.0079	0.0028	8	0.0996	2.3646	0.0066	No
	NC Inc	0.0036	-0.0145	-0.0032	-0.0023	0.0054	0.0017	10	-1.9038	2.2622	0.0039	No
	All M	0.0171	-0.0345	-0.0017	0.0003	0.0118	0.0017	50	-0.9928	2.0096	0.0034	No
	C M	0.0171	-0.0322	0.0033	0.0115	-1.2217	-0.2732	20	-0.0121	2.0930	-0.5718	No
	NC M	0.0167	-0.0345	-0.0010	0.0120	-1.2293	-0.2244	30	0.0044	2.0452	-0.4590	No
Day 4	All Cut	0.0160	-0.0333	0.0004	0.0030	0.0110	0.0021	28	0.2147	2.0518	0.0043	No
	C Cut	0.0110	-0.0208	-0.0029	-0.0049	0.0115	0.0043	7	-0.6701	2.4469	0.0106	No
	NC Cut	0.0160	-0.0333	0.0016	0.0032	0.0109	0.0024	21	0.6578	2.0860	0.0050	No
	All Inc	0.0197	-0.0196	0.0016	0.0021	0.0090	0.0021	18	0.7505	2.1098	0.0045	No
	C Inc	0.0083	-0.0196	0.0003	0.0021	0.0087	0.0031	8	0.0904	2.3646	0.0073	No
	NC Inc	0.0197	-0.0170	0.0026	0.0020	0.0095	0.0030	10	0.8772	2.2622	0.0068	No
	All M	0.0755	-0.0208	0.0016	0.0016	0.0138	0.0020	50	0.8162	2.0096	0.0039	No
	C M	0.0755	-0.0208	0.0037	0.0036	0.0197	0.0044	20	0.8477	2.0930	0.0092	No
	NC M	0.0216	0.0163	0.0002	-0.0009	0.0081	0.0015	30	0.1207	2.0452	0.0030	No
Day 3	All Cut	0.0290	-0.0417	0.0010	0.0017	0.0140	0.0026	28	0.3935	2.0518	0.0054	No
	C Cut	0.0290	-0.0202	0.0038	0.0049	0.0178	0.0067	7	0.5599	2.4469	0.0165	No
	NC Cut	0.0229	-0.0417	0.0001	0.0012	0.0129	0.0028	21	0.0469	2.0860	0.0059	No
	All Inc	0.0078	-0.0191	-0.0031	-0.0027	0.0069	0.0016	18	-1.8973	2.1098	0.0034	No
	C Inc	0.0078	-0.0157	-0.0009	0.0022	0.0082	0.0029	8	-0.3040	2.3646	0.0068	No
	NC Inc	0.0000	-0.0191	-0.0048	-0.0034	0.0055	0.0017	10	-2.7916	2.2622	0.0039	YES
	All M	0.0165	-0.0307	-0.0014	0.0009	0.0105	0.0015	50	-0.9651	2.0096	0.0030	No
	C M	0.0165	-0.0307	-0.0022	-0.0012	0.0124	0.0028	20	-0.8033	2.0930	0.0058	No
	NC M	0.0114	-0.0248	-0.0009	0.0010	0.0091	0.0017	30	-0.5365	2.0452	0.0034	No
Day 2	All Cut	0.0252	-0.0273	-0.0012	-0.0018	0.0114	0.0022	28	-0.5719	2.0518	0.0044	No
	C Cut	0.0252	-0.0273	-0.0004	-0.0032	0.0162	0.0061	7	-0.0574	2.4469	0.0150	No
	NC Cut	0.0187	-0.0230	-0.0015	-0.0018	0.0098	0.0021	21	-0.7114	2.0860	0.0045	No

	All Inc	0.0140	-0.0211	-0.0018	-0.0012	0.0100	0.0024	18	-0.7765	2.1098	0.0050	No
	C Inc	0.0140	-0.0211	-0.0063	-0.0063	0.0120	0.0043	8	-1.4874	2.3646	0.0101	No
	NC Inc	0.0120	-0.0076	0.0018	0.0020	0.0066	0.0021	10	0.8442	2.2622	0.0047	No
	All M	0.0159	-0.0311	-0.0027	0.0002	0.0113	0.0016	50	-1.6735	2.0096	0.0032	No
	C M	0.0130	-0.0266	-0.0026	0.0002	0.0101	0.0023	20	-1.1413	2.0930	0.0047	No
	NC M	0.0159	-0.0311	-0.0027	0.0003	0.0122	0.0022	30	-1.2286	2.0452	0.0045	No
Day 1	All Cut	0.0171	-0.0237	0.0008	0.0015	0.0110	0.0021	28	0.3829	2.0518	0.0043	No
	C Cut	0.0171	-0.0225	0.0017	0.0049	0.0137	0.0052	7	0.3307	2.4469	0.0127	No
	NC Cut	0.0157	-0.0237	0.0005	0.0012	0.0103	0.0022	21	0.2170	2.0860	0.0047	No
	All Inc	0.0170	-0.0156	-0.0002	-0.0006	0.0089	0.0021	18	-0.1134	2.1098	0.0044	No
	C Inc	0.0170	-0.0156	-0.0006	-0.0006	0.0101	0.0036	8	-0.1680	2.3646	0.0085	No
	NC Inc	0.0161	-0.0122	0.0001	-0.0003	0.0084	0.0027	10	0.0194	2.2622	0.0060	No
	All M	0.0356	-0.0227	-0.0002	-0.0025	0.0106	0.0015	50	-0.1576	2.0096	0.0030	No
	C M	0.0176	-0.0158	0.0000	0.0023	0.0088	0.0020	20	0.0110	2.0930	0.0041	No
	NC M	0.0356	-0.0227	-0.0004	-0.0027	0.0118	0.0022	30	-0.1896	2.0452	0.0044	No
Day 0	All Cut	0.0302	-0.0380	0.0019	0.0023	0.0140	0.0030	22	0.6250	2.0796	0.0062	No
	C Cut	0.0302	-0.0380	0.0005	-0.0056	0.0268	0.0120	5	0.0420	2.7764	0.0333	No
	NC Cut	0.0201	-0.0143	0.0023	0.0026	0.0087	0.0021	17	1.0737	2.1199	0.0045	No
	All Inc	0.0124	-0.0092	0.0029	0.0041	0.0065	0.0016	16	1.8017	2.1314	0.0035	No
	C Inc	0.0124	-0.0075	0.0046	0.0068	0.0075	0.0026	8	1.7406	2.3646	0.0063	No
	NC Inc	0.0074	-0.0092	0.0013	0.0019	0.0054	0.0019	8	0.6704	2.3646	0.0045	No
	All M	0.0227	-0.0469	-0.0011	0.0005	0.0140	0.0021	44	-0.5035	2.0167	0.0042	No
	C M	0.0227	-0.0469	-0.0025	0.0002	0.0158	0.0038	17	-0.6441	2.1199	0.0081	No
	NC M	0.0214	-0.0329	-0.0002	0.0009	0.0129	0.0025	27	-0.0702	2.0555	0.0051	No
Day -1	All Cut	0.0399	-0.0283	0.0011	-0.0010	0.0149	0.0028	28	0.3774	2.0518	0.0058	No
	C Cut	0.0399	-0.0283	0.0006	0.0074	0.0246	0.0093	7	0.0633	2.4469	0.0227	No
	NC Cut	0.0268	-0.0131	0.0012	-0.0019	0.0109	0.0024	21	0.5136	2.0860	0.0050	No
	All Inc	0.0174	-0.0157	0.0010	-0.0001	0.0084	0.0020	18	0.5093	2.1098	0.0042	No
	C Inc	0.0139	-0.0157	0.0008	0.0006	0.0084	0.0030	8	0.2614	2.3646	0.0070	No
	NC Inc	0.0174	-0.0077	0.0012	-0.0018	0.0089	0.0028	10	0.4265	2.2622	0.0064	No
	All M	0.0209	-0.0274	-0.0005	-0.0003	0.0099	0.0014	50	-0.3756	2.0096	0.0028	No
	C M	0.0175	-0.0184	0.0004	-0.0006	0.0092	0.0021	20	0.1776	2.0930	0.0043	No
	NC M	0.0209	-0.0274	-0.0011	0.0001	0.0104	0.0019	30	-0.5893	2.0452	0.0039	No

Day -2	All Cut	0.0193	-0.0436	0.0015	0.0043	0.0143	0.0027	28	0.5411	2.0518	0.0055	No
	C Cut	0.0193	-0.0436	-0.0005	0.0004	0.0218	0.0083	7	-0.0560	2.4469	0.0202	No
	NC Cut	0.0155	-0.0336	0.0021	0.0059	0.0114	0.0025	21	0.8439	2.0860	0.0052	No
	All Inc	0.0211	-0.0154	0.0007	0.0017	0.0088	0.0021	18	0.3141	2.1098	0.0044	No
	C Inc	0.0211	-0.0143	0.0028	0.0035	0.0104	0.0037	8	0.7560	2.3646	0.0087	No
	NC Inc	0.0087	-0.0154	-0.0010	0.0005	0.0075	0.0024	10	-0.4412	2.2622	0.0054	No
	All M	0.0309	-0.0287	0.0014	0.0012	0.0121	0.0017	50	0.8373	2.0096	0.0034	No
	C M	0.0309	-0.0287	0.0056	0.0035	0.0132	0.0029	20	1.8905	2.0930	0.0062	No
	NC M	0.0196	-0.0267	-0.0013	-0.0010	0.0106	0.0019	30	-0.6886	2.0452	0.0040	No
Day -3	All Cut	0.0190	-0.0282	-0.0009	-0.0013	0.0093	0.0018	28	-0.5139	2.0518	0.0036	No
	C Cut	0.0020	-0.0282	-0.0090	-0.0060	0.0104	0.0039	7	-2.2877	2.4469	0.0096	No
	NC Cut	0.0190	-0.0092	0.0018	0.0004	0.0073	0.0016	21	1.1345	2.0860	0.0033	No
	All Inc	0.0199	-0.0255	0.0027	0.0049	0.0108	0.0026	18	1.0378	2.1098	0.0054	No
	C Inc	0.0199	-0.0255	-0.0004	0.0008	0.0132	0.0047	8	-0.0823	2.3646	0.0111	No
	NC Inc	0.0188	-0.0117	0.0051	0.0076	0.0084	0.0027	10	1.9058	2.2622	0.0060	No
	All M	0.0178	-0.0257	0.0013	0.0021	0.0090	0.0013	50	1.0523	2.0096	0.0025	No
	C M	0.0178	-0.0257	-0.0005	-0.0010	0.0111	0.0025	20	-0.2011	2.0930	0.0052	No
	NC M	0.0175	-0.0136	0.0026	0.0029	0.0071	0.0013	30	1.9681	2.0452	0.0027	No
Day -4	All Cut	0.0289	-0.0266	0.0019	0.0027	0.0112	0.0021	28	0.9184	2.0518	0.0043	No
	C Cut	0.0289	-0.0094	0.0042	-0.0008	0.0152	0.0057	7	0.7349	2.4469	0.0140	No
	NC Cut	0.0167	-0.0266	0.0012	0.0040	0.0099	0.0022	21	0.5499	2.0860	0.0045	No
	All Inc	0.0287	-0.0126	0.0023	0.0005	0.0094	0.0022	18	1.0129	2.1098	0.0047	No
	C Inc	0.0287	-0.0097	0.0028	-0.0004	0.0119	0.0042	8	0.6723	2.3646	0.0100	No
	NC Inc	0.0169	-0.0126	0.0018	0.0012	0.0075	0.0024	10	0.7492	2.2622	0.0054	No
	All M	0.0224	-0.0472	0.0006	0.0022	0.0131	0.0019	50	0.3327	2.0096	0.0037	No
	C M	0.0194	-0.0472	-0.0029	-0.0025	0.0169	0.0038	20	-0.7661	2.0930	0.0079	No
	NC M	0.0224	-0.0205	0.0030	0.0023	0.0095	0.0017	30	1.7039	2.0452	0.0036	No
Day -5	All Cut	0.0437	-0.0211	0.0012	0.0001	0.0117	0.0022	28	0.5636	2.0518	0.0045	No
	C Cut	0.0437	-0.0211	0.0063	-0.0001	0.0205	0.0078	7	0.8146	2.4469	0.0190	No
	NC Cut	0.0121	-0.0152	-0.0004	0.0003	0.0068	0.0015	21	-0.3031	2.0860	0.0031	No
	All Inc	0.0154	-0.0230	-0.0013	0.0001	0.0088	0.0021	18	-0.6388	2.1098	0.0044	No
	C Inc	0.0154	-0.0103	0.0021	0.0010	0.0084	0.0030	8	0.7168	2.3646	0.0070	No
	NC Inc	0.0050	-0.0230	-0.0041	-0.0014	0.0086	0.0027	10	-1.5172	2.2622	0.0061	No

All M	0.0227	-0.0552	-0.0012	0.0004	0.0121	0.0017	50	-0.6911	2.0096	0.0035	No
C M	0.0227	-0.0266	0.0001	0.0027	0.0115	0.0026	20	0.0265	2.0930	0.0054	No
NC M	0.0114	-0.0552	-0.0020	0.0002	0.0127	0.0023	30	-0.8730	2.0452	0.0047	No

SIL-VER	Raw Return	Max	Min	Mean	Me-dian	St.D	St.Er-ror	Count	T Stat	Criti-cal T	MOE	95%**
Day 5	All Cut	0.1045	-0.0634	-0.0024	-0.0063	0.0275	0.0052	28	-0.4687	2.0518	0.0107	No
	C Cut	0.1045	-0.0286	0.0023	-0.0188	0.0468	0.0177	7	0.1297	2.4469	0.0433	No
	NC Cut	0.0273	-0.0634	-0.0040	-0.0045	0.0188	0.0041	21	-0.9774	2.0860	0.0086	No
	All Inc	0.0202	-0.0379	-0.0011	-0.0019	0.0134	0.0031	18	-0.3595	2.1098	0.0066	No
	C Inc	0.0155	-0.0379	-0.0003	0.0034	0.0175	0.0062	8	-0.0484	2.3646	0.0146	No
	NC Inc	0.0202	-0.0132	-0.0018	-0.0049	0.0099	0.0031	10	-0.5762	2.2622	0.0071	No
	All M	0.0710	-0.0710	0.0002	0.0024	0.0240	0.0034	50	0.0686	2.0096	0.0068	No
	C M	0.0710	-0.0470	0.0050	0.0271	0.4196	0.0938	20	0.0532	2.0930	0.1964	No
	NC M	0.0375	-0.0710	0.0022	0.0214	-1.4752	-0.2693	30	-0.0081	2.0452	-0.5509	No
Day 4	All Cut	0.0566	-0.0597	0.0012	0.0037	0.0269	0.0051	28	0.2421	2.0518	0.0104	No
	C Cut	0.0566	-0.0571	-0.0076	-0.0020	0.0396	0.0150	7	-0.5073	2.4469	0.0366	No
	NC Cut	0.0421	-0.0597	0.0042	0.0054	0.0217	0.0047	21	0.8807	2.0860	0.0099	No
	All Inc	0.0152	-0.0306	0.0003	0.0019	0.0125	0.0029	18	0.0997	2.1098	0.0062	No
	C Inc	0.0152	-0.0306	-0.0022	-0.0008	0.0134	0.0047	8	-0.4708	2.3646	0.0112	No
	NC Inc	0.0147	-0.0240	0.0023	0.0045	0.0120	0.0038	10	0.6083	2.2622	0.0086	No
	All M	0.1247	-0.0596	0.0024	-0.0001	0.0263	0.0037	50	0.6421	2.0096	0.0075	No
	C M	0.1247	-0.0596	0.0064	0.0023	0.0380	0.0085	20	0.7490	2.0930	0.0178	No
	NC M	0.0354	-0.0361	-0.0003	-0.0003	0.0143	0.0026	30	-0.1015	2.0452	0.0053	No
Day 3	All Cut	0.1093	-0.1012	0.0004	-0.0005	0.0330	0.0062	28	0.0690	2.0518	0.0128	No
	C Cut	0.1093	-0.0395	0.0125	0.0009	0.0495	0.0187	7	0.6652	2.4469	0.0458	No
	NC Cut	0.0355	-0.1012	-0.0036	-0.0026	0.0259	0.0057	21	-0.6329	2.0860	0.0118	No
	All Inc	0.0382	-0.0393	-0.0026	-0.0018	0.0158	0.0037	18	-0.7005	2.1098	0.0078	No
	C Inc	0.0382	-0.0183	0.0041	0.0020	0.0160	0.0056	8	0.7278	2.3646	0.0134	No
	NC Inc	0.0103	-0.0393	-0.0080	-0.0053	0.0141	0.0045	10	-1.7871	2.2622	0.0101	No

	All M	0.0264	-0.0598	-0.0021	0.0019	0.0185	0.0026	50	-0.7996	2.0096	0.0053	No
	C M	0.0264	-0.0598	-0.0034	0.0004	0.0247	0.0055	20	-0.6166	2.0930	0.0116	No
	NC M	0.0199	-0.0373	-0.0012	0.0019	0.0133	0.0024	30	-0.5013	2.0452	0.0050	No
Day 2	All Cut	0.0440	-0.0450	-0.0034	0.0011	0.0213	0.0040	28	-0.8391	2.0518	0.0083	No
	C Cut	0.0375	-0.0450	-0.0036	-0.0055	0.0288	0.0109	7	-0.3297	2.4469	0.0266	No
	NC Cut	0.0440	-0.0386	-0.0033	0.0014	0.0191	0.0042	21	-0.7944	2.0860	0.0087	No
	All Inc	0.0221	-0.0432	-0.0049	-0.0048	0.0165	0.0039	18	-1.2521	2.1098	0.0082	No
	C Inc	0.0221	-0.0432	-0.0114	-0.0114	0.0210	0.0074	8	-1.5389	2.3646	0.0175	No
	NC Inc	0.0179	-0.0156	0.0003	-0.0031	0.0103	0.0033	10	0.1041	2.2622	0.0074	No
	All M	0.0711	-0.1066	-0.0031	-0.0007	0.0235	0.0033	50	-0.9201	2.0096	0.0067	No
	C M	0.0144	-0.1066	-0.0086	0.0012	0.0266	0.0060	20	-1.4516	2.0930	0.0125	No
	NC M	0.0711	-0.0526	0.0007	-0.0007	0.0208	0.0038	30	0.1764	2.0452	0.0078	No
Day 1	All Cut	0.0263	-0.0721	-0.0039	-0.0019	0.0215	0.0041	28	-0.9469	2.0518	0.0084	No
	C Cut	0.0234	-0.0327	-0.0075	-0.0108	0.0239	0.0090	7	-0.8356	2.4469	0.0221	No
	NC Cut	0.0263	-0.0721	-0.0026	-0.0009	0.0212	0.0046	21	-0.5675	2.0860	0.0096	No
	All Inc	0.0130	-0.0342	-0.0046	-0.0033	0.0126	0.0030	18	-1.5501	2.1098	0.0063	No
	C Inc	0.0114	-0.0342	-0.0070	-0.0033	0.0153	0.0054	8	-1.2888	2.3646	0.0128	No
	NC Inc	0.0130	-0.0256	-0.0027	-0.0035	0.0106	0.0033	10	-0.8219	2.2622	0.0076	No
	All M	0.0350	-0.0432	-0.0015	-0.0011	0.0158	0.0022	50	-0.6786	2.0096	0.0045	No
	C M	0.0350	-0.0365	-0.0001	-0.0021	0.0183	0.0041	20	-0.0189	2.0930	0.0086	No
	NC M	0.0210	-0.0432	-0.0025	-0.0011	0.0142	0.0026	30	-0.9584	2.0452	0.0053	No
Day 0	All Cut	0.0647	-0.0730	-0.0004	0.0034	0.0259	0.0055	22	-0.0761	2.0796	0.0115	No
	C Cut	0.0647	-0.0730	-0.0111	0.0218	0.0502	0.0225	5	-0.4927	2.7764	0.0624	No
	NC Cut	0.0228	-0.0357	0.0027	0.0044	0.0143	0.0035	17	0.7825	2.1199	0.0073	No
	All Inc	0.0168	-0.0211	0.0012	0.0042	0.0124	0.0031	16	0.3738	2.1314	0.0066	No
	C Inc	0.0163	-0.0188	0.0014	0.0021	0.0119	0.0042	8	0.3439	2.3646	0.0099	No
	NC Inc	0.0168	-0.0211	0.0009	0.0065	0.0137	0.0049	8	0.1802	2.3646	0.0115	No
	All M	0.0465	-0.0897	-0.0005	0.0045	0.0277	0.0042	44	-0.1211	2.0167	0.0084	No
	C M	0.0465	-0.0773	0.0016	0.0085	0.0262	0.0064	17	0.2557	2.1199	0.0135	No
	NC M	0.0429	-0.0897	-0.0018	0.0041	0.0290	0.0056	27	-0.3306	2.0555	0.0115	No

Day -1	All Cut	0.0543	-0.0495	-0.0007	0.0020	0.0222	0.0042	28	-0.1699	2.0518	0.0086	No
	C Cut	0.0543	-0.0328	0.0058	0.0080	0.0302	0.0114	7	0.5110	2.4469	0.0279	No
	NC Cut	0.0354	-0.0495	-0.0029	-0.0013	0.0192	0.0042	21	-0.6898	2.0860	0.0087	No
	All Inc	0.0162	-0.0365	-0.0028	-0.0004	0.0142	0.0033	18	-0.8329	2.1098	0.0070	No
	C Inc	0.0151	-0.0235	-0.0036	-0.0040	0.0124	0.0044	8	-0.8287	2.3646	0.0104	No
	NC Inc	0.0162	-0.0365	-0.0021	0.0016	0.0161	0.0051	10	-0.4137	2.2622	0.0115	No
	All M	0.0334	-0.0482	0.0003	-0.0001	0.0156	0.0022	50	0.1275	2.0096	0.0044	No
	C M	0.0334	-0.0170	0.0060	0.0079	0.0137	0.0031	20	1.9666	2.0930	0.0064	No
	NC M	0.0333	-0.0482	-0.0035	-0.0030	0.0158	0.0029	30	-1.2286	2.0452	0.0059	No
Day -2	All Cut	0.0783	-0.0985	-0.0006	-0.0006	0.0311	0.0059	28	-0.1037	2.0518	0.0121	No
	C Cut	0.0783	-0.0630	0.0010	0.0122	0.0455	0.0172	7	0.0583	2.4469	0.0421	No
	NC Cut	0.0265	-0.0985	-0.0011	0.0017	0.0261	0.0057	21	-0.2011	2.0860	0.0119	No
	All Inc	0.0642	-0.0259	0.0011	-0.0017	0.0216	0.0051	18	0.2064	2.1098	0.0108	No
	C Inc	0.0642	-0.0186	0.0065	0.0059	0.0276	0.0097	8	0.6680	2.3646	0.0230	No
	NC Inc	0.0292	-0.0259	-0.0033	-0.0028	0.0157	0.0050	10	-0.6687	2.2622	0.0112	No
	All M	0.0587	-0.0396	0.0031	0.0032	0.0185	0.0026	50	1.1891	2.0096	0.0053	No
	C M	0.0587	-0.0396	0.0092	0.0040	0.0217	0.0049	20	1.9029	2.0930	0.0102	No
	NC M	0.0264	-0.0390	-0.0010	0.0023	0.0150	0.0027	30	-0.3560	2.0452	0.0056	No
Day -3	All Cut	0.0390	-0.0487	0.0030	0.0068	0.0177	0.0033	28	0.8856	2.0518	0.0069	No
	C Cut	0.0390	-0.0487	-0.0043	-0.0167	0.0306	0.0116	7	-0.3717	2.4469	0.0283	No
	NC Cut	0.0232	-0.0145	0.0054	0.0072	0.0108	0.0024	21	2.2829	2.0860	0.0049	YES
	All Inc	0.0164	-0.0219	-0.0010	0.0023	0.0114	0.0027	18	-0.3777	2.1098	0.0057	No
	C Inc	0.0164	-0.0219	0.0009	0.0040	0.0138	0.0049	8	0.1797	2.3646	0.0116	No
	NC Inc	0.0107	-0.0155	-0.0025	-0.0006	0.0096	0.0030	10	-0.8387	2.2622	0.0068	No
	All M	0.0235	-0.0606	0.0013	0.0047	0.0179	0.0025	50	0.5040	2.0096	0.0051	No
	C M	0.0224	-0.0606	-0.0017	0.0068	0.0234	0.0052	20	-0.3338	2.0930	0.0109	No
	NC M	0.0235	-0.0447	0.0033	0.0037	0.0132	0.0024	30	1.3627	2.0452	0.0049	No
Day -4	All Cut	0.0455	-0.0460	0.0026	-0.0001	0.0193	0.0037	28	0.7253	2.0518	0.0075	No
	C Cut	0.0455	-0.0306	0.0071	-0.0005	0.0283	0.0107	7	0.6664	2.4469	0.0262	No
	NC Cut	0.0390	-0.0460	0.0012	0.0000	0.0160	0.0035	21	0.3318	2.0860	0.0073	No

		Max	Min	Mean	Median	St.D	St.Error	Count	T Stat	Critical T	MOE	95%**
	All Inc	0.0659	-0.0314	-0.0017	-0.0038	0.0212	0.0050	18	-0.3406	2.1098	0.0105	No
	C Inc	0.0659	-0.0314	0.0010	-0.0058	0.0286	0.0101	8	0.0973	2.3646	0.0239	No
	NC Inc	0.0229	-0.0278	-0.0039	-0.0031	0.0143	0.0045	10	-0.8533	2.2622	0.0102	No
	All M	0.0648	-0.0748	-0.0005	0.0000	0.0232	0.0033	50	-0.1622	2.0096	0.0066	No
	C M	0.0648	-0.0748	-0.0061	0.0006	0.0325	0.0073	20	-0.8400	2.0930	0.0152	No
	NC M	0.0418	-0.0258	0.0032	0.0000	0.0134	0.0024	30	1.3043	2.0452	0.0050	No
Day -5	All Cut	0.0357	-0.0316	0.0026	-0.0035	0.0177	0.0033	28	0.7696	2.0518	0.0069	No
	C Cut	0.0349	-0.0316	0.0020	-0.0101	0.0252	0.0095	7	0.2064	2.4469	0.0233	No
	NC Cut	0.0357	-0.0163	0.0028	-0.0007	0.0152	0.0033	21	0.8355	2.0860	0.0069	No
	All Inc	0.0286	-0.0464	-0.0040	-0.0018	0.0173	0.0041	18	-0.9744	2.1098	0.0086	No
	C Inc	0.0286	-0.0179	0.0019	0.0031	0.0149	0.0053	8	0.3661	2.3646	0.0125	No
	NC Inc	0.0134	-0.0464	-0.0087	-0.0043	0.0184	0.0058	10	-1.4986	2.2622	0.0132	No
	All M	0.0585	-0.0510	0.0006	0.0017	0.0166	0.0024	50	0.2713	2.0096	0.0047	No
	C M	0.0585	-0.0299	0.0017	-0.0008	0.0203	0.0045	20	0.3706	2.0930	0.0095	No
	NC M	0.0185	-0.0510	-0.0001	0.0019	0.0140	0.0026	30	-0.0227	2.0452	0.0052	No

Copper
Raw Returns

		Max	Min	Mean	Median	St.D	St.Error	Count	T Stat	Critical T	MOE	95%**
Day 5	All Cut	0.0261	-0.0425	-0.0021	-0.0017	0.0152	0.0029	28	-0.738	2.052	0.006	No
	C Cut	0.0000	-0.0327	-0.0034	-0.0059	0.0183	0.0069	7	-0.496	2.447	0.017	No
	NC Cut	0.0261	-0.0425	-0.0017	-0.0016	0.0146	0.0032	21	-0.531	2.086	0.007	No
	All Inc	0.0214	-0.0360	-0.0002	-0.0029	0.0160	0.0038	18	-0.054	2.110	0.008	No
	C Inc	0.0175	-0.0256	0.0010	0.0014	0.0163	0.0058	8	0.181	2.365	0.014	No
	NC Inc	0.0214	-0.0360	-0.0012	-0.0029	0.0164	0.0052	10	-0.231	2.262	0.012	No
	All M	0.0396	-0.0652	-0.0008	-0.0024	0.0173	0.0024	50	-0.341	2.010	0.005	No
	C M	0.0396	-0.0162	0.0029	-0.0022	0.0159	0.0036	20	0.807	2.093	0.007	No
	NC M	0.0305	-0.0652	-0.0033	-0.0027	0.0180	0.0033	30	-1.005	2.045	0.007	No
Day 4	All Cut	0.0451	-0.0967	-0.0056	0.0000	0.0250	0.0047	28	-1.191	2.052	0.010	No
	C Cut	0.0112	-0.0967	-0.0243	-0.0162	0.0387	0.0146	7	-1.659	2.447	0.036	No
	NC Cut	0.0451	-0.0301	0.0006	0.0018	0.0152	0.0033	21	0.177	2.086	0.007	No

	All Inc	0.0229	-0.0604	-0.0022	0.0027	0.0207	0.0049	18	-0.460	2.110	0.010	No
	C Inc	0.0116	-0.0438	-0.0054	0.0007	0.0178	0.0063	8	-0.855	2.365	0.015	No
	NC Inc	0.0229	-0.0604	0.0003	0.0057	0.0235	0.0074	10	0.035	2.262	0.017	No
	All M	0.0517	-0.0374	0.0025	0.0002	0.0167	0.0024	50	1.047	2.010	0.005	No
	C M	0.0517	-0.0374	0.0055	-0.0006	0.0211	0.0047	20	1.172	2.093	0.010	No
	NC M	0.0283	-0.0288	0.0004	0.0014	0.0130	0.0024	30	0.181	2.045	0.005	No
Day 3	All Cut	0.1164	-0.0282	0.0070	0.0047	0.0255	0.0048	28	1.462	2.052	0.010	No
	C Cut	0.1164	-0.0162	0.0230	0.0132	0.0446	0.0168	7	1.366	2.447	0.041	No
	NC Cut	0.0273	-0.0282	0.0017	0.0027	0.0128	0.0028	21	0.618	2.086	0.006	No
	All Inc	0.0166	-0.0212	-0.0012	-0.0021	0.0103	0.0024	18	-0.503	2.110	0.005	No
	C Inc	0.0127	-0.0089	0.0003	-0.0009	0.0078	0.0028	8	0.123	2.365	0.007	No
	NC Inc	0.0166	-0.0212	-0.0025	-0.0046	0.0123	0.0039	10	-0.637	2.262	0.009	No
	All M	0.0292	-0.0336	-0.0003	0.0002	0.0131	0.0019	50	-0.182	2.010	0.004	No
	C M	0.0292	-0.0328	-0.0018	-0.0010	0.0145	0.0033	20	-0.556	2.093	0.007	No
	NC M	0.0229	-0.0336	0.0006	0.0002	0.0123	0.0022	30	0.285	2.045	0.005	No
Day 2	All Cut	0.0292	-0.0477	-0.0009	0.0010	0.0177	0.0033	28	-0.264	2.052	0.007	No
	C Cut	0.0292	-0.0178	0.0096	0.0127	0.0172	0.0065	7	1.487	2.447	0.016	No
	NC Cut	0.0192	-0.0477	-0.0044	-0.0014	0.0168	0.0037	21	-1.200	2.086	0.008	No
	All Inc	0.0281	-0.0168	0.0041	0.0019	0.0128	0.0030	18	1.355	2.110	0.006	No
	C Inc	0.0203	-0.0168	0.0007	-0.0022	0.0144	0.0051	8	0.132	2.365	0.012	No
	NC Inc	0.0281	-0.0078	0.0068	0.0027	0.0115	0.0036	10	1.886	2.262	0.008	No
	All M	0.0544	-0.0284	0.0009	0.0030	0.0162	0.0023	50	0.394	2.010	0.005	No
	C M	0.0544	-0.0269	0.0012	0.0023	0.0202	0.0045	20	0.273	2.093	0.009	No
	NC M	0.0254	-0.0284	0.0007	0.0031	0.0132	0.0024	30	0.281	2.045	0.005	No
Day 1	All Cut	0.0679	-0.0541	0.0048	0.0034	0.0209	0.0040	28	1.219	2.052	0.008	No
	C Cut	0.0679	-0.0541	0.0037	0.0032	0.0367	0.0139	7	0.266	2.447	0.034	No
	NC Cut	0.0306	-0.0144	0.0052	0.0036	0.0137	0.0030	21	1.742	2.086	0.006	No
	All Inc	0.0358	-0.0298	-0.0002	-0.0023	0.0182	0.0043	18	-0.055	2.110	0.009	No
	C Inc	0.0098	-0.0298	-0.0086	-0.0104	0.0126	0.0044	8	-1.939	2.365	0.011	No
	NC Inc	0.0358	-0.0285	0.0065	0.0115	0.0198	0.0063	10	1.033	2.262	0.014	No

	All M	0.0484	-0.0368	0.0032	0.0058	0.0151	0.0021	50	1.479	2.010	0.004	No
	C M	0.0484	-0.0199	0.0051	0.0036	0.0168	0.0038	20	1.354	2.093	0.008	No
	NC M	0.0329	-0.0368	0.0019	0.0060	0.0140	0.0026	30	0.732	2.045	0.005	No
Day 0	All Cut	0.0236	-0.0676	0.0001	0.0055	0.0196	0.0042	22	0.022	2.080	0.009	No
	C Cut	0.0189	-0.0676	-0.0084	0.0036	0.0342	0.0153	5	-0.551	2.776	0.043	No
	NC Cut	0.0236	-0.0403	0.0026	0.0056	0.0136	0.0033	17	0.791	2.120	0.007	No
	All Inc	0.0499	-0.0183	0.0046	0.0008	0.0182	0.0045	16	1.021	2.131	0.010	No
	C Inc	0.0499	-0.0183	0.0076	0.0008	0.0250	0.0088	8	0.858	2.365	0.021	No
	NC Inc	0.0135	-0.0079	0.0017	0.0002	0.0078	0.0028	8	0.606	2.365	0.007	No
	All M	0.0557	-0.0482	-0.0009	-0.0005	0.0199	0.0030	45	-0.318	2.015	0.006	No
	C M	0.0557	-0.0482	0.0032	0.0033	0.0231	0.0056	17	0.577	2.120	0.012	No
	NC M	0.0299	-0.0432	-0.0035	-0.0010	0.0176	0.0033	28	-1.046	2.052	0.007	No
Day -1	All Cut	0.0263	-0.0332	-0.0037	-0.0023	0.0133	0.0025	28	-1.470	2.052	0.005	No
	C Cut	0.0263	-0.0332	-0.0019	-0.0031	0.0216	0.0082	7	-0.233	2.447	0.020	No
	NC Cut	0.0138	-0.0207	-0.0043	-0.0015	0.0098	0.0021	21	-1.998	2.086	0.004	No
	All Inc	0.0384	-0.0351	-0.0004	0.0003	0.0146	0.0034	18	-0.123	2.110	0.007	No
	C Inc	0.0117	-0.0095	0.0012	0.0013	0.0069	0.0025	8	0.489	2.365	0.006	No
	NC Inc	0.0384	-0.0351	-0.0017	-0.0051	0.0190	0.0060	10	-0.287	2.262	0.014	No
	All M	0.0243	-0.0276	-0.0002	-0.0010	0.0122	0.0017	50	-0.140	2.010	0.003	No
	C M	0.0243	-0.0276	0.0030	0.0035	0.0144	0.0032	20	0.921	2.093	0.007	No
	NC M	0.0240	-0.0228	-0.0024	-0.0030	0.0101	0.0019	30	-1.286	2.045	0.004	No
Day -2	All Cut	0.0262	-0.0731	-0.0037	0.0002	0.0179	0.0034	28	-1.110	2.052	0.007	No
	C Cut	0.0012	-0.0731	-0.0127	-0.0007	0.0273	0.0103	7	-1.230	2.447	0.025	No
	NC Cut	0.0262	-0.0295	-0.0008	0.0003	0.0131	0.0029	21	-0.271	2.086	0.006	No
	All Inc	0.0160	-0.0168	0.0010	0.0016	0.0099	0.0023	18	0.415	2.110	0.005	No
	C Inc	0.0160	-0.0168	0.0011	0.0017	0.0108	0.0038	8	0.293	2.365	0.009	No
	NC Inc	0.0129	-0.0131	0.0009	0.0006	0.0098	0.0031	10	0.276	2.262	0.007	No
	All M	0.0308	-0.0426	-0.0022	-0.0022	0.0151	0.0021	50	-1.015	2.010	0.004	No
	C M	0.0308	-0.0333	0.0012	0.0008	0.0172	0.0038	20	0.314	2.093	0.008	No
	NC M	0.0190	-0.0426	-0.0044	-0.0035	0.0135	0.0025	30	-1.799	2.045	0.005	No

Day -3	All Cut	0.0240	-0.0556	-0.0104	-0.0059	0.0187	0.0035	28	-2.956	2.052	0.007	YES
	C Cut	-0.0014	-0.0556	-0.0289	-0.0324	0.0255	0.0096	7	-2.997	2.447	0.024	YES
	NC Cut	0.0240	-0.0218	-0.0043	-0.0040	0.0107	0.0023	21	-1.821	2.086	0.005	No
	All Inc	0.0256	-0.0350	-0.0013	0.0035	0.0159	0.0038	18	-0.343	2.110	0.008	No
	C Inc	0.0256	-0.0323	0.0024	0.0051	0.0164	0.0058	8	0.419	2.365	0.014	No
	NC Inc	0.0142	-0.0350	-0.0043	-0.0058	0.0157	0.0050	10	-0.858	2.262	0.011	No
	All M	0.0502	-0.0357	0.0062	0.0057	0.0161	0.0023	50	2.713	2.010	0.005	YES
	C M	0.0338	-0.0357	0.0081	0.0122	0.0190	0.0042	20	1.900	2.093	0.009	No
	NC M	0.0502	-0.0159	0.0049	0.0048	0.0141	0.0026	30	1.915	2.045	0.005	No
Day -4	All Cut	0.0249	-0.0409	0.0014	0.0036	0.0147	0.0028	28	0.493	2.052	0.006	No
	C Cut	0.0249	-0.0293	0.0008	0.0082	0.0195	0.0074	7	0.108	2.447	0.018	No
	NC Cut	0.0238	-0.0409	0.0016	0.0032	0.0134	0.0029	21	0.536	2.086	0.006	No
	All Inc	0.0280	-0.0134	0.0007	-0.0031	0.0121	0.0029	18	0.253	2.110	0.006	No
	C Inc	0.0190	-0.0134	-0.0005	-0.0032	0.0112	0.0040	8	-0.120	2.365	0.009	No
	NC Inc	0.0280	-0.0121	0.0017	-0.0031	0.0134	0.0042	10	0.398	2.262	0.010	No
	All M	0.0466	-0.0290	0.0015	0.0000	0.0162	0.0023	50	0.639	2.010	0.005	No
	C M	0.0271	-0.0290	0.0012	0.0039	0.0173	0.0039	20	0.321	2.093	0.008	No
	NC M	0.0466	-0.0256	0.0016	-0.0016	0.0157	0.0029	30	0.562	2.045	0.006	No
Day -5	All Cut	0.0441	-0.0180	0.0040	0.0004	0.0151	0.0028	28	1.389	2.052	0.006	No
	C Cut	0.0441	-0.0162	0.0178	0.0177	0.0191	0.0072	7	2.459	2.447	0.018	YES
	NC Cut	0.0213	-0.0180	-0.0006	-0.0009	0.0104	0.0023	21	-0.286	2.086	0.005	No
	All Inc	0.0124	-0.0508	-0.0068	-0.0059	0.0164	0.0039	18	-1.751	2.110	0.008	No
	C Inc	0.0124	-0.0508	-0.0086	-0.0070	0.0216	0.0076	8	-1.125	2.365	0.018	No
	NC Inc	0.0102	-0.0240	-0.0053	-0.0044	0.0119	0.0037	10	-1.417	2.262	0.008	No
	All M	0.0258	-0.0655	-0.0016	-0.0009	0.0153	0.0022	50	-0.763	2.010	0.004	No
	C M	0.0183	-0.0297	-0.0007	0.0007	0.0137	0.0031	20	-0.232	2.093	0.006	No
	NC M	0.0258	-0.0655	-0.0023	-0.0017	0.0164	0.0030	30	-0.757	2.045	0.006	No

Palladium Raw Returns

		Max	Min	Mean	Me-dian	St.D	St.Er-ror	Count	T Stat	Criti-cal T	MOE	95%**
Day 5	All Cut	0.044	-0.040	0.001	0.001	0.021	0.005	18	0.13	2.11	0.01	No
	C Cut	0.044	-0.007	0.008	-0.001	0.024	0.012	4	0.71	3.18	0.04	No
	NC Cut	0.032	-0.040	-0.002	0.002	0.020	0.005	14	-0.29	2.16	0.01	No
	All Inc	0.021	-0.023	-0.008	-0.007	0.013	0.004	11	-1.99	2.23	0.01	No
	C Inc	-0.003	-0.023	-0.012	-0.009	0.008	0.003	7	-3.90	2.45	0.01	YES
	NC Inc	0.021	-0.021	0.000	-0.001	0.017	0.009	4	-0.02	3.18	0.03	No
	All M	0.060	-0.050	-0.002	-0.003	0.022	0.004	32	-0.54	2.04	0.01	No
	C M	0.060	-0.050	0.001	-0.006	0.028	0.007	15	0.09	2.14	0.02	No
	NC M	0.023	-0.050	-0.005	-0.002	0.016	0.004	17	-1.15	2.12	0.01	No
Day 4	All Cut	0.026	-0.022	0.000	-0.004	0.013	0.003	18	-0.15	2.11	0.01	No
	C Cut	0.014	-0.016	-0.005	-0.008	0.013	0.007	4	-0.71	3.18	0.02	No
	NC Cut	0.026	-0.022	0.001	0.003	0.014	0.004	14	0.20	2.16	0.01	No
	All Inc	0.045	-0.030	-0.003	-0.009	0.024	0.007	11	-0.44	2.23	0.02	No
	C Inc	0.045	-0.030	-0.006	-0.009	0.025	0.009	7	-0.65	2.45	0.02	No
	NC Inc	0.024	-0.023	0.002	0.004	0.024	0.012	4	0.18	3.18	0.04	No
	All M	0.061	-0.055	0.000	0.000	0.026	0.005	32	0.09	2.04	0.01	No
	C M	0.040	-0.036	0.002	0.007	0.023	0.006	15	0.40	2.14	0.01	No
	NC M	0.061	-0.055	-0.001	-0.001	0.028	0.007	17	-0.18	2.12	0.01	No
Day 3	All Cut	0.102	-0.046	0.000	-0.009	0.034	0.008	18	0.03	2.11	0.02	No
	C Cut	0.060	-0.046	-0.002	-0.011	0.044	0.022	4	-0.09	3.18	0.07	No
	NC Cut	0.102	-0.042	0.001	-0.004	0.033	0.009	14	0.10	2.16	0.02	No
	All Inc	0.031	-0.011	0.007	0.004	0.014	0.004	11	1.58	2.23	0.01	No
	C Inc	0.031	-0.007	0.009	-0.001	0.016	0.006	7	1.53	2.45	0.01	No
	NC Inc	0.010	-0.011	0.002	0.005	0.009	0.005	4	0.43	3.18	0.01	No
	All M	0.042	-0.032	-0.002	0.000	0.017	0.003	32	-0.52	2.04	0.01	No
	C M	0.031	-0.032	-0.006	0.000	0.018	0.005	15	-1.39	2.14	0.01	No
	NC M	0.042	-0.024	0.003	-0.001	0.016	0.004	17	0.72	2.12	0.01	No
Day 2	All Cut	0.042	-0.038	-0.004	-0.002	0.019	0.005	18	-0.94	2.11	0.01	No
	C Cut	0.042	-0.038	0.008	0.013	0.035	0.017	4	0.44	3.18	0.06	No
	NC Cut	0.006	-0.030	-0.008	-0.003	0.012	0.003	14	-2.36	2.16	0.01	YES

	All Inc	0.028	-0.006	0.008	0.005	0.011	0.003	11	2.29	2.23	0.01	YES
	C Inc	0.028	-0.006	0.004	0.004	0.012	0.004	7	1.01	2.45	0.01	No
	NC Inc	0.020	0.000	0.014	0.017	0.009	0.005	4	2.99	3.18	0.01	No
	All M	0.077	-0.038	0.000	-0.002	0.020	0.004	32	-0.02	2.04	0.01	No
	C M	0.077	-0.030	0.005	-0.001	0.025	0.006	15	0.75	2.14	0.01	No
	NC M	0.019	-0.038	-0.004	-0.005	0.015	0.004	17	-1.19	2.12	0.01	No
Day 1	All Cut	0.023	-0.029	0.001	0.004	0.013	0.003	18	0.16	2.11	0.01	No
	C Cut	0.009	-0.029	-0.003	0.004	0.017	0.009	4	-0.36	3.18	0.03	No
	NC Cut	0.023	-0.027	0.002	0.003	0.013	0.003	14	0.45	2.16	0.01	No
	All Inc	0.032	-0.066	-0.007	-0.003	0.029	0.009	11	-0.74	2.23	0.02	No
	C Inc	0.032	-0.066	-0.008	0.001	0.036	0.014	7	-0.58	2.45	0.03	No
	NC Inc	0.016	-0.017	-0.004	-0.007	0.015	0.007	4	-0.54	3.18	0.02	No
	All M	0.025	-0.048	0.000	0.003	0.017	0.003	32	-0.01	2.04	0.01	No
	C M	0.023	-0.021	0.005	0.010	0.015	0.004	15	1.35	2.14	0.01	No
	NC M	0.025	-0.048	-0.005	-0.004	0.018	0.004	17	-1.05	2.12	0.01	No
Day 0	All Cut	0.036	-0.032	0.006	0.010	0.018	0.005	13	1.11	2.18	0.01	No
	C Cut	0.027	-0.032	0.001	0.008	0.030	0.018	3	0.05	4.30	0.08	No
	NC Cut	0.036	-0.020	0.007	0.010	0.015	0.005	10	1.48	2.26	0.01	No
	All Inc	0.035	-0.040	-0.003	0.004	0.026	0.008	11	-0.42	2.23	0.02	No
	C Inc	0.035	-0.040	-0.010	-0.026	0.030	0.012	7	-0.84	2.45	0.03	No
	NC Inc	0.020	0.001	0.008	0.006	0.008	0.004	4	1.97	3.18	0.01	No
	All M	0.055	-0.069	-0.002	0.002	0.023	0.004	28	-0.57	2.05	0.01	No
	C M	0.013	-0.069	-0.011	-0.002	0.024	0.007	12	-1.52	2.20	0.02	No
	NC M	0.055	-0.026	0.004	0.006	0.020	0.005	16	0.72	2.13	0.01	No
Day -1	All Cut	0.042	-0.049	-0.004	0.003	0.021	0.005	18	-0.81	2.11	0.01	No
	C Cut	0.042	-0.010	0.011	0.006	0.023	0.011	4	0.95	3.18	0.04	No
	NC Cut	0.016	-0.049	-0.008	-0.005	0.019	0.005	14	-1.61	2.16	0.01	No
	All Inc	0.053	-0.069	-0.007	-0.003	0.037	0.011	11	-0.64	2.23	0.02	No
	C Inc	0.053	-0.069	-0.001	-0.001	0.043	0.016	7	-0.03	2.45	0.04	No
	NC Inc	0.012	-0.044	-0.019	-0.022	0.024	0.012	4	-1.57	3.18	0.04	No
	All M	0.046	-0.023	0.005	0.003	0.013	0.002	32	2.20	2.04	0.00	YES
	C M	0.046	-0.023	0.006	0.002	0.017	0.004	15	1.41	2.14	0.01	No
	NC M	0.019	-0.011	0.004	0.003	0.009	0.002	17	1.92	2.12	0.00	No
Day -2	All Cut	0.026	-0.027	0.004	0.003	0.016	0.004	18	1.11	2.11	0.01	No

	C Cut	0.026	-0.010	0.006	0.003	0.015	0.008	4	0.76	3.18	0.02	No
	NC Cut	0.025	-0.027	0.004	0.003	0.016	0.004	14	0.83	2.16	0.01	No
	All Inc	0.039	-0.044	0.001	-0.001	0.024	0.007	11	0.18	2.23	0.02	No
	C Inc	0.039	-0.044	0.002	-0.001	0.028	0.010	7	0.16	2.45	0.03	No
	NC Inc	0.022	-0.023	0.001	0.002	0.019	0.010	4	0.07	3.18	0.03	No
	All M	0.042	-0.036	0.001	-0.001	0.018	0.003	32	0.33	2.04	0.01	No
	C M	0.042	-0.036	0.003	-0.002	0.021	0.006	15	0.50	2.14	0.01	No
	NC M	0.026	-0.024	0.000	0.000	0.014	0.003	17	-0.15	2.12	0.01	No
Day -3	All Cut	0.021	-0.031	-0.001	-0.001	0.016	0.004	18	-0.39	2.11	0.01	No
	C Cut	-0.003	-0.031	-0.014	-0.010	0.013	0.006	4	-2.13	3.18	0.02	No
	NC Cut	0.021	-0.028	0.002	0.007	0.015	0.004	14	0.51	2.16	0.01	No
	All Inc	0.014	-0.059	-0.022	-0.021	0.023	0.007	11	-3.13	2.23	0.02	YES
	C Inc	0.001	-0.048	-0.023	-0.021	0.020	0.007	7	-3.11	2.45	0.02	YES
	NC Inc	0.014	-0.059	-0.019	-0.015	0.031	0.016	4	-1.22	3.18	0.05	No
	All M	0.030	-0.039	0.004	0.005	0.014	0.003	32	1.47	2.04	0.01	No
	C M	0.019	-0.025	0.003	0.004	0.013	0.003	15	0.79	2.14	0.01	No
	NC M	0.030	-0.039	0.005	0.006	0.016	0.004	17	1.22	2.12	0.01	No
Day -4	All Cut	0.035	-0.021	0.001	0.000	0.015	0.004	18	0.41	2.11	0.01	No
	C Cut	0.002	-0.014	-0.006	-0.006	0.007	0.003	4	-1.76	3.18	0.01	No
	NC Cut	0.035	-0.021	0.004	0.005	0.017	0.004	14	0.80	2.16	0.01	No
	All Inc	0.021	-0.060	-0.004	0.001	0.020	0.006	11	-0.61	2.23	0.01	No
	C Inc	0.021	-0.008	0.004	0.003	0.009	0.003	7	1.05	2.45	0.01	No
	NC Inc	0.002	-0.060	-0.016	-0.004	0.029	0.015	4	-1.12	3.18	0.05	No
	All M	0.059	-0.032	0.003	0.001	0.020	0.004	32	0.70	2.04	0.01	No
	C M	0.059	-0.032	0.001	0.000	0.023	0.006	15	0.08	2.14	0.01	No
	NC M	0.036	-0.022	0.004	0.003	0.018	0.004	17	1.00	2.12	0.01	No
Day -5	All Cut	0.026	-0.042	-0.002	-0.001	0.017	0.004	18	-0.59	2.11	0.01	No
	C Cut	0.022	-0.020	0.004	0.006	0.018	0.009	4	0.40	3.18	0.03	No
	NC Cut	0.026	-0.042	-0.004	-0.001	0.017	0.005	14	-0.89	2.16	0.01	No
	All Inc	0.038	-0.078	0.004	0.015	0.032	0.010	11	0.45	2.23	0.02	No
	C Inc	0.038	-0.078	0.005	0.015	0.039	0.015	7	0.36	2.45	0.04	No
	NC Inc	0.016	-0.025	0.003	0.010	0.019	0.010	4	0.28	3.18	0.03	No
	All M	0.022	-0.107	-0.008	-0.005	0.024	0.004	32	-1.83	2.04	0.01	No
	C M	0.022	-0.107	-0.006	0.004	0.032	0.008	15	-0.75	2.14	0.02	No

NC M	0.013	-0.039	-0.009	-0.010	0.014	0.003	17	-2.69	2.12	0.01	YES

Platinum Raw Returns

		Max	Min	Mean	Median	St.D	St.Error	Count	T Stat	Critical T	MOE	95%**
Day 5	All Cut	0.0245	-0.0451	-0.0067	-0.0068	0.0179	0.0042	18	-1.592	2.110	0.009	No
	C Cut	0.0037	-0.0451	-0.0159	-0.0111	0.0214	0.0107	4	-1.485	3.182	0.034	No
	NC Cut	0.0245	-0.0409	-0.0041	-0.0052	0.0167	0.0045	14	-0.917	2.160	0.010	No
	All Inc	0.0438	-0.0271	-0.0049	-0.0087	0.0202	0.0061	11	-0.809	2.228	0.014	No
	C Inc	0.0438	-0.0217	-0.0051	-0.0116	0.0229	0.0086	7	-0.588	2.447	0.021	No
	NC Inc	0.0144	-0.0271	-0.0047	-0.0030	0.0177	0.0089	4	-0.526	3.182	0.028	No
	All M	0.0716	-0.0511	0.0014	0.0016	0.0207	0.0038	30	0.377	2.045	0.008	No
	C M	0.0716	-0.0197	0.0077	0.0083	0.0234	0.0065	13	1.193	2.179	0.014	No
	NC M	0.0147	-0.0511	-0.0034	0.0008	0.0175	0.0043	17	-0.800	2.120	0.009	No
Day 4	All Cut	0.0247	-0.0212	-0.0001	0.0043	0.0160	0.0038	18	-0.028	2.110	0.008	No
	C Cut	0.0126	-0.0209	-0.0037	-0.0033	0.0153	0.0076	4	-0.486	3.182	0.024	No
	NC Cut	0.0247	-0.0212	0.0009	0.0064	0.0165	0.0044	14	0.210	2.160	0.010	No
	All Inc	0.0141	-0.0283	-0.0051	-0.0070	0.0139	0.0042	11	-1.211	2.228	0.009	No
	C Inc	0.0140	-0.0283	-0.0077	-0.0119	0.0153	0.0058	7	-1.334	2.447	0.014	No
	NC Inc	0.0141	-0.0120	-0.0005	-0.0020	0.0115	0.0058	4	-0.082	3.182	0.018	No
	All M	0.0426	-0.0211	0.0026	0.0016	0.0141	0.0026	30	0.990	2.045	0.005	No
	C M	0.0254	-0.0211	-0.0007	0.0015	0.0123	0.0034	13	-0.196	2.179	0.007	No
	NC M	0.0426	-0.0145	0.0050	0.0018	0.0153	0.0037	17	1.353	2.120	0.008	No
Day 3	All Cut	0.0302	-0.0486	-0.0053	-0.0039	0.0177	0.0042	18	-1.265	2.110	0.009	No
	C Cut	0.0209	-0.0219	-0.0023	0.0041	0.0176	0.0088	4	-0.264	3.182	0.028	No
	NC Cut	0.0302	-0.0486	-0.0061	-0.0035	0.0183	0.0049	14	-1.252	2.160	0.011	No
	All Inc	0.0251	-0.0064	0.0043	0.0020	0.0092	0.0028	11	1.539	2.228	0.006	No
	C Inc	0.0123	-0.0064	0.0004	0.0008	0.0065	0.0025	7	0.142	2.447	0.006	No
	NC Inc	0.0251	0.0018	0.0111	0.0088	0.0099	0.0049	4	2.251	3.182	0.016	No
	All M	0.0307	-0.0539	-0.0011	-0.0006	0.0146	0.0027	30	-0.397	2.045	0.005	No
	C M	0.0160	-0.0539	-0.0064	-0.0014	0.0179	0.0050	13	-1.291	2.179	0.011	No
	NC M	0.0307	-0.0085	0.0030	-0.0003	0.0103	0.0025	17	1.213	2.120	0.005	No

Day 2	All Cut	0.0825	-0.0267	0.0070	0.0020	0.0248	0.0058	18	1.205	2.110	0.012	No
	C Cut	0.0825	-0.0042	0.0314	0.0237	0.0374	0.0187	4	1.682	3.182	0.059	No
	NC Cut	0.0322	-0.0267	0.0001	0.0011	0.0156	0.0042	14	0.015	2.160	0.009	No
	All Inc	0.0011	-0.0420	-0.0094	-0.0074	0.0124	0.0038	11	2.512	2.228	0.008	YES
	C Inc	0.0011	-0.0420	-0.0099	0.0001	0.0159	0.0060	7	-1.637	2.447	0.015	No
	NC Inc	-0.0058	-0.0123	-0.0087	-0.0083	0.0028	0.0014	4	-6.201	3.182	0.004	YES
	All M	0.0276	-0.0520	-0.0024	-0.0026	0.0165	0.0030	30	-0.794	2.045	0.006	No
	C M	0.0276	-0.0132	0.0023	-0.0016	0.0133	0.0037	13	0.620	2.179	0.008	No
	NC M	0.0273	-0.0520	-0.0060	-0.0036	0.0182	0.0044	17	-1.352	2.120	0.009	No
Day 1	All Cut	0.0265	-0.0222	0.0019	0.0009	0.0107	0.0025	18	0.763	2.110	0.005	No
	C Cut	0.0078	0.0016	0.0056	0.0064	0.0028	0.0014	4	3.975	3.182	0.004	YES
	NC Cut	0.0265	-0.0222	0.0009	-0.0012	0.0120	0.0032	14	0.279	2.160	0.007	No
	All Inc	0.0395	-0.0302	0.0017	-0.0028	0.0241	0.0073	11	0.239	2.228	0.016	No
	C Inc	0.0395	-0.0272	0.0057	-0.0073	0.0277	0.0105	7	0.543	2.447	0.026	No
	NC Inc	0.0101	-0.0302	-0.0052	-0.0003	0.0175	0.0087	4	-0.590	3.182	0.028	No
	All M	0.0353	-0.0306	-0.0014	-0.0037	0.0158	0.0029	30	-0.474	2.045	0.006	No
	C M	0.0353	-0.0306	-0.0012	-0.0043	0.0182	0.0050	13	-0.237	2.179	0.011	No
	NC M	0.0317	-0.0227	-0.0015	-0.0031	0.0143	0.0035	17	-0.432	2.120	0.007	No
Day 0	All Cut	0.0439	-0.0402	0.0017	-0.0009	0.0193	0.0047	17	0.352	2.120	0.010	No
	C Cut	0.0199	-0.0207	-0.0015	-0.0037	0.0204	0.0118	3	-0.127	4.303	0.051	No
	NC Cut	0.0439	-0.0402	0.0023	0.0005	0.0198	0.0053	14	0.439	2.160	0.011	No
	All Inc	0.0311	-0.0181	0.0057	0.0079	0.0167	0.0050	11	1.143	2.228	0.011	No
	C Inc	0.0311	-0.0181	0.0040	-0.0054	0.0203	0.0077	7	0.523	2.447	0.019	No
	NC Inc	0.0169	-0.0039	0.0088	0.0111	0.0092	0.0046	4	1.901	3.182	0.015	No
	All M	0.0350	-0.0435	-0.0038	-0.0030	0.0165	0.0031	28	-1.228	2.052	0.006	No
	C M	0.0199	-0.0435	-0.0080	-0.0020	0.0178	0.0052	12	-1.551	2.201	0.011	No
	NC M	0.0350	-0.0192	-0.0007	-0.0036	0.0153	0.0038	16	-0.188	2.131	0.008	No
Day -1	All Cut	0.0366	-0.0372	-0.0052	-0.0050	0.0156	0.0037	18	-1.420	2.110	0.008	No
	C Cut	0.0063	-0.0266	-0.0061	-0.0050	0.0100	0.0050	4	-1.222	3.182	0.016	No
	NC Cut	0.0063	-0.0266	-0.0061	-0.0050	0.0100	0.0027	14	-2.286	2.160	0.006	YES

	All Inc	0.0289	-0.0393	0.0021	0.0032	0.0228	0.0069	11	0.301	2.228	0.015	No
	C Inc	0.0289	-0.0175	0.0099	0.0077	0.0161	0.0061	7	1.628	2.447	0.015	No
	NC Inc	0.0263	-0.0393	-0.0117	-0.0169	0.0284	0.0142	4	-0.824	3.182	0.045	No
	All M	0.0248	-0.0272	0.0008	0.0018	0.0114	0.0021	30	0.389	2.045	0.004	No
	C M	0.0125	-0.0272	-0.0023	-0.0021	0.0107	0.0030	13	-0.772	2.179	0.006	No
	NC M	0.0248	-0.0204	0.0032	0.0050	0.0117	0.0028	17	1.128	2.120	0.006	No
Day -2	All Cut	0.0444	-0.0150	0.0093	0.0109	0.0147	0.0035	18	2.665	2.110	0.007	YES
	C Cut	0.0287	-0.0150	0.0055	0.0061	0.0127	0.0064	4	0.871	3.182	0.020	No
	NC Cut	0.0287	-0.0150	0.0055	0.0061	0.0127	0.0034	14	1.630	2.160	0.007	No
	All Inc	0.0382	-0.0195	0.0077	0.0085	0.0185	0.0056	11	1.375	2.228	0.012	No
	C Inc	0.0382	-0.0170	0.0148	0.0199	0.0179	0.0068	7	2.188	2.447	0.017	No
	NC Inc	0.0085	-0.0195	-0.0048	-0.0041	0.0133	0.0066	4	-0.723	3.182	0.021	No
	All M	0.0243	-0.0264	0.0017	0.0018	0.0111	0.0020	30	0.819	2.045	0.004	No
	C M	0.0243	-0.0181	0.0059	0.0076	0.0107	0.0030	13	1.981	2.179	0.006	No
	NC M	0.0124	-0.0264	-0.0016	-0.0005	0.0106	0.0026	17	-0.613	2.120	0.005	No
Day -3	All Cut	0.0139	-0.0262	-0.0051	-0.0019	0.0113	0.0027	18	-1.926	2.110	0.006	No
	C Cut	0.0139	-0.0227	-0.0033	-0.0002	0.0107	0.0054	4	-0.614	3.182	0.017	No
	NC Cut	0.0139	-0.0227	-0.0033	-0.0002	0.0107	0.0029	14	-1.148	2.160	0.006	No
	All Inc	0.0243	-0.0211	-0.0002	-0.0006	0.0188	0.0057	11	-0.031	2.228	0.013	No
	C Inc	0.0036	-0.0106	-0.0020	-0.0006	0.0055	0.0021	7	-0.988	2.447	0.005	No
	NC Inc	0.0243	-0.0211	0.0031	0.0046	0.0205	0.0103	4	0.300	3.182	0.033	No
	All M	0.0446	-0.0128	0.0051	0.0022	0.0127	0.0023	30	2.187	2.045	0.005	YES
	C M	0.0300	-0.0119	0.0049	0.0027	0.0128	0.0036	13	1.367	2.179	0.008	No
	NC M	0.0446	-0.0128	0.0052	0.0021	0.0130	0.0032	17	1.658	2.120	0.007	No
Day -4	All Cut	0.0171	-0.0311	-0.0028	-0.0009	0.0108	0.0025	18	-1.086	2.110	0.005	No
	C Cut	0.0171	-0.0113	-0.0001	0.0007	0.0088	0.0044	4	-0.025	3.182	0.014	No
	NC Cut	0.0171	-0.0113	-0.0001	0.0007	0.0088	0.0024	14	-0.047	2.160	0.005	No
	All Inc	0.0147	-0.0370	-0.0038	-0.0038	0.0136	0.0041	11	-0.924	2.228	0.009	No
	C Inc	0.0147	-0.0107	0.0003	0.0008	0.0087	0.0033	7	0.099	2.447	0.008	No
	NC Inc	0.0074	-0.0370	-0.0110	-0.0072	0.0189	0.0094	4	-1.166	3.182	0.030	No

	All M	0.0291	-0.0246	-0.0040	-0.0033	0.0112	0.0020	30	-1.963	2.045	0.004	No
	C M	0.0121	-0.0246	-0.0087	-0.0114	0.0107	0.0030	13	-2.936	2.179	0.006	YES
	NC M	0.0291	-0.0153	-0.0004	-0.0019	0.0104	0.0025	17	-0.155	2.120	0.005	No
Day -5	All Cut	0.0296	-0.0383	-0.0003	0.0033	0.0192	0.0045	18	-0.061	2.110	0.010	No
	C Cut	0.0253	-0.0383	-0.0024	0.0033	0.0178	0.0089	4	-0.268	3.182	0.028	No
	NC Cut	0.0253	-0.0383	-0.0024	0.0033	0.0178	0.0047	14	-0.502	2.160	0.010	No
	All Inc	0.0293	-0.0225	0.0063	0.0054	0.0152	0.0046	11	1.387	2.228	0.010	No
	C Inc	0.0293	-0.0225	0.0016	0.0016	0.0161	0.0061	7	0.256	2.447	0.015	No
	NC Inc	0.0243	0.0010	0.0147	0.0168	0.0101	0.0051	4	2.909	3.182	0.016	No
	All M	0.0295	-0.0422	-0.0021	-0.0010	0.0170	0.0031	30	-0.668	2.045	0.006	No
	C M	0.0280	-0.0422	-0.0046	-0.0025	0.0204	0.0057	13	-0.818	2.179	0.012	No
	NC M	0.0295	-0.0223	-0.0001	0.0001	0.0142	0.0035	17	-0.036	2.120	0.007	No