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Oil price fluctuations, online public concern and safe haven markets during covid-19

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I would like to acknowledge my supervisor for his enormous support and efforts in constructing my thesis.

My family that has stood by me all through my studies, I am very grateful.

Abstract

The spread of COVID-19 across the globe, which began at the end of December 2019, is an invisible global shock whose impact is not limited to health related issues. Its effects have rapidly propagated to the global economic and financial system as well. This thesis measures the effects of the outbreak of covid-19 and of related public concerns with respect to the oil, gold and real estate markets. Public concern is proxied through topic and country specific *google trends indices.* Whereas, the severity of the outbreak is proxied through the Oxford COVID-19 Government Response Stringency indices. First, I analyse their cross-correlation with the performance of financial markets. Second, I estimate their impact on oil and safe haven market indices. This for five oil producing countries, namely the US, Saudi Arabia, Russia, China and Nigeria. In addition, I check if during the outbreak the exchange rate of the currencies of these countries, with respect to the dollar, responded to COVID-19, and to related concerns measured with Google Trends indices.

keywords: Google Trends, Real estate, REIT, Oil, Gold, COVID-19, US, Saudi Arabia, Russia, China and Nigeria

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INTRODUCTION

In the year 2019, remarkable performances of the world's major asset classes were experienced especially in December, making it the strongest annual performance since 2019. Dirk Thiels (Bloomberg, 2019), the Brussels-based Head of Investment Management at KBC Asset Management NV described it as `a grand cru which in wine terms means a very good vintage'. Amidst the unprecedented gains from the classes, professional forecasters as well as David Holohan (Bloomberg, 2019), the head of equity strategy at Mediolanum predicted a sideways movement from the initial direction mainly due to an unexpected increase in the value of these classes. Fast Track to 2020 and these sideways movements predicted do come to pass but not due to the reason formerly indicated rather by a pandemic, COVID-19 to be precise.

The spread of COVID-19 across the globe, which began in December 2019, has claimed hundreds of thousands of lives, instilling fear in millions of people as no effective cure has been found yet and its means of spread is airborne. The oil industry is one of the many industries greatly hit by this pandemic. Studies on oil shocks and oil glut due to clashes between suppliers and their desire to maintain or increase their market share has been conducted, however until the spread of COVID-19 where we see dramatic drop in the oil price, very little research has been undertaken related to the impact of global pandemic on the oil market. This forms one of the major objectives for conducting this work. This thesis, focuses on the impact of COVID-19 and its related public concern on the oil market.

Over the years, during different financial crisis and circumstances, investors have been urged to hedge and diversify their investment portfolios so as to mitigate the negative impact of such crisis on their portfolios. Such actions include mostly the purchase of gold, US treasuries, German bonds, investment in real estate, and currencies like the US dollar and the yen, as they have relatively lower correlation with the performance of commonly traded stocks or consistent yielding abilities or low volatility. However that is not to say that, all havens efficacy in maintaining their value is realized in all crisis. In this thesis we shall analyse investors perception about some safe havens, gold and real estate to be specific during the outbreak of

COVID-19, using Google trend as a proxy of the public concern and of investors' perception.

In summary, this thesis is conducted by first gathering financial data on each of the three markets; oil, gold and real estate market. Then, we proxy concerns related to these markets through two-time series based on search engine data for a period ranging from January 1st to June 5th 2020, during which the outbreak of COVID-19 occurred and was declared by the WHO a global pandemic. Data on public concern was collected for three studied markets, and for public concerns related to the COVID-19 pandemic itself in five different countries: United States (U.S), Russia, Saudi Arabia, China and Nigeria. These concern proxies are based on Google relative search volumes by country, Google Trends indexes.

The outbreak of COVID-19 has pushed several governments to implement measures to mitigate the spread of the pandemic, one which is adopted by most is the lockdown and closing of national borders. Governments intervention and actions to curb the spread of COVID-19 differs from one country to the other according to the rate at which the virus spreads in that particular country. In order to analyse and estimate the impact of government response for the five countries to the outbreak of COVID-19, we utilise a set of measures, called Government Response Stringency Indexes, which are a composite measure based on nine response indicators including school closures, workplace closures, and travel bans. These indexes have been constructed to proxy the Government response of the selected countries to the COVID-19 pandemic (Hale, Thomas, Sam, Anna, Toby, Beatriz, 2020).

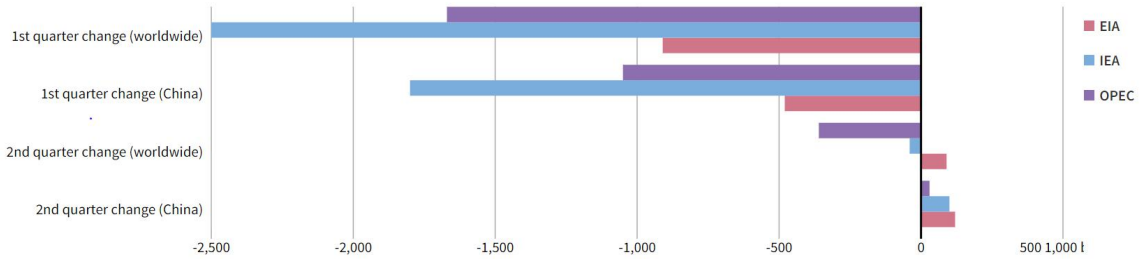
Secondly, analysis on the instantaneous dependency and cross-correlation between market indexes, Google indexes and government response indexes for the five countries is conducted, then the index for each of the analyzed markets that is highly correlated with the Google indexes and government response indexes are selected for further estimation of the impact and severity of COVID-19 on the three markets with a VAR model.

Lastly,we analyse how exchange rates, for the Russian Ruble, Chinese yuan Renminbi, Nigerian Naira and Saudi Arabian Riyal, with the American Dollar (as the base) responded to the outbreak of COVID 19 during the selected period, in the five analysed countries.

CHAPTER ONE

Oil Markets and Safe Havens during the COVID-19 crisis

Over the decades, impact of industrial growth, globalization and regionalisation on several economies is widely known and talked about. However, the building and running of factories, cities, international trade among countries cannot be done without the energy sector, hence serving as an essential input to all economic activities. Due to a halt in many economic activities and many working remotely from home to curb the spread of COVID-19, the demand for oil has sharply decreased in the first quarter of this year with respect to 2019 (fig 1.1) worldwide.



Sources: U.S. Energy Information Administration, International Energy Agency, Organization of the Petroleum Exporting Countries

Figure 1.1: Oil demand slumps in first quarter of 2020 worldwide and China

In the 20th and 21st century, only four influenza pandemics have hit the globe with two being mild (H5N1 bird flu and swine flu) and two being severe (Spanish flu and COVID-19) and three have had no or a short term impact on global macroeconomy and the financial market. COVID-19 has affected not only the global economy but the financial market as well, especially oil futures, shaking the grounds of investors and making them feel insecure about the safety of their investments and yields.

In this chapter, we shall discuss the oil markets, safe havens market, the usage of web data in economic and financial studies, to analyse and explain oil futures price dynamics and model them through regression methods, used to statistically describe our case studied, and the relation between investor concerns and selected markets.

1.1 General overview of oil and its impact on global economy

Given the intertwined nature of the oil industry with other industries, the former plays an important role in production and consumption processes, and regulates supply

and demand of goods and services, hence directly affecting the standard of living (Energy and Economy, page 400). Low oil prices do benefit users but may actually cause real income loss on the side of the producers and the oil producing countries as the oil industry may contribute a noticeable amount to the countries' revenue. Husain, Arezki, Breuer, Haksar, Helbing, Medas and Sommer (2015) focused on the global implications of lower oil prices and observed that the fall of brent oil prices by 50% within the second half of 2014 and early 2015 had a negative impact on petroleum product markets and placed strains on the financial sector by amplifying credit risk, oil surplus and global liquidity. This thesis analyzes the contribution of COVID-19 to the higher fluctuations experienced in the oil market and and its impact on the exchange rates of the currencies of four oil producing countries with respect to the American Dollar (as the base) since oil contracts are traded in dollars.

With China accounting for close to 50% of oil demand, a 25% decrease in oil demand in that country, where COVID-19 epidemic originated from, was captured in the oil price in the first quarter of 2020 by a rapid fall although supply glut was also a factor of the drop(figure 2.4). It is undeniably true that oil is a booster for growth in oil producing countries in particular, but the question is how can the governments of these oil producing countries analyzed, formulate policies that can stabilize the growth process? If oil prices are volatile, what measures can be put in place to mitigate the impact and damage generated by oil price fluctuations?

1.1.1 Major players in the oil market

The players in the oil market can be categorized into three groups; the demand side, the supply side and oil futures. The main players on the demand side being firms who are dependent on oil for their activities and the household. Due to the the large number of players on the demand side, no individual can influence oil price trends however demand shocks can impact the oil price negatively or positively depending on the type of shock. On the supply side we actually have quite a few players i.e National Oil Companies and the Private Oil Companies. Although there has been substantial increase in the number of companies over the years, the decision of few powerful companies do have an impact on the oil price (Max 2016). Nonetheless, we cannot ignore the role of oil futures on the market, which was not included in the oil market category in (Max, 2016) when analyzing the impact of oil price changes on

growth for seven OECD countries. By reason of the high market liquidity and demand of oil, its regarded as one of the best commodities to be traded on the futures market by investors. Taking this into consideration and the gap in aforementioned work, in this thesis, the market is proxied through two oil futures, WTI and Brent oil futures specifically, to analyse the impact of COVID-19 on the market.

During pandemics in the likes of COVID-19, usually most economic activities, as well as travelling and other forms of entertainment are restricted to curb death rate, slashing fuel consumption so demand levels drop, leading to a decrease in oil demand and prices as illustrated during the SARS epidemic (Roeger, 2006). In the case of COVID-19, due to the digital era in which this pandemic is occurring, work is being increasingly engaged remotely, but several companies have cut down production and laid off hundreds of thousands of workers, reducing real income and purchasing power of consumers.On the other hand drops do not only affect the revenues and profits of oil companies but also the oil futures, and hence the wealth of investors.

As said by John Hoeven, the US Senator of North Dakota, one of the keys to unlocking energy potential of the planet is creating an environment that attracts private investment (Energy economic growth, Industry agenda 2012). Since the oil industry is more capital intensive compared to other industries, the stability in the oil market, especially for what concerns its price, can serve as a magnet to attract investors and assure them significant returns on their investments. Prices and their trends, signal to investors the potential yield (short-selling) of a stock. With a steep downward trend in the oil prices today like never before, and a decline in current and planned investments, some safe havens like gold is expected to respond to oil price shock and rise in price. Although gold is not co-integrated with oil price shocks, yet oil price fluctuations have a nonlinear effect on gold price returns (Le, Chang, 2012). This evident in the gold closing prices recorded in first quarter 2020 (fig 1.2).

Source: ***https://www.macrotrends.net/1333/historical-gold-prices-100-year-chart***

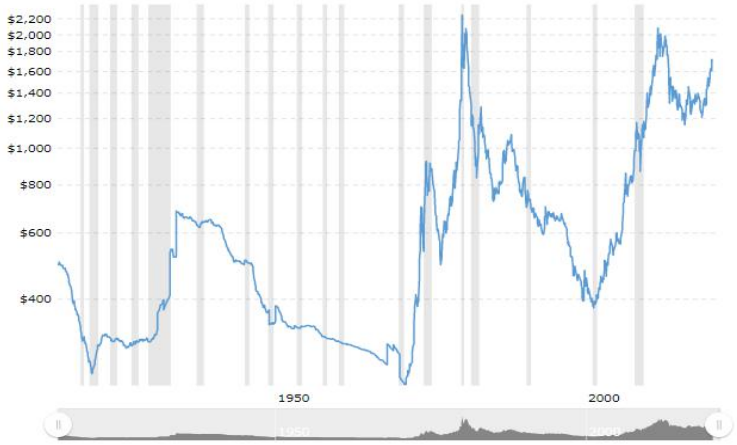
Figure 1.2: Gold prices from April 2019 to July 2020

1.2 Gold as a safe haven

"The recessionary fallout of the Covid-19 outbreak on the global economy suggests investors are likely to continue to seek refuge in gold," says BNP commodities analyst commodities Harry Tchilinguirian (CBNC news, 2020).

It is reasonable for an investor to choose carefully which asset to add to his investment portfolio to obtain the highest possible yield and as well hedge his investment against inflation and loss when the financial market is highly unstable. That is to say asset selection and allocation is of dire importance when taking decisions related to investments. Over the years, just a few pandemics did have impact on the financial market, i.e.the Spanish flu and COVID-19. In this section we shall view and discuss gold historical prices.

1.2.1 Historical overview of gold prices over time



source *https://www.macrotrends.net/1333/historical-gold-prices-100-year-chart*

Figure 1.3: Gold prices-100 year historical chart

- Before the spread of Spanish flu in 1918, there was a downward trend in gold prices which began during the world war, however the Spanish flu drew the prices further down till the end of the pandemic. Yet it did not take long for for gold to recover and experience an upward trend in its prices.

- Gold has been in a bull market for a long period of time even during the 2008 financial crisis (Table 1.1) such that when major assets were not faring well as their values plunged, only the U.S.Treasury Bonds, Japan Government Bonds(JGB) and the money market saw a surge in value along with gold. U.S treasury bonds saw these surge due to the fact that the central banks being the biggest investor, bought back the bonds with newly printed money (Mcguire, 2010), whilst JGB's yield remained low and stable due to high domestic ownership of JGB and being regarded as a safe-haven with its flows from heightened sovereign risks in Europe and its high correlation with the U.S Treasury Bonds (Lam and Tokuoka, 2011).

Name	2008 Performance
S&P 500	(37.0%)
Russell 1000	(37.6%)
Russell 2000	(33.8%)
MSCI US REIT	(38.0%)
MSCI AC World	(42.2%)
EM Asia	(53.0%)
EM Latin America	(51.4%)
EAFE & Canada	(43.6%)
U.S. Treasury Bonds	13.7%
Japan Government Bonds	3.7%
U.S. TIPS	(2.4%)
EM Government Bonds	(6.9%)
U.S. Investment Grade Credit	(3.1%)
Commercial MBS	(20.5%)
U.S. High Yield	(26.2%)
Global Hedge Fund Index	(23.3%)
Money Market	1.8%
Crude Oil	(53.5%)
Copper	(54.2%)
Agriculture	(28.9%)
Silver	(23.0%)
Gold	**5.8%**

Source: bloomberg

Table 1.1: Major assets and their performance 2008

With gold increasing in value by 5.8% and its price increasing steadily, this presupposes that the virtue of gold as safe haven for the investment portfolios against inflation was strengthened during this period.

- In the 1970s and early 2000s, figure 1.3 shows a steady upward trend in the price, however dramatic downward trends are observed before the year 2000 and an upward trend from 2001 till now.

The surge in gold price during the COVID-19 pandemic can, to some extent, be related to real interest rates. Gold's efficacy as a hedge is best seen when real interest rates experience a downward trend. For instance in figure 1.4, in the early 70's where real interest fell below zero, -1.281% in 1975, the price of gold did boom till early 80's **(**figure 1.3). With similar occurrence today where economic growth is dwindling, and real interest rates are in the negatives and predicted to be in the zeros, hence eroding the value of dollar, gold is experiencing an upward trend, performing its best. Being a non-productive asset, gold asset, gold best serves as a hegding instrument, particularly in turbulent times as the one we are living (Kumar, 2014).

source: the world bank IMf, International Financial Statistics and data files using World Bank data on the GDP deflator

Figure 1.4 Real interest rates U.S from 1961-2018

In general, the historical chart of gold prices reveals relatively high volatility of the prices as big swings both upwards and downwards are recorded. Gold is regarded as a volatile asset by many financial professional (Mcguire,2010) and it is important to realize that unexpected economic events such as COVID-19 and investors perception can drive gold price fluctuations. Taken into consideration the above mentioned factors to gold price volatility, we focus on the impact of public concern related to gold and COVID-19 on the gold market.

1.3 Real Estate as a safe haven

During a financial crisis or periods of instability in financial market, over the years, investors are found seeking refuge in assets which are commonly regarded as safe havens like gold and real estates to hedge their portfolios. That been said does not automatically mean that any amount of shares of these assets performs the exact meant purpose for which it was purchased, that is hedging against inflation, because with the U.S real estates bubble that burst in 2008, which drove the financial market into a crisis, investors with a balanced well (diversified) portfolio were better off than concentrated real estate investors and speculators.

As shown in table 1.2, real estate as an investment can be categorized into four sectors;

	Equity	Debt
Private	Direct Investment in Real Estate	Direct Investment in Real Estate Mortgages
Public	Real Estate Investment Trusts (REITs) Real Estate Operating Companies (REOCs)	Commercial Mortgage Backed Securities (CMBS)

source Ling and Wang, 2010 pg.2

Table 1.2 Categories of real estate as an investment

These sectors differentiate from each other by their risk levels and liquidity profiles. Although the debt sector provides priority claim on future revenue at a specified rate and period, especially during liquidation over equity, relatively less risky, equity holders are entitled to active participation in the management of real estate properties hence benefiting from growth and property appreciation (Ling and Wang, 2010).This thesis focuses on the impact of COVID-19 and investors' concerns related to the real estate market, which is commonly regarded as safe haven. The impact of this crisis can be adequately calculated by analyzing the growth of the real estate industry and property appreciation, which is a sector highly probable to be directly affected by the situation of the the global economy and financial market. The equity category of commercial real estate investment is of more importance to the production of effective and accurate results. We shall then use REITs to represent real estate investment as its shares are traded publicly, making it relatively liquid than direct investment in real estate which deals more privately with buyers and sellers of real estate properties and the powerhouse for most emerging markets.

REITs is a company that owns, finances or operates an income-generating real estate across a range of property sectors, deriving its capital from investors in return for dividend and diversify their portfolios. By law, REITs must pay out at least 90% of its taxable income to investors as dividend. In a way this guarantees investors a steady cash flow, and its low correlation with the performance of other commonly traded stocks like S& P500 (FTSE NAREIT All equity REIT index have outperformed S&P 500 index 15 years out of the last 25 years) index, to some extent makes it an inflation hedge especially during a financial turmoil like the one currently being experienced.

Ralph (2012) stated that there are two types of REITs but in actual sense there are many REITs that are categorized into 3 sections namely equity REITs, mortgage REITs and hybrid REITs. These are classified according to how and where their shares are traded and held; publicly traded REITs, public non-traded REITs and private REITs. Publicly traded REITs are regulated by the U.S Securities and Exchange Commission (SEC) and listed on National securities exchange. Public non-traded REITs are those regulated on SEC but not listed on national securities exchange. Private REITs just like its name goes is neither registered on SEC nor traded on national securities exchange.Its estimated, according to the National

Association of Real Estate Investment Trusts (NAREIT), that all REITs own approximately $3 trillion in gross assets with publicly traded equity REITs accounting for $2 trillion which is ⅔ of the gross asset . For this reason we shall focus particularly on publicly traded equity REITs. Since their creation in 1916, REITs have grown in size and proven to have a track record of strong steady performance (NAREIT). Nonetheless occurrences that affect global economy growth is likely to affect REITs in general.

COVID-19 has shaken to the core the health system of several countries, spreading its tentacles to the global economy. Measures put in place by several governments although to curb the spread of the virus has halted a lot of economic activities, deteriorated several business conditions, as well as households as millions are laid off, with companies unable to cover minimum cost of production, including the payment of rent for commercial properties, and household struggling with rent payment. With REITs in general deriving their income from collection of rents, with which dividend is gotten, distributed to investors and invested in building projects, any blockage of this cash flow channel can suffocate REITs as it thrives on building projects like the construction of factories, malls or office building. These projects during these times are less prioritized and can be postponed compared to other areas like food, lightening, water, clothing and transportation. For instance the financial crisis that hit the globe from mid 2008 to early 2009 even though not a pandemic, percentage change in global output fell from 5.2% to 3% in 2008 then to -0.6% in 2009 (Overview of the World Economic Outlook Projections, 2010). With decline in building projects leading to 4.5% points to that GDP fall, total returns decreased by 37.73% on FTSE Nareit equity REITs by the end of 2008. Nonetheless, it did not take long to recover with an increase in total returns by 27.99% in 2009 (Annual returns for the FTSE Nareit U.S real estate index series). As of May 5th, 2020, all equity REITs saw a decline in its dollar price by 3.47% with a predicted contraction in global real GDP annually by -3%, which would result in a worst year than that of the 2008 financial crisis.

1.4 Similarities and distinctions between gold and real estates when considered as safe havens

- REITs shareholders pay income tax on their dividends. High management fee for professional management.

- Both gold and REITs often have less correlation with the performance of commonly traded stocks and historically seen outperforming them but gold does not outperform stocks on the long run as it does not grow and yield cash flows.
- REITs yield cash flow and over the years have proven to grow but gold does neither of these. Gold is a metal and by monetary definition a currency however classified as an investment so long as currencies used worldwide are not linked to gold.
- Gold price responds to the expansion and contraction of currencies especially the dollar which circulates and is produced faster than the mining of gold. REITs are companies that operate or buy real estates sourcing their capital from a pool of investors and deriving their income from the collection of rents.

1.5 Google Trends and its usage in economic and financial studies

Google Trends (GT), recently has been found to be of significant importance in informative and predictive analysis in economic and financial studies. With GT, analysis are made using topics which comprises of collection of Goolge search engine queries made over time from the gigantuan dataset storage, the retrieved relative query volumes can be related to a specific topic or keyword , can be filtered by category and geographic area. The resulting time series can be used, especially in the finance sector, for forecasting and portfolio diversification and optimization (Kristoufek, 2013).

GT analysis can also be used in the identification of herd instinct in specific sectors; trading strategies influenced by current strategies implemented by many others in that specific sector, revealed through volumes of related web searches on the Google search engine (Preis, Reith and Stanley,2010), as well as stock market valuation among countries and comparison of trading strategies (Wan Jiang, 2016). GT has also been used to detect influenza epidemics (Ginsberg et al. 2009) and proxying economic phenomena i.e. unemployment rates (Askitas and Zimmermann 2009). This thesis measures public concern related to the oil, gold and real estate markets with GT indexes, using them as proxies during the outbreak of COVID-19.

1.6 Statistical methodology and modelling

In this thesis data is collected from investing.com and Google Trends. Although GT has been found to be of useful tool for interpretive and predictive analysis in financial studies, however, search query volumes data can be a noisy proxy of investors' concerns, as search query data collected on GT indices comes from a broader audience, i.e worldwide web search with countries having significant differences in trading strategies and activities Jiang (2016). For instance Jiang (2016) makes a comparison between US and China stock market performance using search query data from both GT and Baidu. With these countries having different trading activities and interactions which can create a large amount of noise, manipulating the validity of the proxy, seeks to reduce such noise by utilizing a penalized linear regression method LASSO, and collects volume of search query data on selected undervalued, but growing companies on the two selected countries stock market to represent the interest in stocks. In this thesis, we shall focus on search query data from the US, Russia , Saudi Arabia, China and Nigeria. GT topics used in this thesis are: oil, gold and real estate, which are attractive to both investors and the 'layman' due to its diverse characteristics and uses, hence large amount of noise is anticipated.

In previous studies statistical methods like AR and TVP-AR (Costola, Iacopini , Santagiustina, 2020), and recent methods like Pearson product-moment correlation coefficient and fisher transformation (Preis, Reith and Stanley, 2010) have been employed for the analysis of GT indexes and their relation with the financial markets. This thesis utilizes VAR models (Pfaff, 2008) in its empirical analysis. In order to reduce anticipated noise, Google indexes for these five countries that have relatively high instantaneous dependent relation, and lags that are useful predictors of the financial markets' indexes are selected to be modeled with VAR.

1.7 Research objectives, hypothesis and summary of following chapters

The main research objectives are:

- analyse and estimate the effect of COVID 19 on the oil, gold and real estate markets for US, Russia, Saudi Arabia,China and Nigeria.
- analyse and estimate the impact of public concern related to oil, gold and real estate on their financial markets during the outbreak of COVID 19 with Google trends as a measuring tool

- measure the severity of the outbreak of COVID 19 on oil, gold and real estates market with government response indicators for the five countries.

Research hypothesis:

- the dynamic of China's public concern for COVID-19 anticipates that for Russia, Saudi Arabia, Nigeria and US during the outbreak of COVID-19.
- the oil market is negatively affected by the outbreak of COVID-19.
- the gold market is positively affected by the outbreak of COVID-19.
- the real estate market is positively affected by the outbreak of COVID-19.
- Public concern for gold and real estate positively affects their performance on the financial market.
- Public concern for oil negatively affects their performance on the financial market.
- The exchange rate for the currencies of selected countries with respect to the dollar responded to the outbreak of COVID-19 and its related Google trends indexes.

Research questions:

- To what degree does gold and real estate prices instantaneously depend on the volatility of oil price?
- Are gold and real estate safe havens during the outbreak of COVID-19?
- The following chapters are structured as follows:
- Chapter 2 gives in depth information on data strategy and processing.
- Chapter 3 focuses of the econometric model estimation results, comments on results, robustness checks and then conclusion.

CHAPTER TWO

Web data, financial data and its application

In this chapter, we explain how data was collected and processed. The instantaneous linear dependency and lag relation of research parameters are also discussed in this chapter, then we finally introduce and describe the resulting time-series.

2.1 Data collection and source

In recent years, GT has been tested as an adequate measuring tool for online public concern along with others like BAIDU and featured in several recent economics and financial studies for predictive and interpretative purposes based on Herbert Simon's theory of decision making. (Mondria, Wu & Zhang, 2010) investigated the determinants of portfolio choice and attention allocation using Google Trend and concluded that investors concern reflected the financial market state and used to anticipate future trends. However, this thesis focusing on the interpretative and predictive characteristics of online public concern in relation to the performance of oil, gold and real estate, and GT deemed as easily accessible, commonly used and highly accepted measuring tool for recent studies in several fields of research, GT then quickly surfaces as a good option for this thesis for the measuring of online public concern.

In order to achieve the objectives of this study, analyzing and estimating the relation between public concern and the performance of the selected markets during the outbreak of COVID-19, financial data at daily frequency (ranging from 1/01/2020 to 05/06/2020) is collected from investing.com, with five working days summing up to be a week, as markets do not operate during the weekend.. There are several alternative sources from which similar financial data can be collected, for instance bloomberg, world bank, yahoo finance and etc.

2.2 Time series description

The time series used for this study are : GT Oil, GT Gold, GT Real Estate, GT Covid, Government response indicators(OxCGRT) for the five countries,Brent Oil futures US dollar, WTI Oil futures, Gold futures,S&P_TSX Global Gold Total Return, DowJones Equity REIT total return, DowJones Equity all REIT, USD/RUB, USD/SAR, USD/CNY and USD/NGN .

Oil market indexes are proxied through:

- log of Brent oil closing prices (BRENTPR)
- Daily price changes of Brent oil (BRENTPR_CH)
- log of WTI oil closing prices (WTIPR)
- Daily price changes of WTI oil(WTIPR_CH)

Gold market indexes are proxied through:

- log of Gold futures closing prices (Gold_FutPR)
- Gold futures daily price variations(Gold_FutPR_CH)
- log of S&P_TSX Global Gold Total Return closing prices(Gold_SPPR)
- S&P_TSX Global Gold Total Return daily price variations (Gold_SPPR_CH)

Real Estate market indexes are proxied through:

- log of DowJonesEquityREITTotalReturn closing prices (REIPR)
- DowJonesEquityREITTotalReturn daily price variations (REITPR_CH)
- log of Dow Jones Equity All REIT closing prices (REIT_allPR)
- Dow Jones Equity All REIT daily price variations (REIT_allPR_CH)

Google oil index for United States, Saudi Arabia, Russia, China and Nigeria respectively are proxied through:

- US_GToil - google hits for the topic oil in US
- SA_GToil - google hits for the topic oil in Saudi Arabia
- RU_GToil - google hits for the topic oil in Russia
- CN_GToil - google hits for the topic oil in China
- NG_GToil - google hits for the topic oil in Nigeria

Google gold index for United States, Saudi Arabia, Russia, China and Nigeria respectively are proxied through:

- US_GTgold - google hits for the topic oil in US
- SA_GTgold - google hits for the topic oil in Saudi Arabia
- RU_GTgold - google hits for the topic oil in Russia

- CN_GTgold - google hits for the topic oil in China
- NG_GTgold - google hits for the topic oil in Nigeria

Google real estate index for United States, Saudi Arabia, Russia, China and Nigeria respectively are proxied through:

- US_GTre - google hits for the topic oil in US
- SA_GTre - google hits for the topic oil in Saudi Arabia
- RU_GTre - google hits for the topic oil in Russia
- CN_GTre - google hits for the topic oil in China
- NG_GTre - google hits for the topic oil in Nigeria

Google covid index for United States, Saudi Arabia, Russia, China and Nigeria respectively are proxied through:

- US_GTcovid - google hits for the topic oil in US
- SA_GTcovid - google hits for the topic oil in Saudi Arabia
- RU_GTcovid - google hits for the topic oil in Russia
- CN_GTcovid - google hits for the topic oil in China
- NG_GTcovid - google hits for the topic oil in Nigeria

Government response index for United States, Saudi Arabia, Russia, China and Nigeria respectively proxied are through:

- US_OxCGRT - US government response indicator
- SA_OxCGRT - Russia's government response indicator
- RU_OxCGRT - Saudi Arabia's government response indicator
- CN_OxCGRT - China's government response indicator
- NG_OxCGRT - Nigeria's government response indicator

Saudi Arabia, Russia, China and Nigeria currencies with respect to the US dollar are proxied through:

- USD/SAR - Saudi Arabian Riyal with respect to American dollar
- USD/RUB - Russian Ruble with respect to American dollar
- USD/CNY - Chinese Yuan Renminbi with respect to American dollar
- USD/NGN - Nigerian Naira with respect to American dollar

GToil , GTgold, GTre and GTcovid are based on the corresponding GT topics, topics are set of terms that have equivalent meanings in different languages . These GT indexes are used as a proxy for public concern, respectively related to oil, gold, real estate and COVID-19.

USD/RUB, USD/SAR, USD/CNY and USD/NGN are forex indexes used to analyse the depreciation and appreciation of the currencies of Russia, Saudi Arabia, Chna and Nigeria with respect to the US dollar during the outbreak of COVID-19. With all oil contracts coated in dollars, forex between the dollar and the currencies of the four countries serves as a viable medium for undertaking such analysis as the exchange rate will directly impact the extraction, import and export of oil in these countries, and hence the revenue of these countries during the outbreak of COVID-19.

On the side of financial data , Brent and West Texas Intermediate (WTI) oil futures are selected as indexes for the oil market as their prices serve as a benchmark for pricing oil purchases globally and oil being considered by investors as one of the best commodities traded on the futures market due to reasons already mentioned in the previous chapter. DowJones Equity REIT total return and DowJones all Equity REIT are used as indexes for the real estate market on the basis of they being REIT's and publicly traded on the US SEC as per discussions in Chapter one. Also, Dow Jones is one of the commonly viewed equity indices globally. Gold futures and S&P_TSX Global Gold Total Return are selected as indexes for the gold market due to its recognition on the international markets.

The five countries selected for this studies are highly linked to specific characteristics of these countries which are deemed of particular interest for the purposes of this studies. US, Saudi Arabia and Russia are the three largest global oil suppliers,accounting for approximately an aggregate of 41% of the world's production as at 2019 hence analysis on the impact of covid-19 on the oil market and the globe as a whole can be significantly undertaken with these countries, yielding significant results in relations to the objectives of this study. The outbreak of COVID-19 is said to have began from a market in Wuhan, China in December, 2019, hence the selection of China to analyse the effect of the outbreak of COVID-19 on the country's economy. On the other hand, China is a net importer of oil and highly dependent on its oil import to cater for a significant portion of its oil needs/consumption. A turbulence in the oil market such as the one caused by COVID-19 is highly probable to have an appreciable impact on China's economy due to the aforementioned reasons, hence the selection of China. Alongside CHINA being another emerging country is selected as a representative to analyse the effect of COVID-19 on emerging markets. With Nigeria being one of the African countries with the highest recorded COVID-19 cases, it is selected as a representative of

developing countries and used to analyse the impact of COVID-19 on the Africa continent. Nigeria is not seen among the list of the ten largest world oil suppliers however its heavy dependence on revenue generated from the export of oil produced leaves its economy to some extent at the 'mercy' of the oil market and any turbulence in this market can destabilize Nigeria's economy.

2.3 Data processing

GT and financial data are collected over a period of T= 158 market days from 1 January to 5th June 2020. On the side of financial data, closing price of the commodities and forex were downloaded from investing.com. The financial data is collected according to the operation days of the financial market which is five working days in a week with GT data collected over seven days in week pattern hence GT and the financial data collected are modified to conform to the pattern of the financial market which is five days in a week. Oil, Gold and Real Estate indices were downloaded from Google Trends using R package gtrendsR **(Massicotte and Eddelbuettel, 2020)**.

Parameter	Value(s)	Description
GT covid	/2Fm/2F01cpyy ("coronavirus"topic) /2Fm/2F0bp_wy("oil" topic) /2Fm/2F025rs2z("gold" topic) /2Fm/2F06k1r("real estatel" topic)	Parameter for topic identifier
time	(from)1/01/2020-(to)6/06/2020	Time filtering parameter
geo	US, RU,SA,CN,NG	geographical area filtering parameter
gprop	"web"	Source type filtering parameter: "web" stands for all Google search engine data

Table 2.1 GT query arguments with indices rescaled in [0,100] interval

Google Trends generates its time series following the procedure therein represented in figure(2.1)

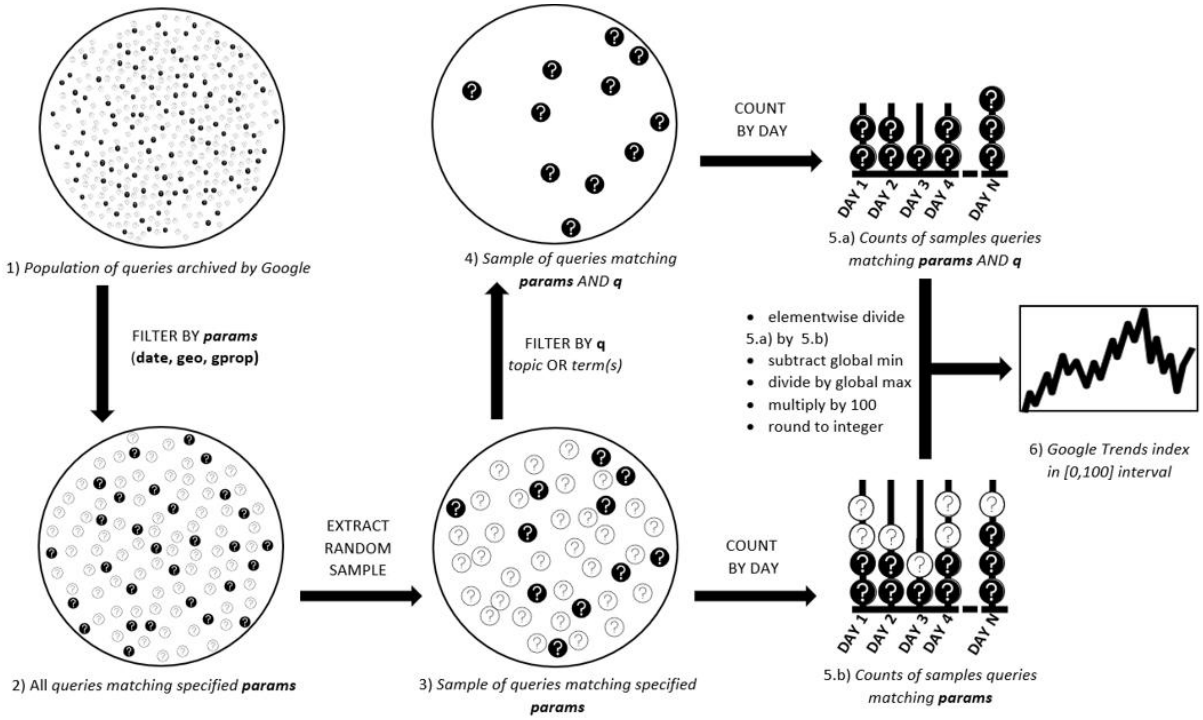


Figure 2.1: Flow chart of Google Trends data extraction process. Balls represent queries, black colour represents queries matching the topic parameter q.
Source: Costola et al. (2020)

2.4 Descriptive statistics

In this section we shall describe the features of our data basically to provide summaries of our data and conduct simple graphical analysis as well.

2.4.1 Graphical representation of oil, gold and real estate indexes

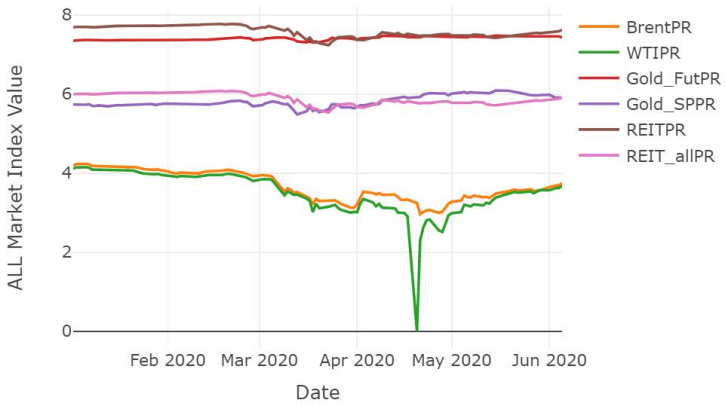


Figure 2.2 All market time series

Graphical representation of all the market indexes with respect to their prices reveals them moving with a similar trend although at different values. Interestingly, all experience turbulence symmetrically between March and April 2020 but the oil market indexes are seen to record consistency in the volatility after April with WTIPR recording the highest drop in value, reaching 0. This can be attributed to the spread of COVID-19 in the US which began in February but took off like wildfire, with much speed in March 2020 claiming 113,798 of lives as at 5th June 2020 with thousands of cases recorded on a daily basis. WTI oil although traded on the global financial market, is a commodity produced in the US and traded on the US financial market as well, hence the assumed connection with the outbreak of COVID-19 in the US.

2.4.2 Graphical representation of Google oil indexes

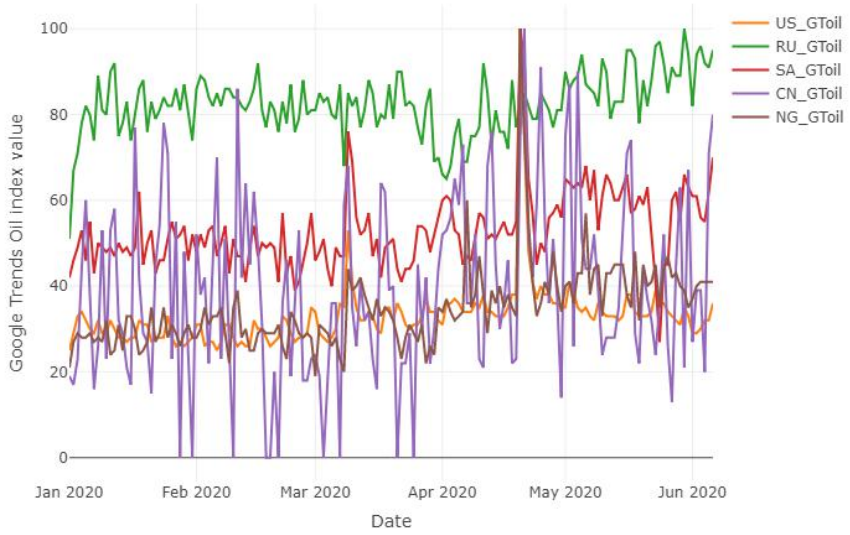


Figure 2.3 Google oil indexes

The above plot in figure 2.3 reveals high volatilty in oil hits in all the five countries showing the uncertainty of the public with respect to oil as the oil price on the financial market began to drop consistently during the outbreak of COVID-19. It is important to note that all these countries were hit by the global pandemic at different times and the huge drops in the oil price on the financial market although coincidence with the outbreak of COVID-19 cannot be fully accredited to it as the driver, yet it is evident that the outbreak of COVID-19 did aggravate public concern uncertainty in this regard. Observing figure 2.3 we can see increase in public concern for Nigeria in mid April, and China between mid April and May 2020. Its during this period that crude oil price began to rise, coming out of the negatives.

Source:https://www.macrotrends.net/1369/crude-oil-price-history-chart?q=

Figure 2.4 Crude Oil price historical chart from October 2019 to July 2020

2.4.3 Graphical representation of Google gold indexes

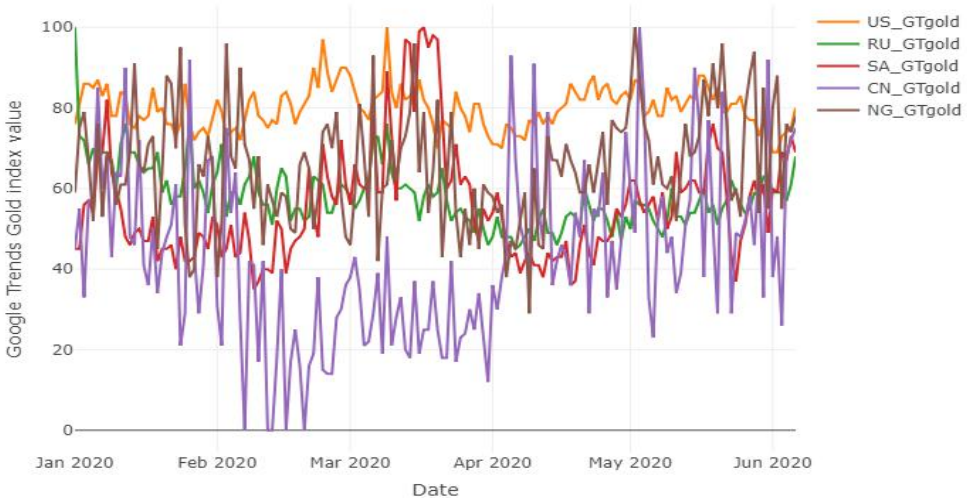


Figure 2.5 Google gold indexes

Graphical representation of the Google gold indexes for all the five countries does not give a clear picture of how public concern for gold relates with its performance on the market as a well as that of oil as it appears a bit clumsy with swings both upwards and downwards especially for CN_GTgold. This is not far from expected as gold as a commodity, aside being traded on the financial market has several uses in medicine, electronics, jewelry just to mention a few. Taken into account the aforementioned observation, in order to effectively measure the effect of public concern in relation to the gold market, we utilise Sample Cross Correlation Function (CCF) to check if Google gold index that are leads the gold market index and select those for further empirical analysis so as to mitigate anticipated noise from the time series.

2.4.4 Graphical representation of Google real estate indexes

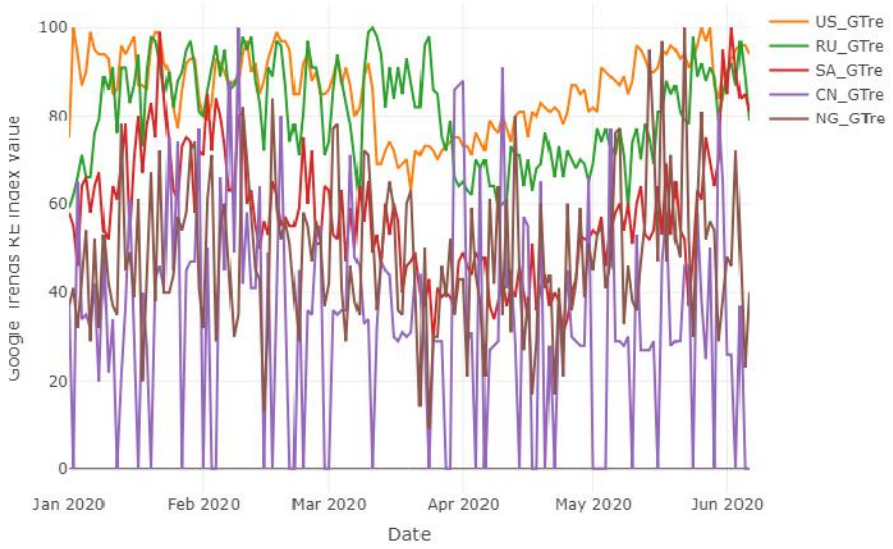


Figure 2.6 Google real estate index for all five countries

Observing figure 2.6 we see similarities in all Google index in relation to oil, gold and real estate for China, big swings in hits both upwards and downwards. This is to say that public concern in the country where COVID-19 originated reveals the concerns of investors regarding these markets during the outbreak of COVID-19.

2.4.5 Graphical representation of Google COVID-19 indexes

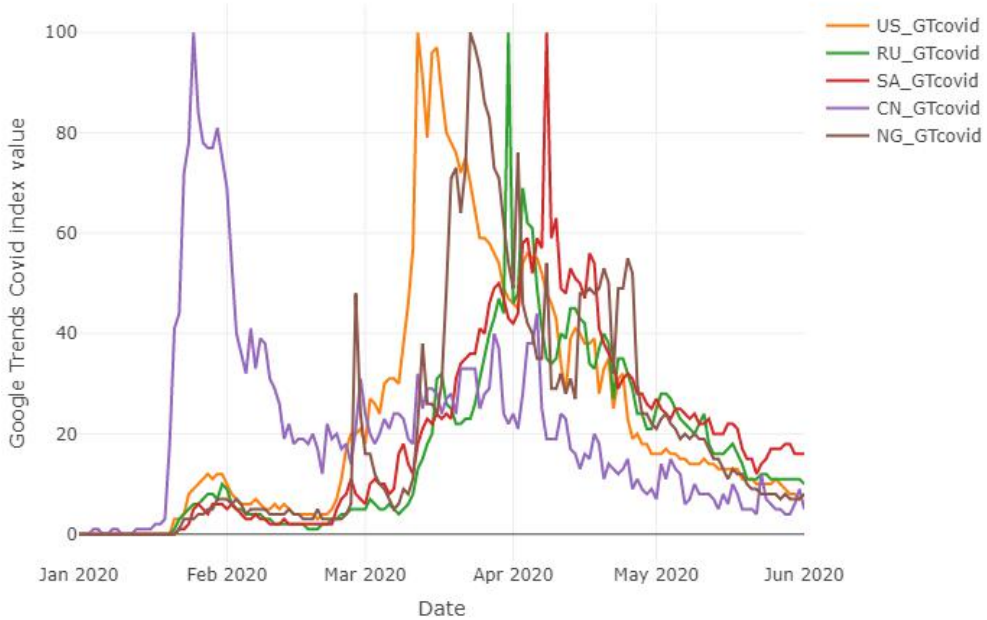


Figure 2.7 Google COVID-19 indexes

Graphical representation of public concern in regards to COVID-19 in the five countries confirms one of the research hypothesis. From figure 2.7 we realize that the public concern in relations to the outbreak of COVID-19 reaches its peak before the others hence we cannot reject the hypothesis that the dynamics of public concern in China related to the outbreak of COVID-19 anticipates that for the other four countries. This is actually expected as the outbreak of COVID-19 began in China at the end of December 2019 but daily recorded cases surged up in January 2020 , recording as high as 14,108 cases on February 12, 2020 according to worldometer.The curve for total case also reached its peak in February 2020 then flattened afterwards. In the US, daily recorded cases saw a consistent upward trend from March 2020 till now. Nigeria, on the other hand recorded it first case of COVID-19 in mid March and afterwards a surge in total cases. Russia, although recorded its first case of COVID-19 in march saw a quick and consistent rise in its daily cases from April 2020 with the curve for total cases yet to peak as it has been moving in an upward trend since April 2020. Similar to Russia is the case of Saudi Arabia but it saw a quick rise in daily recorded cases of COVID-19 in mid April 2020.
In general public concern in the five countries reflects the outbreak of COVID-19 in these countries, positively responding to the spread in the respective countries.

2.5 Linear dependence between stock market indexes and Google indexes

In this section, the linear dependence between the selected stock market indexes, and Google indexes for COVID-19 and the markets within the selected countries is measured and expressed in lagged coherency and instantaneous coherency, utilizing a matrix of absolute cross-correlation as a function of time lag, and a simple linear regression model respectively. We shall also measure the instantaneous linear dependence between the forex indexes and the country specific pairs of Google indexes for COVID-19. In regards to the linear regression model for the stock market indexes; oil, gold and real estate market indexes are the dependent variables and the country specific pairs of Google indexes for COVID-19 and the markets, the explanatory variables. We initially measure the instantaneous linear dependence then the lagged linear dependence relationship.

2.5.1 Instantaneous linear dependence between oil market indexes and Google indexes

In table 2.2, we measure the instantaneous linear dependency between the oil market indexes and the country specific pairs of Google COVID-19 and oil indexes. From the results, we observe that BrentPR responses to only six explanatory variables: US_GTcovid, RU_GTcovid, RU_GToil, NG_GTcovid, CN_GTcovid and SA_GToil with significant coefficient estimates at 5% significance level minimum and r-squared value of 0.8248 Further observations reveals that, BRENTPR negatively responses to all the above Google indexes except for CN_GTcovid, where we see that an incease in investors' concern in relation to the outbreak of COVID-19 in China will reap a 0.36% increase in BRENTPR. This effect is miniscule and taking into consideration the downward trend of daily recorded cases of COVID-19 in China, we consider this effect not a threat unless the trend takes an upward turn.

For WTIPR, it responses to only four explanatory variables:US_GToil, RU_GTcovid, NG_GTcovid and NG_GToil with significant coefficient estimates at 1% significance level minimum and r-squared of 0.8779. WTIPR responses negatively to all the four Google indexes.

With the other oil market indexes, BrentPR_CH and WTIPR_CH, only six coefficient estimates in total were significant at 5% significance level minimum. An increase in investors' concern related to COVID-19 and oil in the US will cause a decrease in price variations in Brent oil futures by 9.3% and 47.4% respectively. An increase in US_GToil and CN_GTcovid will negatively affect price variations in WTI oil futures by 374.6% and 26.9% repectively while WTIPR_CH postively responses to SA_GToil and SA_GTcovid. These outcome gotten shows the huge effect these Google indexes has on the price variations of Brent oil and WTI oil. However looking at their r-squared, daily price variations in WTI oil futures are more explained by US_GToil, CN_GTcovid, SA_GToil and SA_GTcovid compared to the response of daily price variations in Brent oil futures to US_GToil and US_GTcovid. We therefore select BrentPR and WTIPR as oil market indexes for further analysis based on their high r-squared values.

Independent Variables	Dependent Variables			
	BRENTPR	BRENTPR_CH	WTIPR	WTIPR_CH
US_GTcovid	-0.0029953**	-0.093903**	1.762e-05	0.05106
	(0.003851)	(0.008007)	(0.988915)	(0.63524)
US_GToil	0.0066952	-0.474166***	-2.546e-02***	-3.74656***
	(0.102387)	(0.000963)	(2.43e-06)	(9.3e-14)
RU_GTcovid	-0.0069329**	0.048916	-7.813e-03**	0.03156
	(0.001001)	(0.486534)	(0.002882)	(0.88453)
RU_GToil	-0.0120580***	-0.066164	-7.538e-03	0.49578
	(0.000756)	(0.578893)	(0.085185)	(0.18068)
NG_GTcovid	-0.0041719**	0.083852	-5.489e-03***	-0.02474
	(0.001225)	(0.053706)	(0.000695)	(0.85268)
NG_GToil	-0.0064670	0.095959	-1.361e-02**	-0.50749
	(0.061798)	(0.415468)	(0.001984)	(0.16541)
CN_GTcovid	0.0036120***	-0.043246	1.482e-03	-0.26985**
	(0.000196)	(0.179313)	(0.206779)	(0.00758)
CN_GToil	-0.0005120	-0.003924	3.982e-04	0.05002
	(0.563948)	(0.897295)	(0.719640)	(0.59514)
SA_GTcovid	-0.0034143	0.004770	-3.046e-03	0.42866*
	(0.066826)	(0.939949)	(0.189234)	(0.03067)
SA_GToil	-0.0082114*	0.153353	1.506e-04	0.85603*
	(0.011045)	(0.161315)	(0.969774)	(0.01248)
Observations	107	107	107	107
R-squared	0.8248	0.2349	0.8779	0.7437
F-stats (10, Df=96)	45.2***	2.948**	69.05***	27.85***
Residual s.e Df=96	0.1662	5.697	0.2078	27.85

Significant codes: '*'p< 0.001, '**'p< 0.01, '*' p<0.05 , '.' p<0.1**

Table 2.2 Instantaneous linear dependence between Oil Market indexes on Google oil and COVID-19 indexes

2.5.2 Instantaneous linear dependence between gold market indexes and Google indexes

In table 2.3, we measure the instantaneous linear dependency between the gold market indexes and the country specific pairs of Google COVID-19 and gold indexes. From the results, we observe that Gold_FutPR responses to only four out of ten explanatory variables: US_GTgold, US_GTcovid, RU_GTgold, and SA_GTcovid with significant coefficient estimates at 1% significance level minimum and r-squared of 0.6341. Interestingly, Gold_FutPR negatively responses US_GTcovid and RU_GTgold but positively resonses to US_GTgold and SA_GTcovid. Although the

coefficient estimates of the above Google indexes are significant, the values are very small and considered a weak effect on prices of Gold Futures (Gold_FutPR).

For Gold_SPPR, it responses to six out of ten explanatory variables:US_GTgold, US_GTcovid, RU_GTgold, CN_GTgold, CN_GTcovid and SA_GTcovid with significant coefficient estimates at 5% significance level minimum and r-squared of 0.6529. Gold_SPPR responses negatively to US_GTcovid, RU_GTgold, and CN_GTcovid by 0.4%, 1.02% and 0.11% respectively, but positively responses to US_GTgold, CN_GTgold and SA_GTcovid by 0.74%, 0.14% and 0.28% respectively With the other gold market indexes, Gold_FutPR_CH and Gold_SPPR_CH, none of coefficient estimates are significant and with low r-squared values: 0.09901 and 0.0 713 respectively. We can say that the country specific pairs of Google indexes for g old and COVID-19 does little in explaning the price variations in Fold Futures and S& P_TSX Global Gold Total Return. We therefore select Gold FutPR and Gold_SPPR as gold market indexes for further analysis based on their high r-squared.

Independent Variables	**Dependent Variables**			
	Gold_FutPR	Gold_FutPR_CH	Gold_SPPR	Gold_SPPR_CH
US_GTcovid	-8.214e-04** (0.001993)	-0.014899 (0.2955)	-0.0040232*** (2.01e-06)	-0.006436 (0.854)
US_GTgold	2.800e-03*** (3.28e-05)	-0.018218 (0.6059)	0.0073669*** (0.000323)	0.002624 (0.976)
RU_GTcovid	-1.347e-04 (0.691865)	-0.035326 (0.0604)	0.0003272 (0.754169)	-0.007215 (0.875)
RU_GTgold	-2.267e-03*** (0.000704)	-0.009957 (0.7796)	-0.0102327*** (1.47e-06)	-0.128900 (0.143)
NG_GTcovid	-2.900e-04 (0.162816)	0.021978 (0.0549)	-0.0003681 (0.562698)	0.018152 (0.516)
NG_GTgold	3.174e-04 (0.201605)	-0.003035 (0.8230)	0.0014026 (0.067642)	-0.011725 (0.726)
CN_GTcovid	-3.145e-04 (0.090750)	0.001727 (0.8645)	-0.0011424* (0.046345)	0.004166 (0.867)
CN_GTgold	2.106e-04 (0.186259)	0.002142 (0.8054)	0.0014104** (0.004636)	0.011634 (0.587)
SA_GTcovid	1.818e-03*** (2.61e-06)	0.019976 (0.3186)	0.0028252* (0.013087)	-0.006197 (0.900)
SA_GTgold	-8.321e-05 (0.804031)	-0.007434 (0.6861)	0.0014497 (0.161778)	-0.018243 (0.687)
Observations	105	105	105	105
R-squared	0.6341	0.09901	0.6529	0.0713
F-stat(10 df=94)	16.29***	1.033	17.68***	0.7089
Residual (s.e df=94)	0.02915	1.599	0.08963	3.933

Significant codes: '*'p< 0.001, '**'p< 0.01, '*' p<0.05 , '.' p<0.1**

Table 2.3 Linear dependence between gold market indexes on Google oil and COVID-19 indexes

2.5.3 Instantaneous linear dependence between real estate market indexes and Google indexes

In table 2.4, we measure the instantaneous linear dependency between the real estate market indexes and the country specific pairs of Google COVID-19 and real estate indexes. From the results, we observe that REITPR responses to six out of ten explanatory variables: US_GTcovid, RU_GTcovid, NG_GTcovid, NG_GTre, CN_GTcovid and SA_GTre with significant coefficient estimates at 5% significance level minimum and r-squared of 0.7714 Further observations reveals that, REITPR negatively responses to all the above Google indexes except for CN_GTcovid where we see that an incease in investors' concern in relation to the outbreak of COVID-19 in China will reap a 0.1791% increase in REITPR. We consider this effect as miniscule and relatively weak taking into consideration the downward trend of daily recorded cases of COVID-19 in China.

For REIT_allPR, it responses to four of the explanatory variables:US_GTcovid, RU_GTcovid, NG_GTcovid, NG_GTre and CN_GTcovid with significant coefficient estimates at 5% significance level minimum and r-squared of 0.7681. REIT_allPR responses negatively to all the Google indexes with significant estimates except for CN_GTcovid where we see that an incease in investors' concern in relation to the outbreak of COVID-19 in China will reap a 0.187% increase in REIT_allPR. We consider this effect as miniscule and relatively weak taking into consideration the downward trend of daily recorded cases of COVID-19 in China.

With the other real estate market indexes, REITPR_CH and REIT_allPR_CH, only four coefficient estimates were significant at 1% significance level with r-squared values, 0.2111 and 0.2125 respectively. An increase in investors' concern related to COVID-19 in the US will cause a decrease in REITPR_CH and REIT_allPR_CH by 9.8%. An increase in SA_GTcovid will negatively affect REITPR_CH and REIT_allPR_CH by approximately 14%. The effect of the aforementioned Google indexes on REITPR_CH and REIT_allPR_CH are considered weak due to the low r-squared values and the fact that factors that contribute to the daily price variations stocks on the financial market are relatively broader. We then select REITPR_CH and REIT_allPR_CH as real estate market indexes for further analysis.

Independent Variables	Dependent Variables			
	REITPR	REITPR_CH	REIT_allPR	REIT_allPR_CH
US_GTcovid	-2.543e-03*** (0.000297)	-9.784e-02** (0.00449)	-2.543e-03*** (0.000450)	-9.826e-02** (0.00429)
US_GTre	-2.828e-03 (0.164020)	-4.624e-02 (0.64530)	-2.955e-03 (0.159444)	-4.616e-02 (0.64554)
RU_GTcovid	-1.881e-03* (0.036834)	-5.908e-02 (0.18354)	-1.982e-03* (0.033307)	-5.915e-02 (0.18256)
RU_GTre	2.118e-03 (0.062300)	1.053e-01 (0.06201)	2.127e-03 (0.069883)	1.055e-01 (0.06139)
NG_GTcovid	-3.174e-03*** (1.07e-06)	2.406e-02 (0.42719)	-3.189e-03*** (1.95e-06)	2.430e-02 (0.42227)
NG_GTre	-1.207e-03* (0.010070)	-3.849e-02 (0.09502)	-1.243e-03* (0.010312)	-3.845e-02 (0.09509)
CN_GTcovid	1.791e-03*** (0.000134)	5.321e-05 (0.99810)	1.874e-03*** (0.000111)	8.541e-05 (0.99695)
CN_GTre	3.684e-04 (0.273169)	-2.761e-03 (0.86824)	3.774e-04 (0.277214)	-3.080e-03 (0.85301)
SA_GTcovid	4.213e-05 (0.960539)	1.406e-01** (0.00123)	-9.334e-05 (0.915518)	1.407e-01** (0.00121)
SA_GTre	-1.780e-03* (0.047845)	-1.285e-03 (0.97680)	-1.820e-03 (0.050227)	-9.694e-04 (0.98249)
Observations	104	104	104	104
R-squared	0.7714	0.2111	0.7681	0.2125
F-stat(10 df=93)	31.37***	2.488	30.81***	2.51
Residual (s.e df=93)	0.07072	3.512	0.07308	3.509

Significant codes: '*'p< 0.001, '**'p< 0.01, '*' p<0.05 , '.' p<0.1**

Table 2.4 Linear dependence between real estate Market indexes on Google oil and COVID-19 indexes

2.5.4 Instantaneous linear dependence between forex indexes and Google COVID-19 indexes

In this section, we check for the instantaneous linear dependence between the forex indexes and country specific pairs of public concern related to the current global pandemic. As discussed in the previous chapter, we anticipate that the exchange rate for the currencies of Saudi Arabia, Russia, China and Nigeria, with US dollar as base, responded to the outbreak of COVID-19 as the oil market experienced price fluctuations, huge drops especially in crude oil WTI futures to the extent of recording negative prices in April, signifying that produces were paying consumers to purchase oil(figure 2.7). The results are recorded in table 2.5.

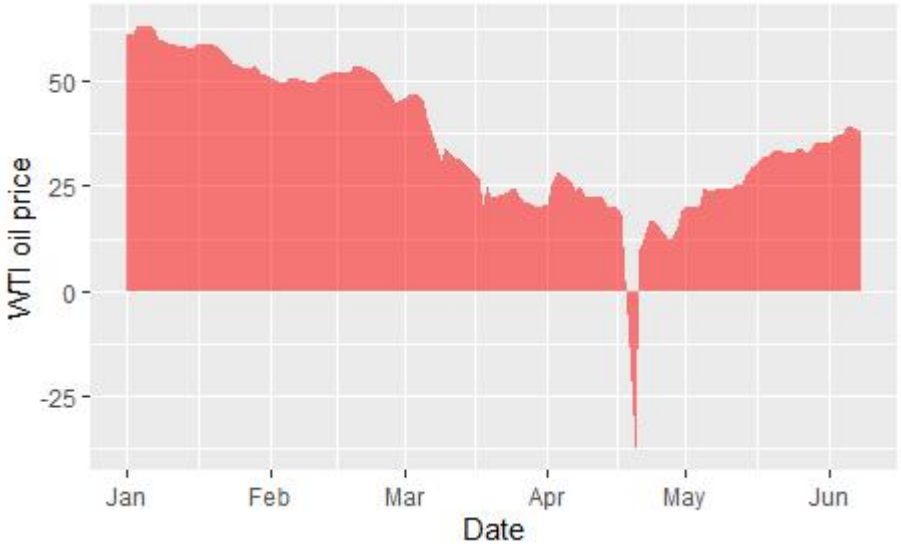


Figure 2.8: Plot of crude oil WTI Futures time series

Independent Variables	Dependent Variables			
	USD/CNY	USD/RUB	USB/NGN	USD/SAR
(Intercept)	1.946e+00*** <2e-16	4.17639*** (<2e-16)	5.7728526*** <2e-16	1.322e+00*** <2e-16
US_GTcovid	-6.095e-05 0.218078	0.0011319*** 3.00e-06	-0.0015763*** 7.65e-08	-5.240e-06 0.11098
CN_GTcovid	-1.589e-04*** 0.000631	-0.0010076*** 5.07e-06	-0.0010066*** 9.53e-05	-9.635e-06** 0.00167
RU_GTcovid	1.149e-04 0.205147	0.0011883** 0.00538	0.0012736* 0.01159	2.878e-05*** 5.46e-06
NG_GTcovid	1.227e-04* 0.033215	0.0008921** 0.00102	0.0008695** 0.00643	-7.802e-07 0.83616
SA_GTcovid	1.590e-04 0.063365	0.0008792* 0.02719	0.0024425*** 9.32e-07	2.291e-05*** 9.24e-05
obs	99	99	99	99
R-squared	0.4657	0.8278	0.7219	0.7281
Residual s.e(df=93)	0.008063	0.03734	0.04429	0.0005343
F. stat(df=5;93)	16.21***	89.42***	48.29***	49.81***

Significant codes: '*'p< 0.001, '**'p< 0.01, '*' p<0.05 , '.' p<0.1**

Table 2.5 Instantaneous linear dependence between forex indexes and Google COVID-19 indexes

As we can see from table 2.5, USD/CNY responses to CN_GTcovid and NG_GTcovid with significant coefficients at 5% significance level minimum. An increase in investors' concern in relation to COVID-19 in China will lead to a decrease in the USD/CNY forex pair daily quotation by 0.01589% and an increase in investors' concern in relation to the outbreak of COVID-19 in Nigeria will lead to an

increase in USD/CNY by 0.001227%. We can see that USD/RUB and USD/NGN response to all the country specific pairs of Google indexes for COVID-19 with significant coefficient estimates and relatively higher r-sqaured compared to the others. An increase in investors' concern for the outbreak of COVID-19 in the US, Russia, Nigeria and Saudi Arabia increases the amount of Russia Ruble needed to purchase a unit dollar by 0.11%, 0.11%, 0.089% and 0.08792% respectively while and increase in CN_GTcovid decreases the amount of Russian ruble needed to purchase a unit dollar by 0.1% approximately.

What is of much concern now is the response of all the four forex pairs to US_GTcovid as daily recorded cases of COVID-19 in the US is on the increase and the US dollar is the base for the four currencies. From table 2.5, we can see that an increase in US_GTcovid will decrease the amount of Nigerian naira needed to purchase a unit dollar by 0.1576%.
In general, all the four forex pairs respond to the outbreak of COVID-19 especially in the countries in which the currencies are spent.

2.5.5 Lagged dependence between stock market and Google indexes

One of the objectives of this work is to establish the relationship between the market and the Google time series, and at this point we indicate that by identifying whether the market time series are leading or lagging behind the Google time series. This lead/lag relationship is measured using the time series cross correlation function (CCF) and it aids in the identification of lags of the Google time series that might have predictive characteristics over the market time series being highly correlated to the other.

	WTIPR	US_GToil	RU_GToil	SA_GToil	CN_GToil	NG_GToil
WTIPR		-0.8027 (L=0)	-0.4042 (L=25)	-0.6263 (L=0)	-0.3761 (L=1)	-0.7421 (L=0)
US_GToil	-0.8027 (L=0)		0.3281 (L=25)	0.7326 (L=0)	0.3785 (L=0)	0.8181 (L=0)
RU_GToil	-0.4042 (L=-25)	0.3281 (L=-25)		0.3297 (L=-25)	0.2772 (L=-24)	0.2953 (L=-9)
SA_GToil	-0.6263 (L=0)	0.7326 (L=0)	0.3297 (L=25)		0.3281 (L=0)	0.7497 (L=0)
CN_GToil	-0.3761 (L=-1)	0.3785 (L=0)	0.2772 (L=24)	0.3281 (L=0)		0.3922 (L=0)
NG_GToil	-0.7421 (L=0)	0.8181 (L=0)	0.2953 (L=9)	0.7497 (L=0)	0.3922 (L=0)	

Table 2.6: Matrix of maximum absolute cross-correlation(value and lag order) between oil market index and Google oil index

With primary concern being the relation between WTIPR, the oil market index and the GT oil indexes for the five countries , observations are limited to the results from the table that describes such relation. Table 2.5 reveals a synchronous movement between WTIPR and US_GToil, SA_GToil, and NG_GToil with -0.8027, -0.6263, -0.7421 correlation values respectively. It also reveals the lead of CN_GToil and RU_GToil to WTIPR at one working day and twenty five working days respectively. This relation in general signifies and clearly shows that public concern for oil market in the US, Saudi Arabia, Russia, China and Nigeria reflects WTI oil prices on the financial market. The graphical representation in fig 2.9 reveals a strong (and negative) cross correlation occur between lag -10 and 10 for the US. Given the above consideration we choose the GToil for the five countries for further analysis.

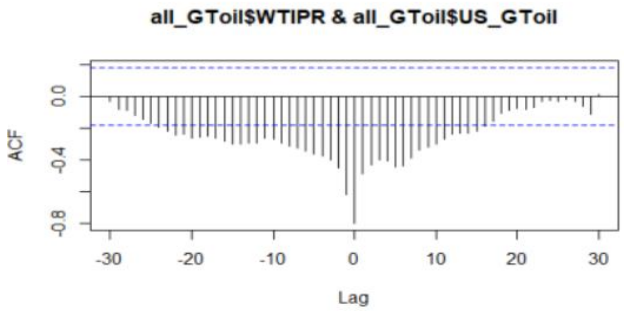


Figure 2.9: Cross correlation between oil market index and US Google oil index

	US_GTgold	RU_GTgold	CN_GTgold	NG_GTgold	Gold_SPPR
US_GTgold		0.3103 (L=7)	0.1937 (L=20)	0.2147 (L=6)	0.2017 (L=-4)
RU_GTgold	0.3103 (L=-7)		0.3126 (L=-25)	0.292 (L=-3)	0.1914 (L=-29)
CN_GTgold	0.1937 (L=-20)	0.3126 (L=25)		0.2511 (L=1)	0.3911 (L=-4)
NG_GTgold	0.2147 (L=-6)	0.292 (L=3)	0.2511 (L=-1)		0.3287 (L=-9)
Gold_SPPR	0.2017 (L=4)	0.1914 (L=29)	0.3911 (L=4)	0.3287 (L=9)	

Table 2.7: Matrix of maximum absolute cross-correlation (value and lag order) between gold market index and Google gold index

Observations made from table 2.7 is geared towards primarily identifying the GT gold indexes with predictive and descriptive characteristics over the gold market index, Gold_SPPR. The table reveals a strong (and posititve) relation between Gold_SPPR and all the GT gold indexes.

	REIT_allPR	US_GTre	RU_GTre	SA_GTre	CN_GTre	NG_GTre
REIT_allPR		0.6655 (L=-2)	0.6612 (L=11)	0.5452 (L=-7)	0.2397 (L=18)	0.2069 (L=4)
US_GTre	0.6655 (L=2)		0.7385 (L=14)	0.698 (L=4)	0.2156 (L=15)	0.3418 (L=9)
RU_GTre	0.6612 (L=-11)	0.7385 (L=-14)		0.582 (L=-5)	0.2338 (L=13)	0.3591 (L=-8)
SA_GTre	0.5452 (L=7)	0.698 (L=-4)	0.582 (L=5)		0.2233 (L=16)	0.3174 (L=5)
CN_GTre	0.2397 (L=-18)	0.2156 (L=-15)	0.2338 (L=-13)	0.2233 (L=-16)		0.2077 (L=8)
NG_GTre	0.2069 (L=-4)	0.3418 (L=-9)	0.3591 (L=8)	0.3174 (L=-5)	0.2077 (L=-8)	

Table 2.8:Matrix of maximum absolute cross-correlation (value and lag order) between real estate market index and Google real estate index

Tabular representation of the cross correlation between real estate index REIT_allPR and the GT real estate indexes for the five countries shows that US_GTre and SA_GTre lags behind REIT_allPR with correlation values of 0.6655, 0.5452 respectively. However RU_GTre, CN_GTre and NG_GTre lead REIT_allPR by significant working days hence only these three indexes are used for further analysis.

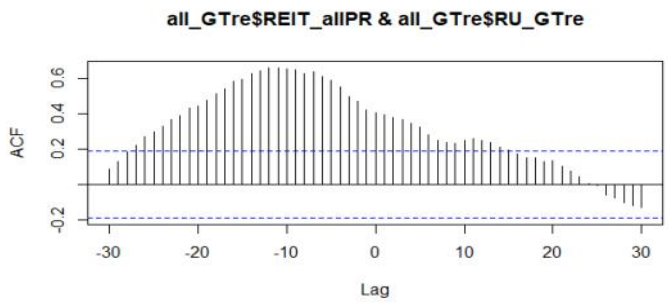


Figure 2.10: Cross-correlation (value and lag order) between real estate market index and RU Google real estate index

	WTIPR	US_GTcovid	RU_GTcovid	SA_GTcovid	CN_GTcovid	NG_GTcovid
WTIPR		-0.6261 (L=-24)	-0.7562 (L=-13)	-0.8669 (L=-7)	0.5156 (L=15)	-0.65 (L=-17)
US_GTcovid	-0.6261 (L=24)		0.8605 (L=11)	0.811 (L=11)	0.3891 (L=-30)	0.9075 (L=5)
RU_GTcovid	-0.7562 (L=13)	0.8605 (L=-11)		0.8883 (L=3)	-0.4853 (L=17)	0.8462 (L=-6)
SA_GTcovid	-0.8669 (L=7)	0.811 (L=-11)	0.8883 (L=-3)		-0.494 (L=16)	0.8062 (L=-9)
CN_GTcovid	0.5156 (L=-15)	0.3891 (L=30)	-0.4853 (L=-17)	-0.494 (L=-16)		-0.3995 (L=-18)
NG_GTcovid	-0.65 (L=17)	0.9075 (L=-5)	0.8462 (L=6)	0.8062 (L=9)	-0.3995 (L=18)	

Table 2.9: Matrix of maximum absolute cross-correlation (value and lag order) between oil market index and Google COVID-19 index

The primary concern for this thesis is the predictive and descriptive characteristics of public concern during the outbreak of COVID-19 on financial market price movements. One of the hypothesis is that public concern for the outbreak of the pandemic will impact and shape to some extent the financial market prices for oil, gold and real estate. Given this consideration, we drop all the GTcovid indexes except for CN_GTcovid as it is the only GTcovid that leads WTIPR at a maximum correlation value of 0.5156 for 15 working days.

	Gold_SPPR	US_GTcovid	RU_GTcovid	SA_GTcovid	CN_GTcovid	NG_GTcovid
Gold_SPPR		0.7485 (L=-28)	0.7766 (L=-19)	0.7963 (L=-20)	-0.4403 (L=6)	0.7126 (L=-24)
US_GTcovid	0.7485 (L=28)		0.8509 (L=11)	0.8006 (L=11)	0.4953 (L=-30)	0.9019 (L=5)
RU_GTcovid	0.7766 (L=19)	0.8509 (L=-11)		0.8833 (L=3)	-0.4742 (L=13)	0.8388 (L=-6)
SA_GTcovid	0.7963 (L=20)	0.8006 (L=-11)	0.8833 (L=-3)		-0.4923 (L=14)	0.7972 (L=-9)
CN_GTcovid	-0.4403 (L=-6)	0.4953 (L=30)	-0.4742 (L=-13)	-0.4923 (L=-14)		-0.3912 (L=-15)
NG_GTcovid	0.7126 (L=24)	0.9019 (L=-5)	0.8388 (L=6)	0.7972 (L=9)	-0.3912 (L=15)	

Table 2.10: Matrix of maximum absolute cross-correlation (value and lag order) between gold market index and Google COVID-19 index

In relation to gold, we drop all the GT covid indexes except for CN_GTcovid as it is the only GT covid that leads Gold_SPPR with a negative correlation value of -0.4403 for 6 working days.

	REIT_allPR	US_GTcovid	RU_GTcovid	SA_GTcovid	CN_GTcovid	NG_GTcovid
REIT_allPR		-0.7607 (L=-5)	-0.7449 (L=6)	-0.7669 (L=4)	0.3816 (L=12)	-0.7689 (L=1)
US_GTcovid	-0.7607 (L=5)		0.8478 (L=11)	0.7966 (L=11)	0.4879 (L=-30)	0.9003 (L=5)
RU_GTcovid	-0.7449 (L=-6)	0.8478 (L=-11)		0.8817 (L=3)	-0.4681 (L=13)	0.8369 (L=-6)
SA_GTcovid	-0.7669 (L=-4)	0.7966 (L=-11)	0.8817 (L=-3)		-0.4833 (L=14)	0.7945 (L=-9)
CN_GTcovid	0.3816 (L=-12)	0.4879 (L=30)	-0.4681 (L=-13)	-0.4833 (L=-14)		-0.3754 (L=-14)
NG_GTcovid	-0.7689 (L=-1)	0.9003 (L=-5)	0.8369 (L=6)	0.7945 (L=9)	-0.3754 (L=14)	

Table 2.11: Matrix of maximum absolute cross-correlation (value and lag order)between real estate market index and Google COVID-19 index

In relation to real estate, we maintain all the GT covid indexes except for US_GTcovid as it is the only GT covid that lags behind REIT_allPR.

	WTIPR	US_OxCGRT	RU_OxCGRT	SA_OxCGRT	CN_OxCGRT	NG_OxCGRT
WTIPR		-0.7161 (L=0)	-0.742 (L=10)	-0.7284 (L=0)	-0.4598 (L=0)	-0.7427 (L=9)
US_OxCGRT	-0.7161 (L=0)		0.8903 (L=7)	0.9819 (L=2)	0.6679 (L=-29)	0.8974 (L=11)
RU_OxCGRT	-0.742 (L=-10)	0.8903 (L=-7)		0.9074 (L=-5)	0.5649 (L=-30)	0.9783 (L=0)
SA_OxCGRT	-0.7284 (L=0)	0.9819 (L=-2)	0.9074 (L=5)		0.6494 (L=-30)	0.9151 (L=9)
CN_OxCGRT	-0.4598 (L=0)	0.6679 (L=29)	0.5649 (L=30)	0.6494 (L=30)		0.5514 (L=30)
NG_OxCGRT	-0.7427 (L=-9)	0.8974 (L=-11)	0.9783 (L=0)	0.9151 (L=-9)	0.5514 (L=-30)	

Table 2.12: Matrix of maximum absolute cross-correlation between oil market index and government response indexes

The severity of the outbreak is proxied through government response indicators for the five countries; US_OxCGRT, SA_OxCGRT, RU_OxCGRT, CN_OxCGRT and NG_OxCGRT. The primary focus of this thesis is to analyse the impact of the government responses on oil, gold and real estate markets hence only those that lead the stock market indexes are of importance to us as it is in line with the objectives of this thesis

Tabular representation (table 2.12) of the results gotten from applying Sample Cross Correlation(CCF) gives a clear sign of significant impact of government response

indicator on the oil market index. US_OxCGRT, SA_OxCGRT and move synchronously with WTIPR at maximum correlation valus of -.7161, -0.7284 and -0.4598 respectively. On the other hand RU_OxCGRT and NG_OxCGRT lead WTIPR at -0.742 and -0.7427 maximum correlation values by ten days and nine days respectively.

	Gold_SPPR	US_OxCGRT	RU_OxCGRT	SA_OxCGRT	CN_OxCGRT	NG_OxCGRT
Gold_SPPR		0.7108 (L=-25)	0.7786 (L=-8)	0.7241 (L=-23)	0.2919 (L=-4)	0.793 (L=-11)
US_OxCGRT	0.7108 (L=25)		0.884 (L=7)	0.9806 (L=2)	0.6619 (L=-27)	0.8912 (L=11)
RU_OxCGRT	0.7786 (L=8)	0.884 (L=-7)		0.9021 (L=-5)	0.5629 (L=-30)	0.9771 (L=0)
SA_OxCGRT	0.7241 (L=23)	0.9806 (L=-2)	0.9021 (L=5)		0.6473 (L=-29)	0.91 (L=9)
CN_OxCGRT	0.2919 (L=4)	0.6619 (L=27)	0.5629 (L=30)	0.6473 (L=29)		0.5487 (L=30)
NG_OxCGRT	0.793 (L=11)	0.8912 (L=-11)	0.9771 (L=0)	0.91 (L=-9)	0.5487 (L=-30)	

Table 2.13: Matrix of maximum absolute cross-correlation between gold market index and government response indexes

In the table 2.13, we realize that there is no significant impact of government responses in the five countries on the gold market during the outbreak of COVID-19. All the government response indexes are lagging behind the gold market index Gold_SPPR.

	REIT_allPR	US_OxCGRT	RU_OxCGRT	SA_OxCGRT	CN_OxCGRT	NG_OxCGRT
REIT_allPR		-0.0166 (L=-30)	0.0779 (L=-30)	-0.0059 (L=-30)	0.0915 (L=30)	0.0606 (L=-30)
US_OxCGRT	-0.0166 (L=30)		0.8825 (L=7)	0.9803 (L=2)	0.6509 (L=-27)	0.8898 (L=11)
RU_OxCGRT	0.0779 (L=30)	0.8825 (L=-7)		0.901 (L=-5)	0.5525 (L=-30)	0.9769 (L=0)
SA_OxCGRT	-0.0059 (L=30)	0.9803 (L=-2)	0.901 (L=5)		0.6364 (L=-29)	0.9089 (L=9)
CN_OxCGRT	0.0915 (L=-30)	0.6509 (L=27)	0.5525 (L=30)	0.6364 (L=29)		0.5384 (L=30)
NG_OxCGRT	0.0606 (L=30)	0.8898 (L=-11)	0.9769 (L=0)	0.9089 (L=-9)	0.5384 (L=-30)	

Table 2.14: Matrix of maximum absolute cross-correlation between real estate market index and government response indexes

Observations from table 2.14 reveals less significant impact of government responses in the five countries on the real estate market indexes over the period of the coronavirus. It also shows only CN_OxCGRT to be leading Gold_SPPR by 30 working days with a less significant correlation value of 0.0915.

	WTIPR	Gold_SPPR	REIT_allPR
WTIPR		0.3285 (L=-25)	0.6914 (L=1)
Gold_SPPR	0.3285 (L=25)		0.1726 (L=30)
REIT_allPR	0.6914 (L=-1)	0.1726 (L=-30)	

Table 2.15: Matrix of maximum absolute cross-correlation between oil, gold and real estate indexes

Considering oil price fluctuations recorded during the outbreak of COVID-19 and the uncertainty on the side of investors related to investment decisions proxied through public concern, as gold and real estate are considered as safe havens, we expect the oil market index (WTIPR) to lead both the gold and real estates market indexes. Contrarily, observations from Table 2.15 shows WTIPR lagging behind REIT_allPR by one working day. Additionally, figure 2.11 shows dominant cross correlation between WTIPR and Gold_SPPR occurring between lag -10 and -25 indicating that an above average value of WTIPR is likely to lead to a below average value in Gold_SPPR twenty days later.

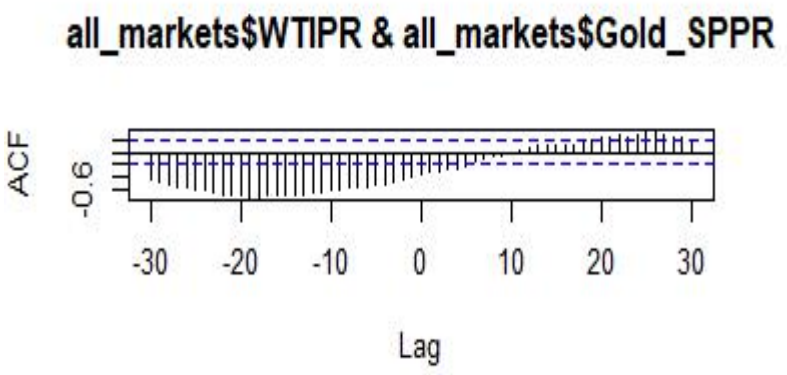


Figure 2.11 Cross correlation between oil market index and gold market index

CHAPTER THREE

VAR MODEL SPECIFICATION

To estimate the impact and severity of public concern with respect to oil, real estate and gold markets on their financial markets, several VAR models are estimated to analyse the dependency between time series.

The endogenous variables are:
The three market indexes; WTIPR, Gold_SPPR and REIT_allPR.
Google oil indexes: US_GToil, RU_GToil, SA_GToil, CN_GToil, NG_GToil
Google gold indexes: US_GTgold, RU_GTgold, CN_GTgold, NG_GTgold
Google real estate indexes: RU_GTre, CN_GTre, NG_GTre
Google covid indexes: RU_GTcovid,SA_GTcovid, CN_GTcovid, NG_GTcovid
Exogenous variables :
US_OxCGRT, RU_OxCGRT, SA_OxCGRT, CN_OxCGRT, NG_OxCGRT.

All the variables are modelled in a symmetrical way so that each variable has an equation with the variables on the right hand side being the lags of all the variables and deterministic regressors as well.
In order to be sure the VAR model chosen is on levels is appropriate to model the time series, we shall test for stationarity, cointegration and autocorrelation as well as normal distribution of the residuals.

3.1 Stationarity and unit root test

In order to utilize a VAR model our time series must be stationary to ensure the relevance of our estimated parameters. With stationary time series we can directly fit a VAR in levels, but if not we can also make use of first differences of our time series and sufficiently apply the VAR model, to differenced (stationary) time series.We then run two stationary tests:

1. Augmented Dickey-Fuller (ADF);

This is a unit root test. The procedure will test for the null hypothesis that the time series have a unit root.

2. Kwiatkowski-Phillips-Schmidt-Shin (KPSS);

Finally here we test the null hypothesis that the series are level stationary as the use of level stationary variables can jeopardize our estimates.

The statistics of these tests can be seen in table 3.1. From the ADF unit root test, looking at the high p-values of our time series especially that for all the market indexed; WTIPR, Gold_SPPR and RET_allPR, we cannot reject the null hypothesis of unit root. Also with the KPSS test where most of the p-values are less than 0.05 , we cannot reject the null hypothesis of level stationarity as US_GTgold, CN_GTre and NG_GTre have statistical values with 0.1 as their p-values.

	ADF TEST		KPSS	
	stat	**P-value**	**stat**	**P-value**
WTIPR	-1.33	0.86	1.35	0.01
Gold_SPPR	-1.51	0.78	1.40	0.01
REIT_allPR	-1.10	0.92	1.30	0.01
US_GToil	-3.89	0.02	1.02	0.01
RU_GToil	-2.40	0.41	0.82	0.01
SA_GToil	-4.87	0.01	1.33	0.01
CN_GToil	-5.17	0.01	0.50	0.04
NG_GToil	-4.06	0.01	1.96	0.01
US_GTgold	-2.76	0.26	0.11	0.1
RU_GTgold	-2.00	0.57	1.58	0.01
CN_GTgold	-2.36	0.42	0.76	0.01
NG_GTgold	-3.72	0.02	0.47	0.05
RU_GTre	-2.52	0.36	0.64	0.02
CN_GTre	-5.75	0.01	0.28	0.1
NG_GTre	-4.21	0.01	0.19	0.1
RU_GTcovid	-1.31	0.86	0.96	0.01
SA_GTcovid	-1.09	0.92	1.08	0.01
CN_GTcovid	-3.61	0.04	0.46	0.05
NG_GTcovid	-2.15	0.51	0.65	0.02

Table 3.1: Stationarity test

We check for the charateristics of the stationarity of oil, gold and real estate market time series respectively by looking at their autocorrelation functions (ACF). They confirm the non stationarity of all the market time series(see in the Appendix C), many significant lags exceed the confidence interval of the ACF i.e. blue dashed line. Their signals are also trend-like, revealing their dependence on time.

3.1.1 Stationarity of first differences

Evidently our level time series are non stationary as we cannot reject the null hypothesis of non stationarity. However, we check for stationarity in the first differences of our times so as to identify whether with differenced time series is appropriate to model our data. In Table.16 the stationarity test for the first difference of the time series are recorded. It shows that our times series are now stationary hence we proceed to estimate with VAR model.

	ADF TEST	
	stat	**P-value**
dWTIPR	-7.03	0.01
dGold_SPPR	-4.50	0.01
dREIT_allPR	-4.61	0.01
dUS_GToil	-7.90	0.01
dRU_GToil	-9.25	0.01
dSA_GToil	-8.04	0.01
dCN_GToil	-8.11	0.01
dNG_GToil	-8.99	0.01
dUS_GTgold	-9.06	0.01
dRU_GTgold	-1.00	0.01
dCN_GTgold	-7.35	0.01
dNG_GTgold	-8.49	0.01
dRU_GTre	-8.43	0.01
dCN_GTre	-8.35	0.01
dNG_GTre	-10.42	0.01
dRU_GTcovid	-4.64	0.01
dSA_GTcovid	-5.20	0.01
dCN_GTcovid	-3.79	0.02
dNG_GTcovid	-4.37	0.01

Table 3.2: Stationary test for first differences of time series

3.2 Optimal Lag identification

We check for the optimal lag to conduct the cointegration test and the VAR model. We utilize four information criterion to identify the optimal lag consistent with the variables used in this thesis;

1. Akaike information criterion (AIC)
2. Hannan-Quinn information criterion (HQ)
3. Schwarz Bayesian information criterion (SC)
4. Akaike final prediction error (FPE)

In tables 3.3, 3.4 and 3.5,which can be seen in the Appendix, the optimal lag order for this criteria, for a maximum lag number 5 are reported. Lag maximum used for the information criteria selected is based on solely the fact that after processing the data, they conform to the date format of the stock market where there are 5 working days in a week.

The tables 3.3, 3.4 and 3.5 are then to be interpreted as the model that records the minimum value tests is chosen. The minimum values are:

AIC(n)	HQ(n)	SC(n)	FPE(n)
2	1	1	2

Table 3.3: Optimal lag for oil

AIC(n)	HQ(n)	SC(n)	FPE(n)
2	2	2	2

Table 3.4: Optimal lag for gold

AIC(n)	HQ(n)	SC(n)	FPE(n)
5	1	1	2

Table 3.5: Optimal lag for real estate

The optimal lag chosen for oil per table 3.3 is 2

The optimal lag chosen for gold per table 3.4 is 2

The optimal lag chosen for real estate per table 3.3.5 is 1

3.3 TEST FOR COINTEGRATION

We test whether time series for the markets are cointegrated i.e. have a long term relationship using the Johansen cointegration test.

	Test	10pct	5pct	1pct
r <= 6	3.19	7.52	9.24	12.97
r <= 5	8.35	17.85	19.96	24.60
r <= 4	27.06	32.00	34.91	41.07
r <= 3	54.05	49.65	53.12	60.16
r <= 2	85.57	71.86	76.07	84.45
r <= 1	126.27	97.18	102.14	111.01
r = 0	184.19	126.58	131.70	143.09

Table 3.6: Johansen cointegration test for oil

We can safely reject the null hypothesis of no cointegration, since the value of the test for r = 0 exceeds the critical value even at the 1% level. The result shows that our time series are cointegrated at matrix rank r=5. Hence 5 counts of cointegration relationship.

	Test	10pct	5pct	1pct
r <= 5	3.10	7.52	9.24	12.97
r <= 4	9.35	17.85	19.96	24.60
r <= 3	20.27	32.00	34.91	41.07
r <= 2	40.37	49.65	53.12	60.16
r <= 1	67.98	71.86	76.07	84.45
r = 0	121.97	97.18	102.14	111.01

Table 3.7: Johansen cointegration test results for gold

We can safely reject the null hypothesis of no cointegration, since the value of the test for r = 0 exceeds the critical value at the 5% level. The result shows that our time series are cointegrated at matrix rank r=2. Hence 2 counts of cointegration relationship.

	Test	10pct	5pct	1pct
r <= 7	1.67	7.52	9.24	12.97
r <= 6	8.17	17.85	19.96	24.60
r <= 5	18.23	32.00	34.91	41.07
r<= 4	34.94	49.65	53.12	60.16
r <= 3	66.41	71.86	76.07	84.45
r <= 2	105.73	97.18	102.14	111.01
r <= 1	174.09	126.58	131.70	143.09
r=0	249.02	159.48	165.58	177.20

Table 3.8: Johansen cointegration test results for real estate

We can safely reject the null hypothesis of no cointegration, since the value of the test for r = 0 exceeds the critical value at the 5% level. The result shows that our time series are cointegrated at matrix rank r=4. Hence 4 counts of cointegration relationship.We can then conclude on a general basis that our time series are cointegrated.

Times series for government response indicators to the outbreak of COVID-19 by the five countries are not tested for stationarity and cointegration as they serve as indicators and not a form of measurement for the efficiency of their various responses. They are then classified as categorical time series.

Athough the original time series are cointegrated at different matrix rank, are of process 1(1) and most works makes use of VECM as it better fits a non stationary time series, a widely used option mainly in economic finance research is to take difference of the non stationary time series that usually produces stationary time series which can then be estimated with a VAR. It is argued that that this option may manipulate the relationship between the original time series **(Lütkepohl 2005)**, however we adopt a VAR basically due to its wide use and the stationarity of our series after taking the differences. Aside that we suspect that our endogenous variables are to some greater extent impacted by their own history aside the deterministic regressors used hence a VAR is deemed sufficient to estimate the impact of public concern on oil and safe haven markets during the outbreak of covid and the severity of the pandemic on these markets (Pfaff, 2008).

3.4 VAR estimates and residual analysis

Taken into consideration the aforementioned point, we set up a VAR (2) model for oil and gold markets then a VAR (1) for real estate market according to the results of the Information Criteria results. The VAR(p)-process for the three markets are defined in line with Pfaff (2008).

Tables in the Appendix B, shows the results of the VAR models defined, with estimated coefficients and the associated standard errors in parentheses. Appendix D also entails of the fit and residuals for the three markets. From these a p-value is calculated and used to identify the significance of the coefficients. B.1 reveals that daily oil futures price on the financial market is explained by its history as the two lagged values of dWTI.oil.price are significant although the r-squared is very low.

Table B.2 we can see that the two lagged values of dGold.S.P.Price do not explain the S&P_TSX Global Gold Total Return on the market as they are not significant even at 5% significance level and has low r-squared value.

B.3 reveals that the real estate daily prices are explained by its history as the first lagged value of REIT.all.price is significant at 0.1% significance level although the r-squared is very low.

The low r-squared values seen in all the three tables is likely associated to the fact that the oil and real estate markets' indexes are significantly related only to their own history whilst the gold market index is significantly related to none of the other endogenous variables including its lagged value.

3.5 Conclusion and discussion

We conclude by reviewing our research hypothesis and questions in the lens of results gotten from the tests conducted, models used, nature of the time series analyzed as well as the countries analyzed.
Firstly, the outcome of a plot of public concern related to the outbreak of COVID-19 (figure 2.6) supports our research hypothesis, that the dynamics of public concern for the outbreak of COVID-19 in China anticipates that of U.S, Russia, Saudi Arabia and Nigeria.
Concerning the oil market indexes, we selected BrentPR and WTIPR, however the the daily price variationsfor WTI oil futures responded to four Google indexes: US_FToil, CN_GTcovid, SA_GTcovid and SA_GTcovid with significant coefficients and r-squared value of 0.7437. This means that 74.37% of WTIPR_CH is explained by these Google indexes hence further studies in this regard is deemed relevant.

In summary, the financial market indexes analyzed responded negatively and/or positively to the public concern in related to the markets and COVID-19. Relative to the response of the financial markets to government response stringency indexes, it did not have any predictive characteristics over gold market index, Gold_SPPR, as al the country specific government response stringency indexes were lagging behind the gold market index.We can then say that comparing the response of the oil, gold and real estate markets indexes, to government response to the outbreak of COVID-19 in the five countries and that of their response to inverstors' concerns proxied through Google Trends, the response to investors' concern about the performance of the financial markets is relatively higher and stronger than that of the government response indexes. This also strengthens the reflective and predictive characteristics of Google Trends.

Taking advantage of the predictive power GT analysis, investors can detect potential asset bubble and manage their portfolios well to avoid a catastrophic event of a bubble burst.

APPENDIX

A Informative Criteria

A.1: Information criteria for oil

	AIC(n)	HQ(n)	SC(n)	FPE(n)
1	2.078796e+01	2.174181e+01	2.314415e+01	1.077605e+09
2	2.069713e+01	2.216461e+01	2.432205e+01	1.011041e+09
3	2.091808e+01	2.289917e+01	2.581172e+01	1.333751e+09
4	2.123287e+01	2.372757e+01	2.739524e+01	2.015387e+09
5	2.147590e+01	2.448422e+01	2.890699e+01	3.003703e+09

A.2: Information criteria for gold

	AIC(n)	HQ(n)	SC(n)	FPE(n)
1	13.73969	14.19593	14.86877	928473.57090
2	1.383373e+01	1.468102e+01	1.593059e+01	1.028994e+06
3	1.398932e+01	1.522767e+01	1.705397e+01	1.229492e+06
4	1.435824e+01	1.598764e+01	1.839068e+01	1.856720e+06
5	1.428216e+01	1.630263e+01	1.928239e+01	1.850132e+06

A.3: Information criteria for real estate

	AIC(n)	HQ(n)	SC(n)	FPE(n)
1	2.547127e+01	2.634558e+01	2.763578e+01	1.161024e+11
2	2.535659e+01	2.693033e+01	2.925270e+01	1.068701e+11
3	2.545741e+01	2.773060e+01	3.108513e+01	1.280584e+11
4	2.526377e+01	2.823640e+01	3.262309e+01	1.233166e+11
5	2.495594e+01	2.862801e+01	3.404687e+01	1.185139e+11

B VAR (P) model estimates

B.1 VAR (2) model estimates for oil

	dWTI.oil.price	dGToil_US	dGToil_SA	dGToil_RU	dGToil_CN	dGToil_NG	dGTcovid_CN
dWTI.oil.price.l1	-0.48*** (1.61e-07)	-0.625 (0.752)	2.439 (0.294)	-1.611 (0.4)	11.39 (0.108)	2.65 (0.286)	-2.342 (0.204)
dGToil_US.index.l1	0.001 (0.814)	-0.121 (0.314)	0.332* (0.019)	0.314** (0.008)	0.878* (0.041)	0.304* (0.045)	0.043 (0.699)
dGToil_SA.index.l1	-0.0002 (0.958)	0.0891 (0.346)	-0.312** (0.005)	-0.036 (0.693)	0.3630 (0.28)	0.088402 (0.455)	-0.043354 (0.621)
dGToil_RU.index.l1	-0.0028 (0.471)	-0.118381 (0.175)	-0.281** (0.006)	-0.503*** (1.62e-08)	-0.113 (0.7141)	-0.315** (0.00432)	-0.026744 (0.74053)
dGToil_CN.index.l1	0.00074 (0.45583)	0.015451 (0.496)	0.017877 (0.50008)	0.02254 (0.3027)	-0.515*** (2.10e-09)	0.016254 (0.566292)	-0.008927 (0.67100)
dGToil_NG.index.l1	-0.0001947 (0.95861)	-0.100380 (0.242	-0.094868 (0.34358)	-0.195 * (0.01881)	-0.47469 (0.1198)	-0.5712*** (3.56e-07)	0.015857 (0.84156)
dGT.covid_CN.index.l1	-0.0001890 (0.96366)	-0.030057 (0.751)	-0.249636* (0.02525)	-0.10900 (0.23285)	-0.55321 (0.1012)	-0.068244 (0.563978)	0.003404 (0.96904)
dWTI.oil.price.l2	-0.26694** (0.00148)	-1.927371 (0.306)	0.488941 (0.82392)	-2.04075 (0.26094)	0.72597 (0.9134)	1.243486 (0.596832)	-2.007594 (0.25052)
dGToil_US.index.l2	-0.0004378 (0.93680)	-0.159594 (0.206)	0.119897 (0.41582)	0.06333 (0.60181)	0.43656 (0.3297)	0.347942 * (0.028413)	-0.048113 (0.68032)
dGToil_SA.index.l2	-0.0027425 (0.49889)	0.002691 (0.977)	-0.108043 (0.31808)	0.04446 (0.61770)	-0.54588 . (0.0979)	-0.096775 (0.402724)	0.066317 (0.43943)
dGToil_RU.index.l2	0.0021043 (0.58308)	0.116407 (0.184)	-0.017459 (0.86428)	-0.344 *** (7.04e-05)	-0.12863 (0.6786)	0.162479 (0.138423)	-0.061948 (0.44497)
dGToil_CN.index.l2	0.0001120 (0.90693)	-0.023072 (0.292)	-0.003157 (0.90159)	0.02847 (0.17754)	-0.391*** (1.35e-06)	-0.015740 (0.564438)	-0.036948 . (0.06972)
dGToil_NG.index.l2	0.0005514 (0.88378)	-0.094180 (0.275)	-0.134265 (0.18316)	-0.03202 (0.69930)	-0.02429 (0.9366)	-0.3880 *** (0.000419)	0.001184 (0.98815)
dGT.covid_CN.index.l2	0.0001093 (0.97888)	0.091743 (0.331)	0.027049 (0.80585)	0.05906 (0.51527)	0.52086 (0.1208)	0.015821 (0.893053)	0.187003 * (0.03361)
const	-0.1381705 (0.27208)	0.746242 (0.794)	4.203639 (0.21033)	3.27891 (0.236)	10.11971 (0.3203)	0.246709 (0.94503)	4.632753 . (0.08259)
trend	-0.00291 * (0.03011)	0.005420 (0.858)	0.035907 (0.31242)	0.04196 (0.1529)	0.08836 (0.4129)	0.008615 (0.82039)	0.011932 (0.67168)
US_OxCGRT	0.0926857 (0.54714)	5.467027 (0.121)	6.935877 . (0.09247)	-2.50306 (0.45946)	8.26660 (0.5073)	-0.370375 (0.932693)	0.820620 (0.80086)

SA_OxCGRT	-0.1425706 (0.40324)	-6.885660. (0.078)	-7.792354 (0.08785)	2.54168 (0.49747)	-10.14342 (0.4626)	1.198466 (0.805077)	0.290438 (0.93573)
RU_OxCGRT	-0.0161080 (0.84320)	0.177506 (0.924)	-0.444704 (0.83768)	-1.47225 (0.41116)	-0.39348 (0.9524)	-0.872424 (0.707088)	0.243925 (0.88734)
CN_OxCGRT	0.0322643 (0.44406)	-0.134489 (0.889)	-1.933746 (0.08663)	-1.70414 (0.06718)	-4.32176 (0.2064)	-0.506621 (0.673082)	-2.326434 (0.00985)
NG_OxCGRT	0.1999452 (0.05407)	0.469101 (0.842)	0.353103 (0.89777)	1.03877 (0.64667)	-0.51718 (0.9506)	0.765139 (0.794607)	-0.865844 (0.69131)
observations	160	160	160	160	160	160	160
Residual s.e (df=137)	0.2775	6.327	7.397	6.097	22.47	7.91	5.867
R2	0.2749	0.1766	0.2136	0.2921	0.3658	0.2977	0.1499
Adjusted R2	0.1691	0.0564	0.09874	0.1888	0.2732	0.1952	0.02575
F-statistic (df=20; 137)	2.597***	1.469	1.86*	2.827***	3.951***	2.904***	1.207

B.2 VAR (2) model estimates (s.e. in parentheses) for gold

	dGold S.P.price	**dGTgold_US**	**dGTgold_RU**	**dGTgold_CN**	**dGTgold_NG**	**dGT.covid_CN**
dGold.S.P.price.l1	1.067e-01 (0.2060)	6.4574 (0.6807)	30.5649** (0.0015)	-7.1237 (0.866)	-20.8978 (0.5208)	15.6347 (0.2748)
dGTgold_US.index.l1	1.359e-04 (0.7614)	-0.1521 . (0.0699)	0.00822 (0.8701)	-0.0455 (0.839)	-0.401 * (0.0217)	0.004 (0.9579)
dGTgold_RU.index.l1	5.007e-05 (0.9450)	0.0167 (0.9021)	-0.377*** (8.19e-06)	0.3232 (0.375)	-0.039 (0.8886)	-0.0807 (0.5129)
dGTgold_CN.index.l1	1.527e-05 (0.9229)	-0.0285 (0.3338)	0.0225 (0.2058)	-0.4941*** (4.49e-09)	0.0976 (0.1115)	0.0175 (0.5148)
dGTgold_NG.index.l1	1.107e-04 (0.5796)	-0.0108 (0.7714)	0.019 (0.3988)	0.1039 (0.300)	-0.7109 *** (3.75e-16)	-0.0136 (0.6875)
dGT.covid_CN.index.l1	-8.310e-04 (0.0845)	-0.0172 (0.8471)	0.0002 (0.9965)	0.102580 (0.670)	0.224052 (0.2277)	0.0402 (0.622)
dGold.S.P.price.l2	-9.508e-02 (0.2728)	-3.5155 (0.82752)	3.9067951 (0.68785)	-43.573245 (0.316)	-11.057 (0.7410)	19.378740 (0.18856)
dGTgold_US.index.l2	4.378e-04 (0.336)	-0.2278 ** (0.008)	0.0507 (0.321)	0.3758 (0.100)	-0.0989 (0.5732)	-0.0795 (0.301)
dGTgold_RU.index.l2	9.375e-04 (0.1755)	0.0988 (0.44306)	-0.1893 * (0.01564)	0.4088 (0.238)	-0.450 . (0.0930)	-0.0827 (0.48037)
dGTgold_CN.index.l2	-4.373e-05 (0.7851)	-0.0047 (0.87436)	-0.0394 * (0.03019)	-0.3285*** (7.14e-05)	0.0584 (0.3467)	0.0329 (0.22756)

dGTgold_NG.index.l2	3.526e-04 (0.0734)	-0.0138027 (0.70554)	-0.0049190 (0.82313)	0.128428 (0.192)	-0.37 *** 2.03e-06	0.011705 (0.72494)
dGT.covid_CN.index.l2	-4.590e-05 (0.9246)	0.1059892 (0.24262)	-0.0060616 (0.91148)	-0.007719 (0.975)	0.065558 (0.7268)	0.225382** (0.00694)
const	4.255e-03 (0.4665)	0.0127858 (0.99063)	-0.5963530 (0.36391O)	-0.677134 (0.817)	-0.799 (0.7231)	0.447412 (0.65186)
trend	-4.271e-05 (0.5021)	0.0003581 (0.97590)	0.0043041 (0.54710)	0.007604 (0.812)	0.0079 (0.7484)	-0.006036 (0.57638)
observations	157	157	157	157	157	157
Residual s.e (df=141)	0.03512	6.549	3.946	17.61	13.58	5.965
R-squared	0.07906	0.08764	0.2745	0.2706	0.4253	0.09567
Adjusted R-squared	-0.005844	0.003525	0.2077	0.2034	0.3724	0.01229
F-statistic (df=13; 141)	0.9312	1.042	4.105***	4.024***	8.028***	1.147

Significant codes: '*'p< 0.001, '**'p< 0.01, '*' p<0.05 , '.' p<0.1**

B.3 VAR (1) model estimates (s.e. in parentheses) for real estate

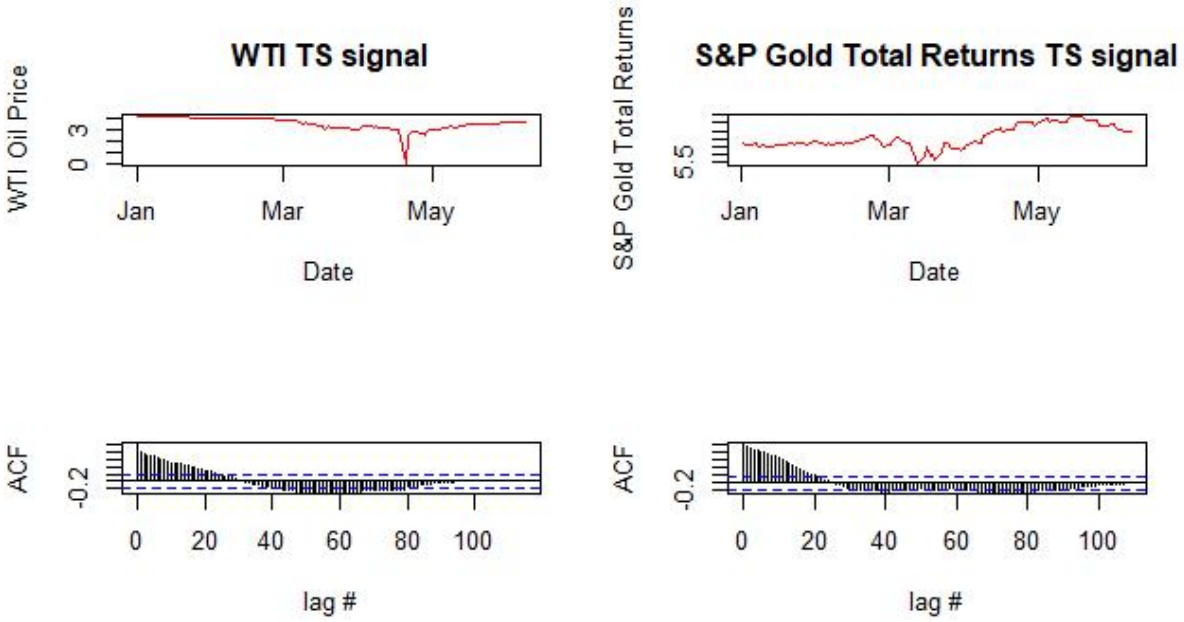
	dREIT.all.price	**dGTre_RU**	**dGTre_CN**	**dGTre_NG**	**dGTcovid_RU**	**dGTcovid_SA**	**dGTcovid_CN**	**dGTcovid_NG**
dREIT.all.price.l1	-3.303e-01 *** (5.29e-05)	-7.577 (0.5876)	57.31579 (0.2933)	20.412912 (0.5918)	2.699723 (0.841)	-1.011e+01 (0.344)	14.36395 (0.22660)	0.86521 (0.95619)
dGTre_RU.index.l1	2.833e-04 (0.543)	-0.225** (0.0065)	0.26011 (0.4150)	-0.5420 * (0.0160)	0.052350 (0.508)	-8.062e-02 (0.198)	-0.01723 (0.80390)	-0.06722 (0.46641)
dGTre_CN.index.l1	-2.061e-05 (0.841)	-0.024 (0.1691)	-0.4655*** (5.82e-10)	0.075372 (0.1266)	0.020637 (0.238)	-8.247e-03 (0.549)	-0.02100 (0.17136)	0.01293 (0.52542)
dGTre_NG.index.l1	-6.467e-05 (0.680)	0.05005 (0.0709)	-0.25277* (0.0197)	-0.3903*** (6.32e-07)	0.007707 (0.772)	-5.920e-03 (0.778)	0.03107 (0.18526)	-0.01675 (0.59001)
dGT.covid_RU.index.l1	-2.141e-04 (0.633)	0.124094 (0.1166)	0.05840 (0.8491)	-0.405 . (0.0607)	-0.387327*** (1.04e-06)	-2.797e-02 (0.642)	0.11213 . (0.09487)	-0.27264 ** (0.00251)
dGT.covid_SA.index.l1	6.049e-04 (0.295)	0.144661 (0.1550)	0.89586* (0.0246)	-0.205707 (0.4568)	-0.018331 (0.852)	-4.325e-01*** (1.02e-07)	0.01433 (0.86773)	-0.19714 . (0.08623)
dGT.covid_CN.index.l1	1.880e-04 (0.734)	-0.053 (0.5831)	0.38583 (0.3100)	-0.316263 (0.2341)	-0.090842 (0.335)	-6.127e-02 (0.410)	0.02351 (0.77592)	0.02639 (0.81004)
dGT.covid_NG.index.l1	-1.594e-04 (0.696)	-0.086 (0.2274)	-0.13053 (0.6402)	0.195198 (0.3179)	0.025565 (0.712)	2.995e-02 (0.584)	0.07816 (0.19959)	-0.12751 (0.11589)

const	-8.985e-03 (0.460)	1.476535 (0.4893)	1.00447 (0.9039	3.777996 (0.5161)	0.866207 (0.675)	8.680e-01 (0.594)	5.33885** (0.00365)	0.16446 (0.94551)
trend	-1.031e-04 (0.192)	0.003637 (0.7929)	0.01697 (0.7534)	-0.000716 (0.9849)	-0.007131 (0.595)	-8.808e-03 (0.405)	0.01334 (0.25735)	-0.01507 (0.33551)
CN_OxGRT	5.206e-03 (0.317)	-0.518 (0.5699)	-0.98307 (0.7822)	-1.304787 (0.5997)	-0.079417 (0.928)	-7.462e-04 (0.999)	-2.38775 ** (0.00239)	0.43855 (0.66996)
observations	160	160	160	160	160	160	160	160
Residuals.e (df=148)	0.03838	6.744	26.29	18.37	6.519	5.147	5.722	7.605
R-squared	0.1226	0.1267	0.2726	0.2539	0.1802	0.1944	0.1265	0.1043
Adjusted R-squared	0.1226	0.06774	0.2235	0.2035	0.1248	0.1399	0.06745	0.04377
F-statistic (df=10; 148)	2.068 *	2.148*	5.547***	5.036***	3.254***	3.57***	2.143 *	1.723

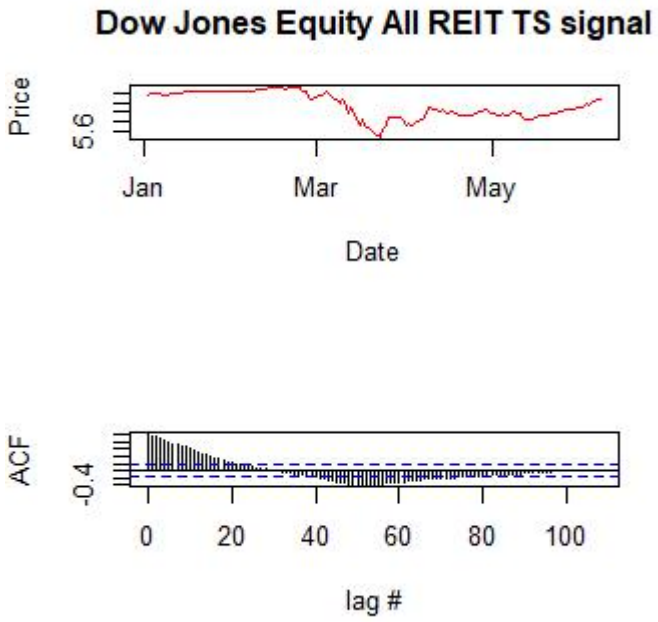
Significant codes: '*'p< 0.001, '**'p< 0.01, '*' p<0.05 , '.' p<0.1**

C Market time series and auto-correlation

C.1 Oil and gold markets time series and its autocorrelation funtion

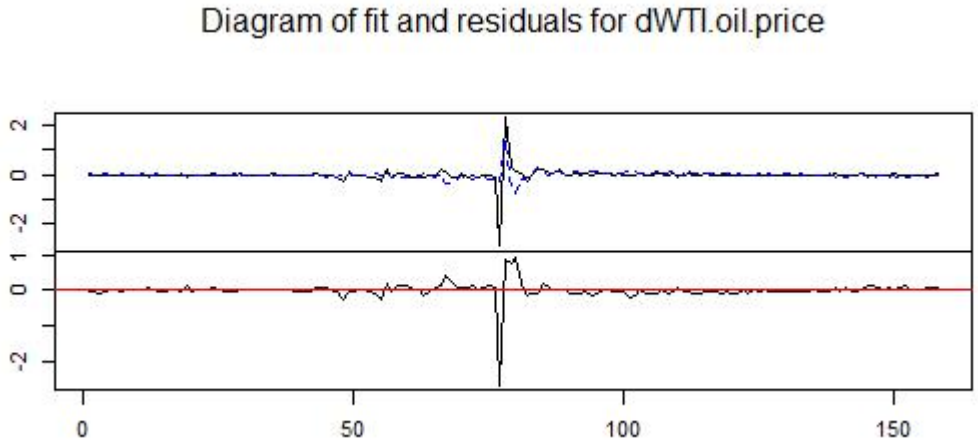


C.2 Real estate market time series and its autocorrelation function

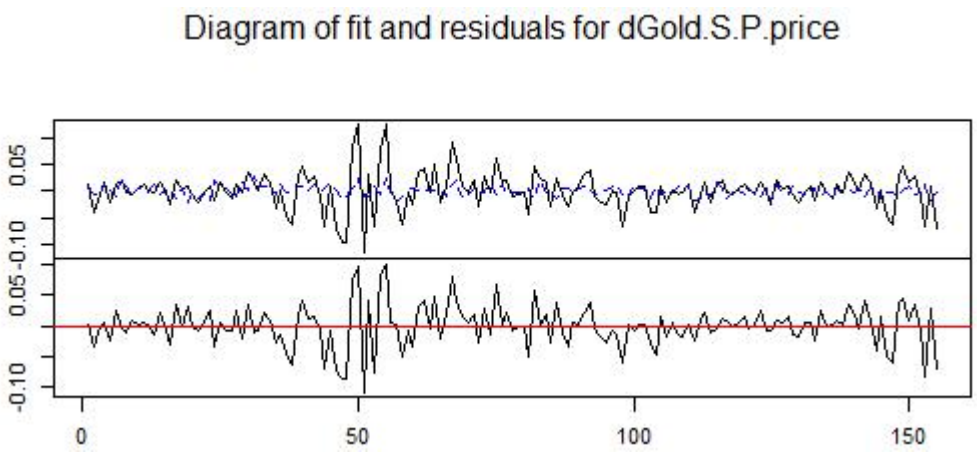


D Fit and residuals for oil, gold and real estate

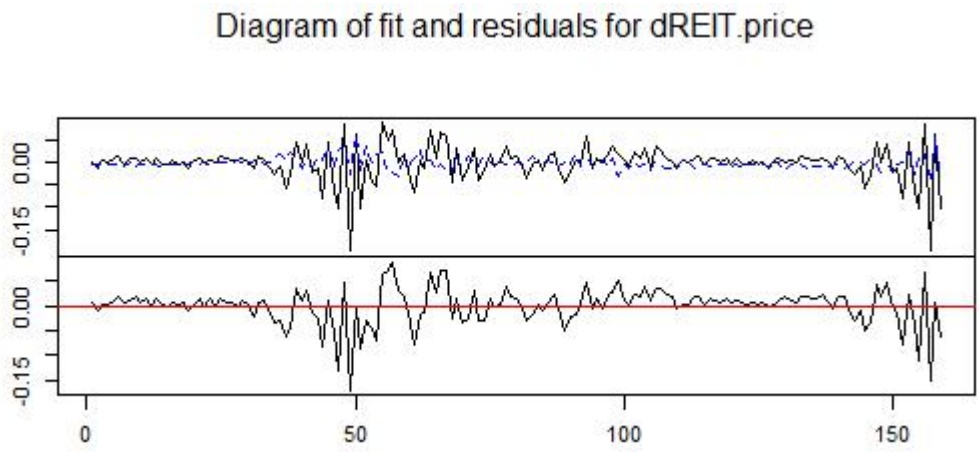
D.1 dWTI fit and residuals for oil



D.2 dGold fit and residuals for gold



D.3 dREIT fit and residuals for real estate



E General Abbreviations

EIA	US Energy Information Administration
REITs	Real Estate Investment Trusts
NAREIT	National Association of Real Investment Trust
SEC	Securities and Exchange Commission
IEA	International Energy Agency

References

The impact of oil price changes on growth for seven OECD countries by Max, Rahael <1990> (Università Ca'Foscari Venezia, 2016)

Zhang, Y. (2013), 'The Links between the Price of Oil and the Value of US Dollar', International Journal of Energy Economics and Policy 3(4), 341–351.

Husain, A. M., Arezki, R., Breuer, P., Haksar, V., Helbing, T., Medas, P. & Sommer, M. (2015), Global implications of lower oil prices, IMF Staff Discussion Note SDN/15/15, International Monetary Fund

Hamilton, J. D. (2011), 'Historical Oil Shocks', National Bureau of Economic Research, Working Paper 16790.

Hamilton, J. D. (1983), 'Oil and the Macroeconomy since World War II', The Journal of Political Economy 91(2), 228–248.

Pfaff B (2008). "VAR, SVAR and SVEC Models: Implementation Within R Package vars." Journal of Statistical Software, 27(4). URL http://www.jstatsoft.org/v27/i04/.

Costola, Michele and Iacopini, Matteo and Santagiustina, Carlo Romano Marcello Alessandro (May 2, 2020). "Public Concern and the Financial Markets during the COVID-19 outbreak". Available at SSRN: https://ssrn.com/abstract=3591193

Massicotte, P., Eddelbuettel, D., 2020. gtrendsr: Perform and display Google Trends queries. R 151 package version 1.4.5.

Hale, Thomas, Sam Webster, Anna Petherick, Toby Phillips, and Beatriz Kira (2020). Oxford COVID-19 Government Response Tracker, Blavatnik School of Government.

Kumar, D. (2014). Return and volatility transmission between gold and stock sectors: Application of portfolio management and hedging effectiveness. IIMB Management Review, 26(1), 5-16.

Stock Market Valuation Using Internet Search Volumes: US-China Comparison by Wan Jiang(2016)...URL https://repository.upenn.edu/cgi/viewcontent.cgi?article=1009&context=spur

Detecting influenza epidemics using search engine query data Jeremy Ginsberg1 , Matthew H. Mohebbi1 , Rajan S. Patel1 , Lynnette Brammer2 , Mark S. Smolinski1 & Larry Brilliant1 2019...URL https://static.googleusercontent.com/media/research.google.com/en//archive/papers/detecting-influenza-epidemics.pdf

Google Econometrics and Unemployment Forecasting by Nikolaos Askitas and Klaus F. Zimmermann 2009...URL http://ftp.iza.org/dp4201.pdf

Global Energy Assessment chapter six Energy and Economy…. URL https://iiasa.ac.at/web/home/research/Flagship-Projects/Global-Energy-Assessment/GEA_Chapter6_economy_hires.pdf

Kurth Yeager… Energy and Economy URL: https://iiasa.ac.at/web/home/research/Flagship-Projects/Global-Energy-Assessment/GEA_Chapter6_economy_hires.pdf

Energy for Economic Growth Energy Vision Update 2012...World Economic Forum

Adelman, M. A. (1972) The World Petroleum Market. Baltimore: Johns Hopkins University Press

The macroeconomic effects of a pandemic in Europe...By Lars Jonung and Werner Roeger, DG ECFIN, European Commission, Brussels

James, S. and T. Sargent (2006), “The Economic Effects of an Influenza Pandemic”, Economic Analysis and Forecasting Division, Department of Finance, Canada, May 9.

US Congressional Budget Office (2006), “A Potential Influenza Pandemic: Possible Macroeconomic Effects and Policy issues”, December, Washington DC.

Economic impact of pandemics…...URL https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/646195/EPRS_BRI(2020)646195_EN.pdf

NAREIT...https://www.reit.com/what-reit

Overview of the World Economic Outlook Projections, 2010 chapter 1 table 1.1

Hard Money taking gold to an investment level Shayne Mcguire, 2010

The World Is Days Away From Booking the Best Asset Returns in a Decade..Bloomberg.. URL https://www.bloomberg.com/news/articles/2019-12-20/the-world-is-days-away-from-the-best-asset-returns-in-a-decade

Assessing the Risks to the Japanese Government Bond (JGB) Market..IMF working Paper by Waikei Raphael Lam and Kiichi Tokuoka ...URL https://www.imf.org/external/pubs/ft/wp/2011/wp11292.pdf

http://www3.weforum.org/docs/WEF_EN_EnergyEconomicGrowth_IndustryAgenda_2012.pdf

"Production of Crude Oil including Lease Condensate 2019" . U.S. Energy Information Administration. Retrieved 31 March 2019

https://www.thebalance.com/how-are-oil-prices-determined-3305650 https://www.bloombergquint.com/markets/the-world-is-days-away-from-the-best-asset-returns-in-a-decade

Can Google Trends search queries contribute to risk diversification Ladislav Kristoufek, 2013 URL https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3776958/

Complex dynamics of our economic life on different scales:insights from search engine query data by Tobias Preis, Daniel Reith and Eugene Stanley (2010).. URL https://royalsocietypublishing.org/doi/full/10.1098/rsta.2010.0284?url_ver=Z39.88-2003&rfr_id=ori%3Arid%3Acrossref.org&rfr_dat=cr_pub++0pubmed&