IS GOLD A SAFE HAVEN, A HEDGE OR A DIVERSIFIER FOR BRICS INVESTORS?

by

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DECLARATION

I, Kayllen Neves declare that the research work reported in this dissertation is my own, except where otherwise indicated and acknowledged. It is submitted for the degree of Master of Management in Finance and Investment at the University of the Witwatersrand, Johannesburg. This thesis has not, either in whole or in part, been submitted for degree or diploma to any other universities.

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ABSTRACT

Gold has been around for thousands of years and its uses have evolved over time from a precious metal to a means of exchange and now as a financial asset that is traded in many forms. The characteristics of gold have been studied extensively over the years for developed markets, but few papers have looked at the metals characteristics for developing and emerging markets. This research seeks to analyse the characteristics of gold in order to establish whether the metal could act as a safe haven, a hedge or a diversifier for BRICS investors. This study replicates the methodology of Baur and Lucey (2010) and uses two principal regression models to analyse the characteristics of gold as a safe haven, a hedge or a diversifier for BRICS equity and bond markets. The property of gold as a safe haven is widely accepted, although there is few academic research on this especially within developing and emerging markets.

The findings of this research show that gold is a hedge on average for Brazilian, Russian and Indian equity markets, while gold is only a hedge for Chinese equity markets at the 2,5 percent quantile. Gold however, was not found to be a hedge on average for South African equity markets. In relation to BRICS bond markets, gold was found to be a hedge for all BRICS bond markets except for the Chinese bond market. The findings of this research in relation to the safe haven property of gold for BRICS investors was not present. This implies that when the BRICS markets face extreme market turmoil, holding gold in BRICS investors' portfolios will provide no protection against their falling bond and equity markets.

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1 INTRODUCTION

1.1 Background and context

Due to globalisation, financial markets have become more integrated which has allowed financial instruments to grow in volume and value (Baur & Lucey, 2010). Among those financial instruments, bond markets have been the usual destination for safety when equity markets experience downturns. However, the escape from equities to bonds for investors as a holding of safety or diversification has not been as rewarding as they once were (Baele, Bekaert, & Inghelbrecht, 2010). The recent liquidity issues in fixed income markets could further destabilise the global financial system, making it more difficult for investors to diversify or find a haven (Flood, 2019). In South Africa, the bond markets are characterized by low liquidity, which restricts investors' ability to use them as safe havens (Grandes & Pinaud, 2004). The other BRIC countries bond markets have higher volatility than developed markets, and these high volatility markets attract foreign investors as they seek higher returns and international diversification (Ortobelli & Petronio, 2015). Furthermore, with the interconnectedness of international financial markets, spill overs from shocks impact the availability for international diversification or holdings of safe haven assets during market downturns (Seetharam & Bodington, 2015).

The interconnectedness of BRICS countries (Brazil, Russia, India, China and South Africa) require BRICS investors to identify other emerging markets to diversify internationally. The risks arising from Brazil, Russia and South Africa impact other BRICS countries as they are net transmitters of shocks through their bond markets (Ahmad, Daly, & Mishra, 2018). However, India and China have low levels of connectedness and therefore could provide an opportunity for diversification and hedging (Ahmad et al., 2018). Globalization has provided a channel for crises spill overs to cascade through international markets. These events have increased stock market volatility, making international portfolio diversification more difficult, and even more so important.

The concerns surrounding the effectiveness of a safe haven in bond markets during equity market turmoil and dwindling diversification opportunities as world markets become more integrated, create the need for a suitable alternative asset or market

that investors could use to protect their portfolios during periods of uncertainty. Some studies have identified gold provides as potentially amenable to usage as a safe haven, hedge or diversifier due to the evolutionary uses of gold and the ever increasing gold price (Anwar & Mulyadi, 2012). Furthermore, gold has been regarded as a safe haven asset as a consensus by financial commentaries (Seetharam & Bodington, 2015). It is well known that safe haven assets provide relief for investors during periods of market turmoil as these assets exhibit low levels of volatility. Gold however exhibits high levels of volatility, especially in the short-run (Jaffe, 1989). This indicates gold's level of risk as an individual asset; however gold returns are proven to be independent and thus could act as a diversifier in portfolios (Jaffe, 1989). Table 1 below shows that the correlations between gold returns and the returns of the major equity indices for BRICS countries are low, which indicates that gold is independent and could act as a diversifier in BRICS investors' portfolios.

Table 1: Correlation Coefficients between Gold and BRICS Equity

	Gold
South African Equity Index - ALSI	0,1998
Brazilian Equity Index - BOVESPA	0,0772
Russian Equity Index - MOEX	0,1526
Indian Equity Index - NIFTY	0,0912
Chinese Equity Index - Shanghai Composite	0,0546

Source: EquityRT, Indices.

Gold as a safe haven has been researched extensively for developed markets such as the United States, United Kingdom and majority of Europe. Results of these studies are indicative of gold being a suitable and effective safe haven asset. However, gold has not been extensively researched in emerging markets such as BRICS countries and is therefore pertinent to do so. Baur and Lucey (2010) were among the first to examine gold as a safe haven for stocks and bonds in developed markets. Their results showed that gold did indeed act as a safe haven during bear markets and a hedge against equities for the United States, United Kingdom and Germany. Some emerging markets, excluding South Africa, were then included in a study by Baur and McDermott (2010), which found that gold was not a safe haven for large emerging

markets. Seetharam and Bodington (2015) replicated the study by Baur and Lucey (2010) for South African investors and found that gold does provide a suitable hedge for any economic state, but gold only acts as a safe haven when South African equity markets experience very large declines. Whilst some studies have examined the role of gold as a safe haven for BRICS equity markets (Chkili, 2016; Raza, Ibrahimy, Ali, & Ali, 2016), it is interesting to examine whether gold can play a similar role for their bond markets as well.

BRICS countries have large populations and their combined economic contribution in 2015 was a nearly a third of the global Gross Domestic Product (GPD) and therefore BRICS countries are major contributors to global economic growth (Reddy, 2017). BRICS and other emerging and developing countries have increased their trade and investment with one another, thus their growing contribution to the world economy makes a study of their financial markets relevant for other developing markets.

1.2 Research Problem

Gold has been well documented as a safe haven for developed economies when markets experience large downturns. However there is minimal evidence on the role of gold as a safe haven for emerging markets. Gold has an independent characteristic and therefore does not move with other financial assets, thus allowing gold to act as a hedge or a diversifier for investors' portfolios (Jaffe, 1989). With financial assets becoming more correlated due to globalization, it is important to identify assets that can provide relief from co-movements. Gold has also been around for centuries, acting as a form of money and was later used as a hedge for inflation (Baur & Lucey, 2010).

Given the nature and history of gold, it is important to understand gold's characteristics within an emerging market context. Investors in emerging markets are dealing with financial markets that are more volatile than developed markets, and therefore it is important for these investors to correctly identify a diversifier for their portfolios, and a safe haven for times of market turmoil. Furthermore, it is worthwhile to examine if gold behaves similarly for all BRICS equity and bond markets. An important consideration to be cognisant of is that gold is priced in U.S. dollars, and the dollar exchange with

BRICS countries may affect the feasibility of investing in gold, particularly during recessionary periods.

Emerging markets have immature financial markets, their volatility is higher, lower liquidity, and therefore emerging market investors bear higher risk as opposed to developed market investors (Ortobelli & Petronio, 2015). This means that for emerging market investors to protect their portfolios from high amounts of risk, they will need a suitable hedge or diversifier to decrease their portfolios risk. Emerging markets investors also require a safe haven, because during recessionary periods, emerging markets feel the adverse effects of these negative markets more severely than developed markets (Seetharam & Bodington, 2015). It is therefore essential that emerging market investors source a suitable safe haven that will offer them protection against extreme market downturns. Furthermore, findings and conclusions of developed markets cannot be directly applied to emerging markets as emerging markets are fundamentally different, in terms of their financial market maturity, political landscape and their global imbalances.

1.3 Research Objectives

1. To ascertain whether gold acts as a hedge, a diversifier or a safe haven for BRICS equities.
2. To ascertain whether gold acts as a hedge, a diversifier or a safe haven for BRICS bonds.
3. To explore the evolution of gold and stock returns after extreme negative shocks to BRICS markets.

1.4 Research Questions

1. Does gold act as a safe haven, hedge or diversifier for BRICS equity markets?
2. Does gold act as a safe haven, hedge or diversifier for BRICS bond markets?
3. What is the evolution of gold and stock returns after extreme negative BRICS market shocks?

1.5 Significance of the study

As outlined in the introduction, gold and its' corresponding characteristics have been studied extensively in developed countries. However, there has been some research on this structure in emerging markets, although, this research is limited. Thus, this study will build on existing knowledge on how gold acts in emerging markets. Furthermore, this study fills the gap in the knowledge in relation to BRICS bond markets where BRICS investors will have an indication if gold can acts as a hedge, a diversifier or a safe haven for BRICS bond markets. Additionally, with a portfolio analysis, this study will provide the significance of having gold included in portfolios and thus will aid in our understanding of the benefits that gold has in investors' portfolios following extreme negative shocks in BRICS equity markets.

2 LITERATURE REVIEW

2.1 Portfolio Theory

The founding father of portfolio theory, Harry Markowitz, developed his portfolio selection model in 1952. In his model he calculated the expected rate of return of a portfolio and with that, showed the variance of the rate of return is a significant measure of the portfolio's risk (Grujić, 2016).

Markowitz's model is built on several behavioural assumptions of investors, and the most important of them is that investors will make a risk assessment of the portfolio based on the variability in expected yield (Grujić, 2016). Following on, investment decisions of investors are made on the expected return and risk. The next assumption deals with the notion that investors will always prefer the highest return for a given level of risk, or alternatively, the lowest level of risk for a given level or return. Markowitz's model differs from classical portfolio theory which used diversification to reduce risk; whereas Markowitz creates efficient portfolios on a risk-adjusted basis, maximizing returns for a given level of risk. This is possible by having securities in a portfolio that have none or negative correlations with other assets in a portfolio, thereby gaining on returns when the other assets are losing. This offers investors the opportunity to decrease portfolio risk when these hedge characteristic securities are part of a portfolio, thereby increasing their risk-adjusted returns.

2.2 Characteristics of Gold as a Hedge

Hedges have been noted in research as having various characteristics. According to Baur and Lucey 2010, if an asset (say A), is negatively correlated or not correlated at all with another asset, portfolio or variable (B) means, the asset (A) can be categorized as a hedge. Hedges are useful for portfolio management as you can use them to diversify your portfolio thereby, increasing your risk-adjusted returns.

In recent years, the commodity gold has been noted as acting as a hedge, which would increase its' current value. Gold is easily traded in an open, constantly traded market which makes it a homogeneous asset as well as an exchange rate hedge (Capie, Mills, & Wood, 2005). In particular, it has been found to act as a hedge against various economic factors. Previous research has explored gold acting as an inflationary

hedge. This means that gold has been investigated as a possible variable protecting against inflation (Ghosh, Levin, Macmillan, & Wright, 2004). These explorations found that gold was highly negatively correlated with The United States inflation levels. Thus, a conclusion was made that gold effectively operates as an inflationary hedge.

Further, it has been noted in previous studies that, in the long term, there was a statistically significant relationship between the price of gold and the U.S inflation rate (Levin, Montagnoli, & Wright, 2006). A relationship between the U.S inflation rate and the value of Gold over a long-term period is expected, as gold is deemed to have a 'store-of-value' quality and it is also priced in US dollars (Seetharam & Bodington, 2015).

Research on various countries shares/equities, operating as an inflationary hedge, have indicated that only countries such as Argentina, Chile, Mexico and Venezuela have shown evidence for equities acting as a significant hedge against inflation. In these countries, there are high inflation rates which could attribute to this finding (Choudhry, 2001). Furthermore, it has been found that real estate securities, although comparable to stocks in other countries, deliver a worse hedge against inflation than equities in other countries (Seetharam & Bodington, 2015). On the other hand, Gold has been shown to have the ability to operate as an inflationary hedge that is not dependent on any factors and allows for portfolio protection from various different levels of inflation. In other words, a non-contingent inflationary hedge such as gold is able to play the role of an inflationary hedge independent of any macro-economic influences that may occur (Seetharam & Bodington, 2015).

Furthermore, due to Gold being priced in U.S dollars, this commodity has the ability to operate as an exchange rate hedge for any investor that holds investments that are also priced in dollars (Capie et al., 2005). In addition, gold has been found to perform as a hedge against currency risk (Iqbal, 2017). Although, the idea of labelling gold as dollar hedge must be made with caution as it was found to vary over time as a result of the gold market expectations of currency instabilities as well as societal perceptions (Capie et al., 2005).

Baur and Lucey (2010) stated that if gold were a hedge, it would be negatively correlated or not correlated at all with other assets or portfolios. However, as Baur and Lucey (2010) stated, if gold was a hedge, this would mean that gold is either uncorrelated or, negatively correlated with other portfolios or assets. They found that gold was not negatively correlated with other assets and thus concluded that it was not an effective mechanism in hedging portfolios.

2.2.1 Diversification in portfolios

Portfolio diversification is key to decreasing overall risk of a portfolio. Markowitz (1952) and Tobin (1952) are popular commentaries in portfolio selection and have provided normative rules for the purpose of diversification in risky assets. These popular rules stipulate that the inclusion of assets in a portfolio will reduce the overall risk of the portfolio, if those assets are not correlated to the ones in the portfolio.

With the ever increasing effects of globalisation, it is important to include assets with diversifiable effects. Furthermore, effective diversifiers are difficult to find, as many assets are increasingly correlated during market uncertainties when volatility effects are more exacerbated (Council, 2020b). Gold however is different as it is seen as negatively correlated to stocks (Jaffe, 1989). Gold has been viewed as not only a portfolio hedge, but also a portfolio diversifier in research (Coudert & Raymond, 2011). It was found by Hillier, Draper, and Faff (2006) that portfolios would perform better when they contained 5 – 10% gold in comparison to portfolios without gold.

In summary of the hedging and diversifier characteristics of gold, it is noted that gold does indeed have the ability to hedge inflation and investments denominated in dollars in the long run, as well as being a portfolio diversifier with its negative correlation to other assets.

2.3 Gold as a Safe Haven

Since gold has been shown to act as a hedge against inflation, and has been around for centuries, it can then be inferred that gold too has a safe haven property. An asset that is uncorrelated or negatively correlated with another asset or a portfolio during times of market turmoil or extreme stress can be classified as a safe haven asset (Baur

& Lucey, 2010). It has been widely accepted amongst financial markets that gold does play the role of a safe haven asset (Seetharam & Bodington, 2015).

When assets are positively correlated, during times of market stress or bear periods, they move in the same direction. Equities are more likely to be positively correlated and will make it more difficult to make favourable returns during bear periods. This allows for safe haven assets to increase in price as the demand for their holdings increases, further benefiting the gold characteristic of being a safe haven asset. However, the safe haven property of gold has only properly been studied since Baur and Lucey's study in 2010.

Baur and Lucey (2010) found that gold is a safe haven in extreme market conditions for the U.S., U.K. and Germany. However, the safe haven property of gold is short lived, and diminishes 15 days after the economic shock. On the one hand, the price of gold during an extreme shock is likely to increase as investors rush to secure returns. On the other hand, once the effect of the safe haven property wears off, the gold price declines. As paranoia creeps into investors, they will remove their funds from gold, and stick them back into the riskier equities. Thus, investors still holding gold after the safe haven effects have worn off, start to experience diminishing returns in their gold holdings (Baur & Lucey, 2010). Interestingly, Baur and McDermott (2010) found that the safe haven property of gold only applied to European markets and not large emerging ones.

However, during the current pandemic caused by COVID-19, the world has seen a surging gold price as it reached an eight-year high, the highest being in the second quarter of 2013 (Council, 2020a). The surging gold price brings into question the characteristics of gold, and whether gold has episodes of bubble-like markets (Baur & Glover, 2015). It is thus important to study the safe haven property of gold within the realms of recent market turmoil.

2.4 Gold as an Investment

Gold has many uses and it experiences demand from many sources. Gold is demanded as an investment, a reserve holding asset and it is used in technology as well as in jewellery, medals, and coins (Council, 2020b). This commodity has also

been classified as a diversifier in portfolios as well as a hedge (Coudert & Raymond, 2011). It is common knowledge that gold has been around for centuries and its' uses, demand and price have increased from the beginning of its useful life. The relevance of gold has increased as institutional investors have welcomed alternatives to equities and bonds as they search for differentiating factors that come with higher risk-adjusted returns (Council, 2020b). The large increase in gold allocations in investment portfolios are attributable to a number of factors. One of these factors being growth among emerging markets, in particular China and India, two of our BRICS countries, as they have seen a large economic expansion. This large economic expansion has led to an increasing investor base for gold thus, contributing to the large increase in gold allocations in global investment demand for gold, which has ultimately contributed to the increasing gold price (Council, 2020b).

Gold can be sourced in a couple of ways, the first being the extraction of gold from mines, and secondly, central banks can lease the commodity (Ghosh et al., 2004). With a couple of sources available for sourcing gold, it can be expected that the supply of gold will thus impact the price and therefore gold as an investment asset. Furthermore, the supply of gold will also fluctuate depending on the amount of gold that is extracted from gold mines, central banks willingness to lease the metal, and whether gold is being used commercially (Levin et al., 2006). Gold distinguishes itself from other investment assets such as equities and bonds, as the accessibility of gold differs as noted by its ability to be sourced. The gold market attracts investors by the scarcity of gold and its long-term attractiveness (Council, 2020b).

Gold does not adhere to normal valuation techniques employed by analysts that they would usually use to value equities and bonds. The price of gold is determined by supply and demand which can be explained by four main drivers (Council, 2020b). The four main drivers that push and pull the gold price are: economic expansion, risk and uncertainty, opportunity cost and, momentum. While this study does not aim to explain gold price movements, it is still important to understand the drivers of the metal's price. This is because it allows investors to have a better understanding of gold and therefore will allow them to time their purchase and disposal of the metal. Economic expansion relates to periods of growth, which ultimately allow for increase in spending on jewellery, technology and long-term savings, all which relate to gold.

Therefore, during economic expansions, the demand for gold will increase, thus pushing the price higher. Conversely, during times of market uncertainty and increased risk, gold has been used as a safe haven, once again boosting the demand for gold. The opportunity cost as a driver of the gold price simply refers to the competition among investment assets, where investors seek an edge on one another, and may cause demand shifts for gold as they seek opportunities to diversify. Lastly, the gold price can also be ignited or dampened by capital flows associated with international trade, as well as capital positioning (Council, 2020b).

Golds uniqueness is accentuated by the many different methods of holding and acquiring the metal as a financial and physical asset. It differentiates itself from other investments like stocks and bonds as it is not only limited to exchange traded products. A physical asset in gold comes in the form of gold bullions. Gold bullions come in the form of bars and coins, and their value is based on their weight and level of purity. The World Gold Council (2020) estimates the holdings of physical gold by investors and central banks at approximately USD 3,7 trillion. This illustrates that the gold market is large and highly liquid. The popular South African gold bullion comes in the form of a Krugerrand.

Contrary to gold as a physical asset, the metal is traded on many exchanges around the world. Where gold is traded on exchanges, the investor never holds the physical asset. Gold exchange traded funds (ETF's) are an example of where investors can access the gold market, without having to hold the physical asset. However, these gold ETF's are backed by gold bullions. The gold ETF is traded on an exchange, and each share of the ETF entitles the investors to a percentage of the bullion. Gold ETF's track the price of gold, as ETF's would track an index. Since there are administration and other costs involved in trading ETF's, the returns from holding the physical gold bullion will be higher than that of the ETF. However, ETF's are traded daily, and selling the gold ETF is easier than selling the physical asset.

Apart from ETF's, investors can also trade gold derivatives. Gold derivatives include broad categories such as options, futures and forwards (Cross, 2000). Within gold futures, the quantity and quality of gold is determined beforehand, and settled upon on at a future specified date. Likewise, with gold options, the investor will have the

specific amount of gold, quality and price predetermined, and it is up to the investor to exercise their call option. Derivatives are complex and tricky products to trade, and are usually only executed by institutional investors.

The final approach to gaining exposure to the gold market is by investing in gold mining companies. This would be an equity investment into a company that extracts, and sells gold. Investors that purchase gold mining companies stock gain indirect access to the gold price. As the gold price increases, the mining companies profits will increase, and therefore their share price too. Thus, the investors return will appreciate when the gold price increases. However, investing in companies, and specifically gold mining companies, comes with a different basket of risks. The investor, will no longer only be exposed to the risks associated with the volatility of the gold price, but they will also be exposed to the risks inherent in the company, and the political environment in which the company operates.

Investing in gold is readily available and possible for all interested parties. Whether it be through ETF's, the derivative market, equities market or through the physical purchase of gold bullions, the risk associated with trading gold will always be there. However, gold does pose many benefits that reduce the riskiness of its purchase. Gold has been considered a beneficial asset for periods of market turmoil, and it also provides positive returns during bull markets (Council, 2020b).

2.5 Gold and Emerging Markets

Emerging markets are characterised by low per capita income, high economic growth rates, high volatility, unstable currencies, and capital markets that are less mature than those in developed countries. However, larger emerging markets like BRICS, experience increased economic growth, and therefore their population have seen an increase in the amount of middle class consumers (Liu, 2016). The increase in middle class consumers in emerging markets coupled with poor investment options has led to an increase in the demand for gold as a financial asset (Liu, 2016).

Gold is desirable to consumers in emerging markets due to the fact that gold can be accessed easier and requires less maintenance compared to equity market

investments. Gold is not the be all and end all for emerging market consumers as an investment, but, the commodity is definitely a permanent feature in their basket of assets in which to choose from. Not only are consumers of emerging markets turning to gold as an investment, central banks in these markets are also increasing their gold reserves (Gopalakrishnan & Mohapatra, 2018).

Given the increase in the demand for gold by emerging markets, several studies have been completed to ascertain whether gold can act as a hedge and a safe haven for equity markets in emerging countries. Kumar (2014) examined the return and volatility spill over between gold and the Indian equity market. He found that the negative correlations were observed during periods of market turmoil. This indicating that gold can be used as a hedge for Indian equity markets, and that portfolios with the inclusion of gold provided diversification benefits, opposed to those without the metal.

Chkili (2016) studied the dynamic relationship between gold and stock markets for BRICS countries. From their findings they concluded that gold can act as a safe haven against extreme market movements, and that the inclusion of gold in an equity portfolio increased the portfolios risk-adjusted returns. However, Bekiros, Boubaker, Nguyen, and Uddin (2017) found that gold does act as a diversifier for BRICS countries but, not as a hedge nor a safe haven. They further found that the diversification effect of gold reduced in the long run.

Seetharam and Bodington (2015) studied the characteristics of gold for the South African equity and bond markets. In their findings, they conclude that gold does act as a hedge for South African investors against South African equities and bonds, but not for international equities. Furthermore, they found that gold did display positive returns during negative shocks, but this was short lived and diminished after two trading days.

2.6 Summary and Key Takeaways

While there are numerous ways of investing in gold, the fundamental aspect of the metals purchase is to provide positive returns for investors. Additional benefits of purchasing gold allows investors to diversify their portfolios while increasing their risk-adjusted returns. There have been a multitude of studies around the phenomenon of

gold acting as a hedge, diversifier and safe haven for developed markets. These studies have concluded that gold can act as a hedge against inflation, exchange rates, equity markets, bond markets and a safe haven during times of extreme market stress. Similar studies have been done for emerging markets and confirmed that gold can operate as a hedge, diversifier and safe haven for some emerging markets including BRICS countries. However, these emerging markets have not been as extensively studied as the developed ones.

South Africa is the world's largest exporter of gold, while Russia, India and China are among the top 10 holders of gold reserves. Furthermore, China and India accounted for 40% of the world's physical gold demand (Bekiros et al., 2017). This indicates the large role BRICS countries play in the market for gold. However, the study of the role that gold plays in these countries is scarce. Additionally, conclusions from developed markets do not provide inferences to emerging markets as they are fundamentally different. Hence, this study seeks to contribute to the existing literature by investigating whether gold can act as a hedge, diversifier or safe haven for equity and bond markets in BRICS countries.

3 METHODOLOGY

The methodology that will be employed in this study will determine whether gold is a hedge, a diversifier or a safe haven for BRICS investors using the respective countries equity and bond market indices. This study will replicate the econometric model adopted by Baur and Lucey (2010). Furthermore, a portfolio analysis will be conducted to indicate the benefits of the inclusion of gold in a portfolio for BRICS investors.

3.1 Data

The BRICS countries and their respective equity and bond indices will be used to conduct this research. Table 2 below describes which indices will be used and their respective currency.

Table 2: Summary of Country and Variable Data

Country	Currency	Stock Market Index	Bond Market Index
Brazil	Brazilian Real - BRL	BOVESPA	S&P B3 Brazil Inflation Linked Series B Index
Russia	Russian Ruble - RUB	MOEX	RBGI (Russian Government Bond Index)
India	Indian Rupee - INR	NIFTY 50	S&P BSE India Bond Index
China	Chinese Yuan - CNY	Shanghai Composite Index	S&P Chinese Government Bond Index
South Africa	South African Rand - ZAR	ALSI (All Share Index)	ALBI (All Bond Index)

The data to be used for analysis will comprise of daily spot gold price and converted from US dollars to the respective countries currency, using the closing daily exchange rate. Furthermore, daily prices for the BRICS countries respective stock and bond market indices, as referenced in Table 2, will be used. The choice of daily observation frequency is informed by previous studies such as Baur and Lucey (2010), Seetharam and Bodington (2015), and Baur and McDermott (2010), all of which use high frequency data. All these data sets will be collected from Bloomberg Terminal. The data will be analysed for each of the BRICS countries individually.

The longest period of data will cover the period from 30 June 2004 to 30 June 2020, a 16-year period. This period of study includes the 2008 global financial crisis, in which the world fell into a recession, which allows for the properties of gold to be examined over various economic cycles. Furthermore, this period will encompass the first two quarters of 2020, in which a global pandemic has caused financial markets to rise and fall, while the gold price has been rising to near an all-time high. This period of study encompasses a time where emerging markets have been growing and largely contributing to global economic growth. Furthermore, emerging markets have been increasing their gold reserves since the 2008 global financial crisis, and it is therefore important to include a period before the crisis and a period after to examine the way gold has behaved for emerging markets, as their financial markets have become more mature and their global economic growth contribution has too increased since 2004.

3.2 Research Design

The econometric model used by Baur and Lucey (2010) will be replicated and is described as follows:

$$r_{gold,t} = a + b_1 r_{stock,t} + b_2 r_{stock,t(q)} + c_1 r_{bond,t} + c_2 r_{bond,t(q)} + e_t \quad (1)$$

In the principal regression above, the dependent variable, r_{gold}, represents the returns on gold. Similarly, r_{stock} and r_{bond}, represent the returns on stock and bond indices. The structure of this model assumes contemporaneous stock and bond returns will affect the gold price, however, in the event that the model does not produce statistically significant results, the model will be re-run with lagged stock and bond returns for each of the BRICS countries, consistent with Baur and Lucey (2010). To account for positive and negative extreme shocks in the equity and bond markets, the terms $r_{stock,t(q)}$ and $r_{bond,t(q)}$ are included. These regressors are included in the regression model to ascertain the role gold plays when stock and bond markets are in turmoil. For this reason, the regressors, $r_{stock,t(q)}$ and $r_{bond,t(q)}$, will only be included for the lower quantiles, those being 5, 2.5 and 1 percent quantiles. However, if the returns for the stock and bond markets are larger than the lower quantiles, the value for these regressors will be zero. The quantiles are arbitrary to an extent, however, they are used by Baur and Lucey (2010) and will therefore be replicated in this study.

The design of this model is aligned with the hypothesis of a safe haven, whereby, if the stocks or bonds exhibit extreme negative returns, investors will begin to purchase gold, thus bidding up the gold price. If however, the price of gold is not affected, investors will neither purchase nor sell the metal, due to adverse market conditions. Furthermore, consistent with (Baur & Lucey, 2010), this study will assume that the price of gold does not affect stock or bond prices.

This study will also use a dynamic regression model in which the error term exhibits conditional autoregressive heteroskedasticity modelled by a GARCH process for the errors in equation (1). The GARCH process is modelled as follows:

$$h_t = \alpha e_{t-1}^2 + \gamma e_{t-1}^2 D(e_{t-1} < 0) + \beta h_{t-1} \quad (2)$$

Since lagged returns can have a different impact than contemporaneous effects, we utilise a dynamic regression model to analyse the linkage between the variables in the model dynamically (Baur & Lucey, 2010). This is further consistent with the dynamic model utilized by Capie et al. (2005). The second term in equation (2) has a threshold denoted by $D(e_{t-1} < 0)$, where the variable will be included such that the error term is negative. As previously mentioned, the models will be augmented with lagged returns if the model does not produce statistically significant results.

3.2.1 Hypothesis

It was previously mentioned that if an asset (say A), is negatively correlated or not correlated at all with another asset, portfolio or variable (B) means, the asset (A) can be categorized as a hedge. Additionally, an asset that is uncorrelated or negatively correlated with another asset or a portfolio during times of market turmoil or extreme stress can be classified as a safe haven asset (Baur & Lucey, 2010). From these two theoretical definitions, two hypothesis can be formed and tested for BRICS investors.

H-1: Gold is a hedge for stocks and for bonds in the BRICS markets.

H-2: Gold is a safe haven for stocks and for bonds in the BRICS markets.

3.2.2 Interpretation of hypothesis and model

Hypothesis 1 can be tested using the coefficients, b_1 and c_1, from equation (1). If the coefficient of stock returns, b_1, is zero or significantly negative, it indicates that the assets are not correlated or negatively correlated with one another. This would mean that gold is a hedge for stocks of the respective BRICS market. Similarly, if the coefficient of bond returns, c_1, is zero or significantly negative, it indicates that gold is a hedge for bonds, due to the lack of correlation or negative correlation that bonds would have with gold.

Hypothesis 2 can be tested using the coefficients, b_2 and c_2, from equation (1). If the summation of the coefficients for stocks, b_1 and b_2, are zero or negative, then gold serves as a safe haven asset for stocks due to the lack of correlations or negative correlations between one another. Similarly, if the summation of the coefficients for bonds, c_1 and c_2, are zero or negative, then gold serves as a safe haven asset for bonds due to the lack of correlations or negative correlations between gold and bonds. Furthermore, in the case of negative correlations between gold and stocks or bonds, then this implies that the price of gold increases under these adverse conditions. This allows investors to be compensated for their losses, should they be holding gold under these adverse conditions.

3.3 Portfolio Analysis

In this section, the study will analyse what effects an extreme negative shock will have on two portfolios of gold and stocks. The two portfolios will be comprised of the average cumulative returns over a period of 50 trading days after the extreme negative shock, this will be done for each of the BRICS countries. In doing the analysis, it will reveal the evolution of gold and stock returns after an extreme negative shock for each country.

In order to be classified as an extreme negative shock in each of the BRICS countries stock market, their indices return will be less than the 5% quantile. The cumulative returns will be calculated for gold and stocks for 50 days as follows:

$$Cumulative\ Return_i = \frac{(Price_{i,t+x} - Price_{i,t})}{Price_{i,t}}\ where\ x = (1,2,3 \dots ,50) \qquad (3)$$

This will indicate how stocks and gold perform the day after the initial shock at t and thereafter at $t + x$ trading days Baur and Lucey (2010). It can be expected that as stock returns begin to recover from the shock, the safe haven of property of gold will begin to decline. Given that this paper is examining the safe haven property of gold to a max of 50 days after the extreme negative shock, the results will indicate a short-term safe haven property of gold.

Furthermore, minimum variance portfolios will be constructed over the full sample period for each of the BRICS countries. This will be done using the returns of gold and each respective countries stock index. The optimal weights of each asset will be examined over the identified periods to examine gold returns in different economic states. The variance of the portfolio will be calculated as follows:

$$\sigma_{portfolio} = \sqrt{\sum_{i=1}^{n} w_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j COV_{ij}} \quad (4)$$

In equation (4) above,

- $\sigma_{portfolio}$ is the standard deviation of the portfolio,
- w_i represents the individual weight of the asset class in the portfolio and it is determined by the proportion of the value of the portfolio,
- σ_i gives the standard deviation of an individual asset,
- COV_{ij} is the covariance of two asset classes, $i \; and \; j$.

To calculate the minimum variance portfolio, one would solve for the asset weights in equation (4) that would produce the minimum portfolio standard deviation. In order to solve for the asset weights in (4) given more than two assets, a number of steps would have to be employed. The first would be to get the excess returns for each asset. Once this has been calculated, we will then create the transpose of the excess returns matrix. This will allow us to calculate the variance-covariance matrix. To solve for the desired weightings that will produce the minimum-variance portfolio, we will begin with dummy weights, those being equal weightings across the different assets. Thereafter, excels built-in solver function will be utilized to optimize the weights to allow for the minimum-variance to be calculated.

4 Empirical Analysis

The empirical analysis for this study will cover the BRICS countries. Each country will be analysed individually, mainly due to differing time periods caused by the availability of data. The data for each country will be in their respective currencies, therefore allowing the study to focus on the characteristics of gold for Brazilian investors, Russian investors, Indian investors, Chinese investors and South African investors.

This section will present and discuss the descriptive statistics for each country's equity and bond indices, as well as gold in their domestic currency. Furthermore, it will show the econometric results of the two regression models followed by a discussion for the full period and sub-sample analysis. Furthermore, the evolution of gold will be analysed through a portfolio analysis for each country before concluding with a summary of the results.

4.1 Brazil Analysis

The data employed for the analysis of the characteristics of gold in Brazil encompass daily price data from BOVESPA (a proxy for the Brazilian equity market), S&P B3 Brazil inflation linked bond index (a proxy for the Brazilian bond market) and US spot closing gold price converted to Brazilian Reals (BRL). The data covers the period 30 November 2005 to 30 June 2020.

4.1.1 Brazil descriptive statistics

Figure 1 below shows the daily prices of the Brazil bond index, Brazil equity index and gold prices in BRL for the respective time period. There is an overall upward trend for all three graphs, with prices higher at the end of the sample period compared to the beginning. The first graph representing the bond index shows steadily increasing prices, with few periods of declining prices. The second graph represents the equity market, and the variability in the index values is more pronounced compared to the bond index. Paying close attention to the equity graph shows a steep decline in the index price between 2008 and 2009, the global financial crisis. During this same period, there is an increment in the gold price. This indicates a potential inverse relationship between the Brazilian equity market and gold price. Further support of this phenomenon through visual inspection of the equity and gold price graphs is

noticeable in the latter part of 2019 and beginning of 2020. The equity mark drops steeply in early 2020, due to the Coronavirus pandemic, while the gold price is evidently increasing.

Figure 1: Line graph representation of Brazil price data

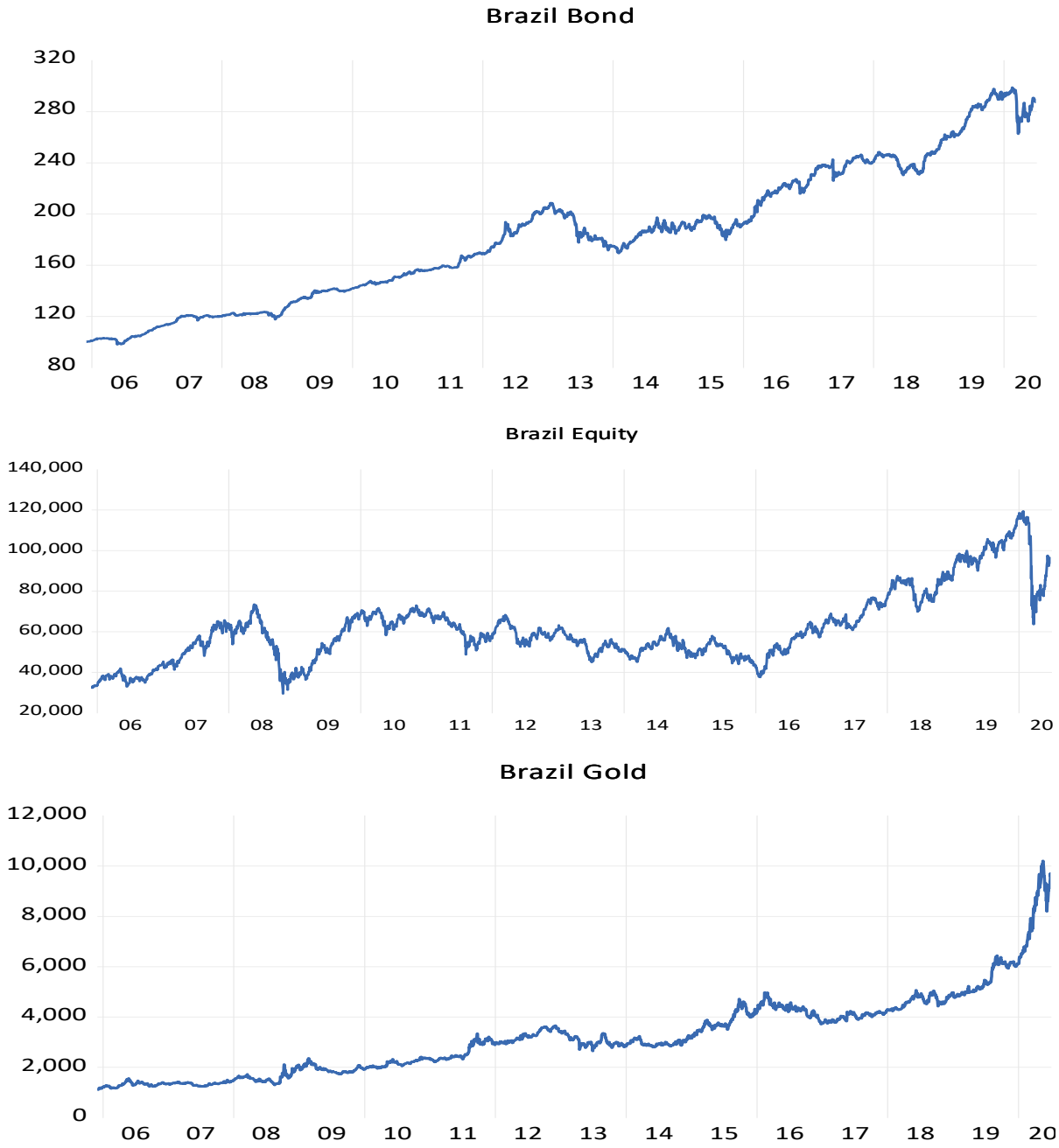


Table 3: Descriptive statistics for Gold, Brazil equity and bond index returns

	Gold	Brazil Equity Index	Brazil Bond Index
Mean (%)	0,0576	0,0287	0,0280
Standard Deviation	0,0142	0,0175	0,0041
Kurtosis	10,8534	12,9949	39,8519
Skewness	0,2661	-0,4367	-1,5481
Minimum	-0,0961	-0,1599	-0,0702
Maximum	0,1464	0,1368	0,0438
Observations	3804	3804	3804

Table 3 presents the descriptive statistics for Brazilian stocks, Brazilian bonds and the gold returns for Brazilian investors. From Table 3, it is evident that gold has a higher daily mean return than both equity and bonds in Brazil. Additionally, daily equity returns in Brazil are marginally higher than daily bond returns. Inspection of the standard deviations indicate that daily equity returns are riskier than gold, and bonds from a Brazilian investors' perspective. The daily return distributions for the Brazilian equity and bond markets are negatively skewed and are leptokurtic. On the contrary, the daily gold return distribution shows positive skewness. The negative skewness and leptokurtosis of Brazilian equity and bond return distributions indicate the series returns have fat left tails. This means that there are more negative returns indicating large losses and higher risk. Golds return distribution tells a different story, while leptokurtic, the return distribution displays positive skewness indicating positive returns while still displaying higher than normal risk. The fact that the gold return distribution for Brazil has high risk but still displays positive returns through the positive skewness is indicative of the fact that gold is a hedge or a possible safe haven for stocks and bonds.

Observation of the minimum and maximum values indicate the largest positive return for gold is expectedly higher than for bonds, but it is also higher than the stock index return. This observation combined with a large negative return for gold is representative of high levels of riskiness, which is confirmed with the high standard deviation of gold compared to bonds. These results are consistent with Jaffe (1989), who noted that high levels of riskiness of gold as an individual asset are an uncommon characteristic of safe haven assets. These results are consistent with Baur and Lucey

(2010) and Seetharam and Bodington (2015) whom note that gold and bonds are not interchangeable assets due to gold's relatively risky characteristic even though past studies have shown that both assets exhibit safe haven properties.

4.1.2 Brazil tests results

Table 4 presents the regression results for equations (1) and (2). The principal regression model given by (1) uses contemporaneous returns. However, in the case that lagged returns increase the variables statistical significance, the regression will be re-run with lagged returns. The Akaike and Schwarz information criteria were used to determine the optimal lag length. Table 4 indicates that the above-mentioned information criteria selected two lags for Brazil. Furthermore, the Akaike and Schwarz information criteria were also used to determine the optimal structure for the GARCH model (2).

The coefficient estimates for b_1 represent the average effect of Brazilian stocks on gold. This coefficient estimate for the contemporaneous return is (-0,2006) and is highly significant at the 1% level of significance. The sign of the coefficient shows that Brazilian stocks are negatively correlated with gold on average. Additionally, the coefficient estimates for c_1 represent the effect of Brazilian bonds on gold. The contemporaneous return for bonds coefficient estimate is (-0,1980) and is statistically significant at the 1% level of significance. This negative coefficient implies that gold is a hedge for bonds in Brazil. Given these results, the theoretical framework suggests that gold acts as a hedge for Brazilian stocks on average, and as a hedge for Brazilian bonds.

In order to establish whether gold is a safe haven asset for either of the independent variables in Table 4, the coefficient estimates would need to be summed. This is to say that if one were interested in identifying whether gold were a safe haven during the independent variables 1% quantile of returns ($b_{2\,(1\%)}$) , they would simply sum the coefficients of b_1, $b_{2\,(5\%)}$, $b_{2\,(2{,}5\%)}$ *and* $b_{2\,(1\%)}$. From Table 4 below, this information can be found in the last column. The example outlined above yields a coefficient estimate of (-0,2892) for stocks in the 1% quantile return distribution. This is to say that the 1% quantile return distribution for Brazilian stocks exhibits a negative correlation with gold,

and therefore, gold can be considered a safe haven asset for Brazilian stocks at the 1% quantile. This result further implies that when Brazilian stock returns show extremely negative returns that fall in the 1% quantile, the gold price increases strongly in Brazil.

The results from Table 4 reveals that the safe haven variables are negative at all percentile levels tested, which implies that gold does act as a safe haven asset for Brazilian equity investors. However, closer inspection of these results show that these results are not statistically significant.

The explanation and examples above can be directly transferred to test for the safe haven characteristic of gold in relation to the bond market of Brazil. Inspection of the summation of coefficient estimates for the bond variables show that the safe haven variables are only negative for the 5% and 2,5% quantiles, while the 1% quantile is positive. This indicates that gold can be considered a safe haven asset for bond returns when they experience extreme market stress above the 1% quantile. However, these results are not statistically significant. Moreover, statistical significance is reached at the 5% level of significance for the 1% quantile of bond returns, however, the safe haven variable has a positive coefficient of (0,2347), which indicates that gold is not a safe haven asset at that level for the Brazilian bond market.

The choice of the optimal lag length leads to a specification of two lags for Brazil. The results following the two lags indicate that lagged effects do show gold as a hedge for Brazilian equities as all Brazilian equity return distributions are statistically significant. Furthermore, the safe haven variables are all negative and statistically significant, which indicates that when investors invest in gold once extreme bear market conditions are prevalent, they experience better protection from losses than if they invested immediately. Furthermore, if we add the lagged effects with the contemporaneous effect, the total effect for Brazils equity market becomes (-0,5783) which is stronger than the contemporaneous effect of (-0,2892).

Table 4: Brazilian estimation results

(1): $r_{gold,t} = a + b_1 r_{stock,t} + b_2 r_{stock,t(q)} + c_1 r_{bond,t} + c_2 r_{bond,t(q)} + e_t$
(2): $h_t = \alpha e_{t-1}^2 + \gamma e_{t-1}^2 D(e_{t-1} < 0) + \beta h_{t-1}$

Brazil (BRL)					
Gold	**Coef. Est.**	**Std. Err.**	**t-stat**	**p-value**	**Sum Coef.**
b_1	-0,2006	0,0241	-7,0019	0,0000***	
$b_{2\ (5\%)}$	-0,0898	0,0641	-1,4008	0,1614	-0,2904
$b_{2\ (2,5\%)}$	0,1348	0,0969	1,3914	0,1642	-0,1556
$b_{2\ (1\%)}$	-0,1336	0,1372	-0,9737	0,3303	-0,2892
c_1	-0,1980	0,0760	-2,6043	0,0092***	
$c_{2\ (5\%)}$	-0,3491	0,3223	-1,0833	0,2787	-0,5471
$c_{2\ (2,5\%)}$	0,1027	0,4029	0,2548	0,7989	-0,4444
$c_{2\ (1\%)}$	0,6791	0,3421	1,9847	0,0472**	0,2347
2 Lags					
b_1	-0,2001	0,0161	-12,4309	0,0000***	
$b_{2\ (5\%)}$	-0,0903	0,0505	-1,7881	0,0738*	-0,2904
$b_{2\ (2,5\%)}$	0,1349	0,0663	2,0332	0,0421**	-0,1555
$b_{2\ (1\%)}$	-0,1336	0,0554	-2,4094	0,0160**	-0,2891
c_1	-0,1998	0,0743	-2,6907	0,0072***	
$c_{2\ (5\%)}$	-0,3475	0,2338	-1,4861	0,1373	-0,5473
$c_{2\ (2,5\%)}$	0,1028	0,2879	0,3570	0,7211	-0,4445
$c_{2\ (1\%)}$	0,6791	0,2177	3,1188	0,0018***	0,2346
Conditional Volatility					
α	$2{,}78_{x10^{-06}}$	$4{,}05_{x10^{-07}}$	6,8643	0,0000***	
γ	0,0768	0,0051	14,9492	0,0000***	
β	0,9095	0,0062	147,4596	0,0000***	

*Note: *** indicates statistical significance at 1%, ** statistical significance at 5%, * statistical significance at 10%. Coef. Est. stands for coefficient estimate, Std. Err. stands for standard error, Sum Coef. is the cumulative coefficient estimates showing the safe haven variable,* $b_{2\ (5\%)}$, $b_{2\ (2.5\%)}$ *and* $b_{2\ (1\%)}$ *are the coefficient estimates for the lower quantiles 5% to 1% of the equity return series,* $c_{2\ (5\%)}$, $c_{2\ (2.5\%)}$ *and* $c_{2\ (1\%)}$ *are the coefficient estimates for the lower quantiles 5% to 1% of the bond return series.*

Inspection of Table 4 in relation to lagged bond returns indicate similar results to that of the contemporaneous bond returns. Gold is a hedge for bonds with a coefficient estimate of (-0,1998) and it is highly statistically significant. The lagged bond returns distribution for the safe haven variables are negative at the 5 and 2,5 percent quantiles and are not statistically significant. The lagged bond return distribution at the most extreme bear market condition is statistically significant at the 1% level of significance, however, the safe haven variable is positive (0,2346). This result implies that gold is not a safe haven for Brazilian bond markets during the most extreme level of market turmoil. Adding the safe haven lagged effects with the contemporaneous effects for Brazilian bond market reveals that the total effect is strongly positive (0,4693),

compared to the contemporaneous effect of (0,2347). This implies that Brazilian bonds and gold move in the same direction if bonds decline.

From the above results, it is clear that gold is a safe haven for equities in Brazil. This fact implies that Brazilian investors that hold gold in both times of normal conditions and market stress are compensated for the losses as a result of negative stock returns due to positive gold returns. Furthermore, Brazilian investors that purchase gold after the extreme shock has occurred also benefit from positive returns from gold, as confirmed by the nonpositive signs of the safe haven variables from the lag augmented regression.

To summarise the results for Brazilian equity and bond markets, it can be noted that gold is a hedge for Brazilian equity markets but not a safe haven for contemporaneous effects. However, given the optimal lag length, gold is a hedge and a safe haven for Brazilian equities two days after an extreme negative shock. Additionally, gold is a hedge for Brazilian bonds both in contemporaneous and lagged effects, however, gold is not a safe haven for Brazilian bonds, as gold and bonds move in the same direction in times of extreme market stress.

4.1.3 Brazil subsample analysis

In this section, the study examines if the results based on the full sample period are also valid in subsamples. Inspection of the equity graph in Figure 1 revealed three bull markets and three bear markets over the full sample period for Brazil. Subsample analysis is important to ascertain whether role of gold is different in bull and bear markets. Consistent with Baur and Lucey (2010), the periods were selected by computing the peaks and troughs in the full sample period for both the bull and bear markets. Table 5 outlines all bull and bear markets and reports their results.

The results reveal that gold is not a hedge for Brazilian equities in the first bull market, the coefficient estimate is positive but not statistically significant. Additionally, the other two bull markets have negative coefficients and are highly statistically significant, implying that gold is a hedge for Brazilian stocks in the respective bull markets. Furthermore, the coefficient estimates for Brazilian stocks in the three bear markets are all negative and statistically significant at the 1% level of significance. These

results indicate that gold is a hedge for Brazilian stocks during bear markets. In relation to the full period sample, these results confirm that on average, gold is a hedge for Brazilian equities.

Further inspection of Table 5 reveals that gold is a hedge for Brazilian bonds in the first and third bull markets, with coefficient estimates of (-0,8915) and (-0,3828) at the 5 and 1 percent level of significance, respectively. Dissimilar to equities, gold is only a hedge for Brazilian bonds in the first out of three bear periods with a coefficient estimate of (-2,5529) at the 5% level of significance. The other two bear periods coefficient estimates are statistically insignificant.

The safe haven property of gold is identified in all market conditions for Brazilian equities, except for the first bull market. On the other hand, gold is not identified as a safe haven asset for Brazilian bonds in all bear markets. This result is consistent with the full sample period, which finds that Brazilian bonds and gold move in the same direction during extreme market stress.

4.1.4 Brazil portfolio analysis

This section analyses the average cumulated returns for a portfolio that consists of gold and stocks for the period spanning 50 trading days after the occurrence of an extreme negative stock return. This allows the study to demonstrate the practical implications of the findings in the previous section and display the evolution of stocks and gold returns through time.

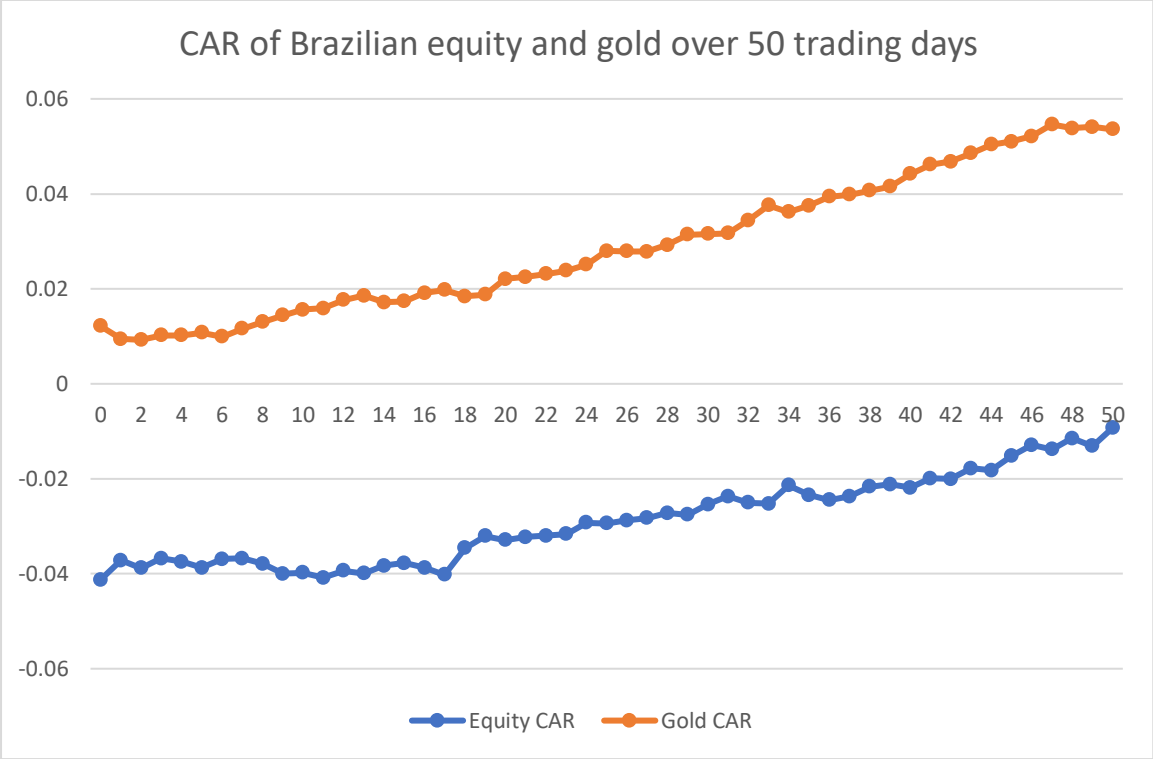
Figure 2 shows the cumulative average equity and gold returns (CAR) after an extreme negative shock in the Brazilian stock market. The extreme negative shock is defined as the fifth percentile of returns for the full sample.

Table 5: Brazilian subsample estimation results

Brazil Subsample Analysis												
	Bull Market (30/11/2005 – 19/05/2008)		**Bear Market (19/05/2008 – 21/11/2008)**		**Bull Market (21/11/2008 – 5/11/2010)**		**Bear Market (5/11/2010 – 21/01/2016**		**Bull Market (21/01/2016 – 23/01/2020**		**Bear Market (23/01/2020 – 30/06/2020)**	
Gold	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**
b_1	0,0262	0,60	-0,2048	-2,62	-0,2621	-5,96	-0,1839	-6,39	-0,2673	-9,51	-0,2969	-4,78
	0,0432	(0,54)	*0,0781*	(0,01)***	*0,0439*	(0,00)***	*0,0287*	(0,00)***	*0,0281*	(0,00)***	*0,0621*	(0,00)***
$b_{2\ (5\%)}$	-0,2571	-2,17	-0,1010	-0,53	-0,1456	-1,04	0,0516	0,55	-0,0895	-1,07	0,2385	2,39
	0,1181	(0,02)**	*0,2064*	(0,59)	*0,1387*	(0,29)	*0,0938*	(0,58)	*0,0833*	(0,28)	*0,0100*	(0,02)**
$b_{2\ (2,5\%)}$	0,2204	1,40	-0,5778	-1,76	0,1870	0,99	-0,1808	-1,42	-0,0910	-0,82		
	0,1573	(0,16)	*0,3280*	(0,08)*	*0,1871*	(0,31)	*0,1265*	(0,15)	*0,1105*	(0,41)		
$b_{2\ (1\%)}$	0,1625	1,05	0,3293	0,96	-0,2027	-1,10	0,0178	0,15	0,1988	1,83		
	0,1544	(0,29)	*0,3424*	(0,34)	*0,1829*	(0,26)	*0,1186*	(0,88)	*0,1082*	(0,06)**		
c_1	-0,8915	-2,54	-2,5529	-2,40	-0,1378	-0,35	-0,0416	-0,44	-0,3828	-3,92	0,0777	0,26
	0,3494	(0,01)**	*1,0595*	(0,02)**	*0,3931*	(0,72)	*0,0945*	(0,65)	*0,0976*	(0,00)***	*0,2990*	(0,79)
$c_{2\ (5\%)}$	0,8952	0,79	-3,2885	-1,53	-1,6044	-1,09	-0,0501	-0,17	-0,1887	-0,52	0,5872	1,32
	1,1215	(0,42)	*2,1463*	(0,13)	*1,4653*	(0,27)	*0,2827*	(0,85)	*0,3594*	(0,60)	*0,4438*	(0,19)
$c_{2\ (2,5\%)}$	-1,5031	-1,10	4,5042	1,63	2,7422	1,52	0,0700	0,20	-0,7515	-1,63		
	1,3650	(0,27)	*2,7495*	(0,10)	*1,8026*	(0,13)	*0,3478*	(0,84)	*0,4592*	(0,10)*		
$c_{2\ (1\%)}$	1,0417	1,02	8,4673	2,30	-0,5390	-0,35	0,5303	1,78	0,7318	2,16		
	1,0211	(0,31)	*3,6734*	(0,02)**	*1,5057*	(0,72)	*0,2963*	(0,07)*	*0,3382*	(0,03)**		
	Conditional Volatility		**Conditional Volatility**		**Conditional Volatility**		**Conditional Volatility**		**Conditional Volatility**		**Conditional Volatility**	
α	$2{,}94_{x10^{-06}}$	1,65	$-2{,}32_{x10^{-06}}$	-0,88	$2{,}62_{x10^{-06}}$	2,29	$7{,}22_{x10^{-06}}$	4,64	$1{,}11_{x10^{-06}}$	3,87	$6{,}88_{x10^{-06}}$	1,02
	$1{,}78_{x10^{-06}}$	(0,09)*	$2{,}63_{x10^{-06}}$	(0,37)	$1{,}14_{x10^{-06}}$	(0,02)**	$1{,}56_{x10^{-06}}$	(0,00)***	$2{,}85_{x10^{-06}}$	(0,00)***	$6{,}79_{x10^{-06}}$	(0,31)
γ	0,0536	3,00	-0,0506	-2,77	0,0349	2,24	0,0857	9,32	0,0163	3,43	-0,0892	-2,58
	0,0178	(0,00)***	*0,0182*	(0,01)***	*0,0156*	(0,02)**	*0,0092*	(0,00)***	*0,0047*	(0,00)***	*0,0346*	(0,01)***
β	0,9293	38,29	1,0891	33,82	0,9427	49,34	0,8704	54,19	0,9683	133,19	1,0821	46,54
	0,0243	(0,00)***	*0,0322*	(0,00)***	*0,0191*	(0,00)***	*0,0161*	(0,00)***	*0,0072*	(0,00)***	*0,0639*	(0,00)***

Note: *** indicates statistical significance at 1%, ** statistical significance at 5%, * statistical significance at 10%, values in italics are the standard errors, values in parenthesis are p-values, *$b_{2\ (5\%)}$, $b_{2\ (2.5\%)}$ and $b_{2\ (1\%)}$ are the coefficient estimates for the lower quantiles 5% to 1% of the equity return series, $c_{2\ (5\%)}$, $c_{2\ (2.5\%)}$ and $c_{2\ (1\%)}$ are the coefficient estimates for the lower quantiles 5% to 1% of the bond return series*.

Figure 2: Cumulative average returns for Brazilian equity and gold returns



From Figure 2, it can be noted that the return for gold is positive on all 50 days following an extreme negative shock in the Brazilian equity market. Additionally, the first day following the extreme negative stock return, the equity market in Brazil increases its return, however remains negative for all 50 trading days. While the returns for gold one day after an extreme negative stock return decrease, they do not reach zero, and thereafter begin to increase. This indicates that the safe haven effect of gold is not eliminated in the 50 days after an extreme negative shock for Brazilian equities. Furthermore, the evolution of gold and stock returns, indicates that the gold price increases steadily for first 46 days after an extreme negative shock in the Brazilian equity market and begins to flatten thereafter.

4.1.4.1 Brazil minimum variance portfolio

To further evaluate the practical implications of gold as a safe haven and a hedge for Brazilian equity and bond markets, the asset weightings were calculated for the two minimum variance portfolios containing gold, the Brazilian equity index and the Brazilian bond index, and the other portfolio excluding the Brazilian bond index. This section aims to determine the optimum weightings for each asset class over the entire

sample period, the 2008 – 2009 global financial crisis as well as the first 6 months of 2020. Table 6 reports the minimum variance portfolio results.

Table 6: Brazil minimum variance portfolio results

Portfolio 1	**Full Sample Period**	**2008 – 2009**	**2020**
Gold (weighting)	0,1046	0,0369	0,1302
Brazil Equity (weighting)	0,0210	0,0000	0,0000
Brazil Bonds (weighting)	0,8744	0,9631	0,8698
Annualised Std. Dev.	7,25%	4,48%	14,60%

Portfolio 2	**Full Sample Period**	**2008 – 2009**	**2020**
Gold (weighting)	0,5803	0,5835	0,7320
Brazil Equity (weighting)	0,4197	0,4165	0,2680
Annualised Std. Dev.	17,96%	25,01%	28,12%

Looking at the results in Table 6 above shows that holding a large portion of Brazilian bonds will provide a much lower standard deviation, as opposed not including bonds in your portfolio, as a result of diversification. Inspection of portfolio 1 in Table 6 reveals that in periods of extreme market stress (2008 – 2009 and 2020), Brazilian investors should decrease their holdings in Brazilian equities to zero. This indicates that because of the high risk inherent in equity returns, investors with the objective of minimizing risk (standard deviation) should not include them in their portfolios during periods of extreme market stress.

The strength of gold is illustrated by its inclusion in the minimum variance portfolio in the full period and during extreme market stress periods. Further inspection of Table 6 reveals that the two-asset portfolio is strongly weighted with gold, and the weighting of gold in the second portfolio increases during periods of market stress. These results confirm the regression analysis, that gold acts as a hedge for Brazilian investors, and increasing the weight of gold in portfolios for Brazilian investors will minimise the adverse effects of falling equity prices on portfolio returns.

4.2 Russian Analysis

The data employed for the analysis of gold characteristics in Russia encompass daily price date from MOEX (a proxy for the Russian equity market), Russian Government

Bond Index (a proxy for the Russian bond market) and US spot closing gold price converted into the Russian Ruble (RUB). The data covers the period 30 June 2004 to 30 June 2020.

4.2.1 Russia descriptive statistics

Figure 3 below shows the daily prices of the Russian bond index, Russian equity index and gold prices in RUB for the full sample period. In all three graphs, the end price is larger than the beginning price. Inspection of the first graph in Figure 3, shows that the bond market in Russia is volatile with large upward and downward spikes. This is contrary to what one would normally expect from a bond graph. The second graph, which plots the Russian equity prices for the full sample period has a more stable upward trend, with a large decrease in prices during 2008 and 2009, due to the global financial crisis. The next large decrease is present in 2020, due to the Corona Virus pandemic. Inspection of the gold price graph in Figure 3, reveals a strengthening gold price over the full sample period. Furthermore, where the equity graph takes a large dip during the global financial crisis, gold prices in Russia surged, showing an inverse relationship. This relationship is also notable in between Russian bonds and the gold price, as there is a large decrease in the bond prices during the same period. This behaviour can also be noticed in 2020, however, it does not apply to Russian bonds in this period, as the bond prices are seen to rise, moving with the gold price.

Table 7 presents the descriptive statistics for Russian stocks, Russian bonds and the gold returns for Russian investors. From Table 7, it is evident that gold has a larger daily mean return than both equities and bonds in Russia. Inspection of the standard deviations reveal that daily equity returns are marginally riskier than gold. Additionally, the standard deviation of daily Russian bond returns is low despite the large declining prices in certain periods as noted from Figure 3. The daily return distributions for the Russian equity and bond markets are negatively skewed and are leptokurtic. Daily gold returns on the other hand show positive skewness. The negative skewness and leptokurtosis of Russian equity and bond return distributions indicate the series returns have fat left tails. This means that there are more negative returns indicating large losses and higher risk. Golds return distribution tells a different story, while leptokurtic, the return distribution displays positive skewness indicating positive returns while still

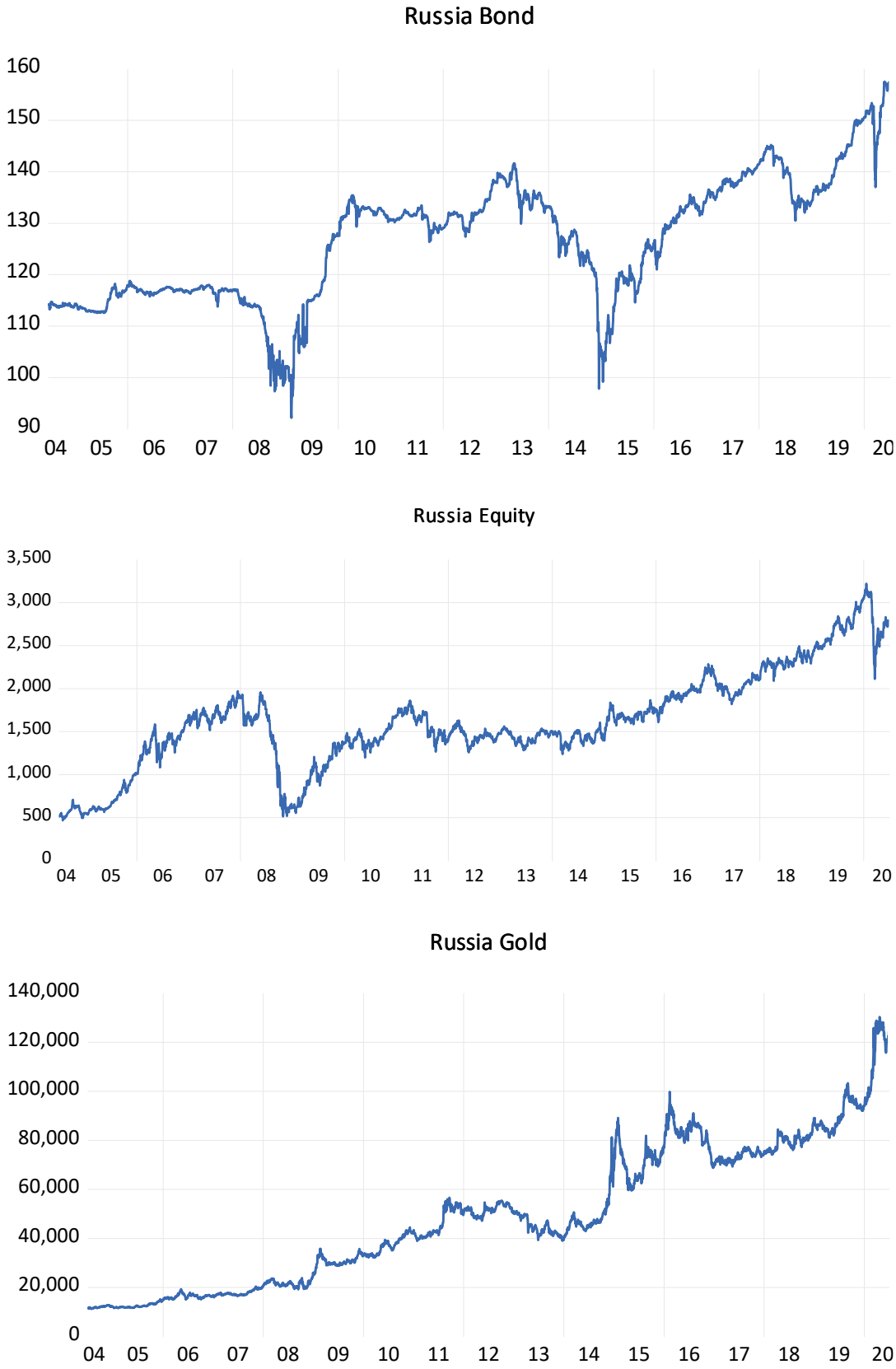
displaying higher than normal risk. the fact that the gold return distribution for Russia has high risk but still displays positive returns through the positive skewness is indicative of the fact that gold is a hedge or a possible safe haven for stocks and bonds.

Further inspection of Table 7 reveals the Russian equity market has a large maximum daily return and a large negative return showing the volatility in the Russian equity market. Large variations are present in both gold and bond returns for Russia. The large negative daily return for gold is representative of the high level risk associated with gold, further confirming the results of Jaffe (1989).

Table 7: Descriptive statistics for Gold, Russian equity and bond index

	Gold	**Russia Equity Index**	**Russia Bond Index**
Mean(%)	0,0576	0,0392	0,0073
Standard Deviation	0,0131	0,0188	0,0052
Kurtosis	9,3748	26,6229	88,7336
Skewness	0,0407	-0,2488	-1,9011
Minimum	-0,1038	-0,2066	-0,0933
Maximum	0,0954	0,2523	0,0716
Observations	4174	4174	4174

Figure 3: Line graph representation of Russian price data



4.2.2 Russia tests results

Table 8 presents the regression results for equations (1) and (2). The principal regression model given by (1) uses daily contemporaneous returns. However, in the case that lagged returns increase the variables statistical significance, the regression will be re-run. The Akaike and Schwarz information criteria was used to determine the optimal lag length and the optimal structure for the GARCH model (2). Table 8 indicates that the aforementioned information criteria selected one lag for Russia.

The coefficient estimates for b_1 represent the average effect of Russian stocks on gold. This coefficient estimate for the contemporaneous return is (-0,0387) and is statistically significant at the 10% level of significance. The sign of the coefficient shows that Russian stocks are negatively correlated with gold on average. Additionally, the coefficient estimate for c_1 represents the effect of Russian bonds on gold. The contemporaneous return for Russian bonds coefficient estimate is (-0,2880) and is statistically significant at the 5% level of significance. This negative coefficients implies that gold is a hedge for bonds in Russia. Given these results, the theoretical framework suggests that gold acts as a hedge for Russian stocks on average, and as a hedge for Russian bonds.

As explained in the econometric results of Brazil, the safe haven variable is determined by the sum of the coefficients for stocks and then for bonds. These results are found in the last column of Table 8. The summation of the coefficient estimates for stocks reveals that for the 1% quantile return, gold is a safe haven asset for Russian stocks as the coefficient estimate is (-0,0026). This means that the 1% quantile return distribution for Russian stocks exhibits a negative correlation with gold, and therefore, gold can be considered a safe haven asset for Russian stocks in the most extreme market stress intervals. Further inspection of Table 8 reveals that only the 5 and 1 percent quantiles have a negative safe haven variable, although these coefficient estimates are not statistically significant. The 2,5% quantile is statistically significant, but the sum of the coefficients to this point are positive, indicating that gold is not a safe haven asset for Russian stocks.

We inspect the same column in Table 8 to see if gold can be a safe haven asset for Russian bonds. The summation of the coefficients from c_1 to $c_{2\ (1\%)}$ reveal that all safe haven variable coefficients are negative. This implies that gold is a safe haven asset for Russian bonds during the most extreme moments of market stress. However, these results are not statistically significant.

The choice of the optimal lag length leads to a specification of one lag for Russia. The results following the one lag only slightly increase the variables statistical significance, and the conclusions made about the first regression can be applied to the lag augmented regression. Gold is a hedge for Russian stocks even after one lag. However, the safe haven variables are not statistically significant, therefore indicating that gold is not a safe haven asset for Russian stocks. The lagged aspect means that, gold is not a safe haven asset for Russian stocks even if gold was bought after the extreme shock occurred. This result is the same for Russian bonds, as the safe haven variables are negative, but are not statistically significant. However, gold is still a hedge for Russian bonds even after one lag, with a coefficient estimate of (-0,2882) and statistically significant at the 5% level of significance.

To summarise the results for Russian equity and bond markets, it can be noted that gold is a hedge on average for Russian equity markets both for contemporaneous and lagged effects. However, gold is not a safe haven for Russian equity markets in any level of market turmoil. Similar results can be conveyed for Russian bond markets. Gold is a hedge for Russian bond markets with both contemporaneous and lagged effects, but gold does not serve has a safe haven asset for Russian bonds.

Table 8: Russian estimation results

(1): $r_{gold,t} = a + b_1 r_{stock,t} + b_2 r_{stock,t(q)} + c_1 r_{bond,t} + c_2 r_{bond,t(q)} + e_t$
(2): $h_t = \alpha e_{t-1}^2 + \gamma e_{t-1}^2 D(e_{t-1} < 0) + \beta h_{t-1}$

Russia (RUB)					
Gold	**Coef. Est.**	**Std. Err.**	**t-stat**	**p-value**	**Sum Coef.**
b_1	-0,0387	0,0218	-1,7758	0,0758*	
$b_{2\ (5\%)}$	-0,0572	0,0661	-0,8643	0,3875	-0,0959
$b_{2\ (2,5\%)}$	0,1816	0,0784	2,3173	0,0205**	0,0857
$b_{2\ (1\%)}$	-0,0883	0,0844	-1,0460	0,2956	-0,0026
c_1	-0,2880	0,1421	-2,0266	0,0428**	
$c_{2\ (5\%)}$	-0,5787	0,3566	-1,6229	0,1047	-0,8667
$c_{2\ (2,5\%)}$	0,1494	0,4364	0,3424	0,7321	-0,7173
$c_{2\ (1\%)}$	0,5693	0,3525	1,6149	0,1064	-0,1480
1 Lag					
b_1	-0,0385	0,0218	-1,7703	0,0768*	
$b_{2\ (5\%)}$	-0,0577	0,0662	-0,8720	0,3833	-0,0962
$b_{2\ (2,5\%)}$	0,1818	0,0784	2,3189	0,0205**	0,0856
$b_{2\ (1\%)}$	-0,0882	0,0843	-1,0465	0,2954	-0,0026
c_1	-0,2882	0,1421	-2,0279	0,0426**	
$c_{2\ (5\%)}$	-0,5491	0,3595	-1,5275	0,1267	-0,8373
$c_{2\ (2,5\%)}$	0,1204	0,4384	0,2745	0,7837	-0,7169
$c_{2\ (1\%)}$	0,5691	0,3526	1,6143	0,1065	-0,1478
Conditional Volatility					
α	$2{,}90_{x10^{-06}}$	$3{,}51_{x10^{-07}}$	8,2588	0,0000***	
γ	0,0860	0,0045	18,9240	0,0000***	
β	0,8969	0,0055	164,2372	0,0000***	

*Note: *** indicates statistical significance at 1%, ** statistical significance at 5%, * statistical significance at 10%. Coef. Est. stands for coefficient estimate, Std. Err. stands for standard error, Sum Coef. is the cumulative coefficient estimates showing the safe haven variable,* $b_{2\ (5\%)}$, $b_{2\ (2.5\%)}$ *and* $b_{2\ (1\%)}$ *are the coefficient estimates for the lower quantiles 5% to 1% of the equity return series,* $c_{2\ (5\%)}$, $c_{2\ (2.5\%)}$ *and* $c_{2\ (1\%)}$ *are the coefficient estimates for the lower quantiles 5% to 1% of the bond return series.*

4.2.3 Russia subsample analysis

This section will speak to the results based on bull and bear market periods for Russian equities and bonds. Inspection of Figure 3 reveals two bull markets and two bear markets across the full sample period.

Inspection of Table 9 reveals that gold is not a hedge in the first bull market as the coefficient estimate is positive, however, gold is a hedge for Russian equities in the second bull market with a highly statistically significant coefficient of (-0,1197). Additionally, gold is not a hedge for Russian stocks in the first bear market. The coefficient estimate is negative, but the result is not statistically significant. Gold is however a hedge for stock in the last bear market with a coefficient estimate of (-

0,4313) and statistical significance at the 1% level of significance. The last bear period corresponds to the Corona Virus pandemic, in which the gold price surged as equities fell, and this results show that Russian investors that held gold in their portfolios would have been compensated for their losses in the equity market with the positive gains in the gold price. It is evident that in the last bear market, only the daily equity and bond returns were included with the 5% quantiles, due to multicollinearity between all the variables.

Inspection of Table 9 below reveals that gold is not a hedge for Russian bonds in neither of the bear markets. The coefficient estimates are positive but not statistically significant. Gold is however a hedge for Brazilian bonds in the second bull market with a coefficient estimate of (-0,4810) and it is statistically significant at the 1% level of significance. The safe haven property of gold is identified in all market conditions for Russian equities, except for the first bull market. Gold is found to be a safe haven asset for Russian bonds only during bull markets. The safe haven property of gold is not identified in the bear periods for Russian bonds. This result is consistent with the full sample analysis as Russian bonds and gold move in the same direction during extreme market stress.

4.2.4 Russia portfolio analysis

This section will analyse the average cumulated returns for a portfolio that consists of gold and stocks for the period spanning 50 trading days after the occurrence of an extreme negative stock return. This will allow the study to demonstrate the practical implications of the findings in the previous section and display the evolution of stocks and gold returns through time.

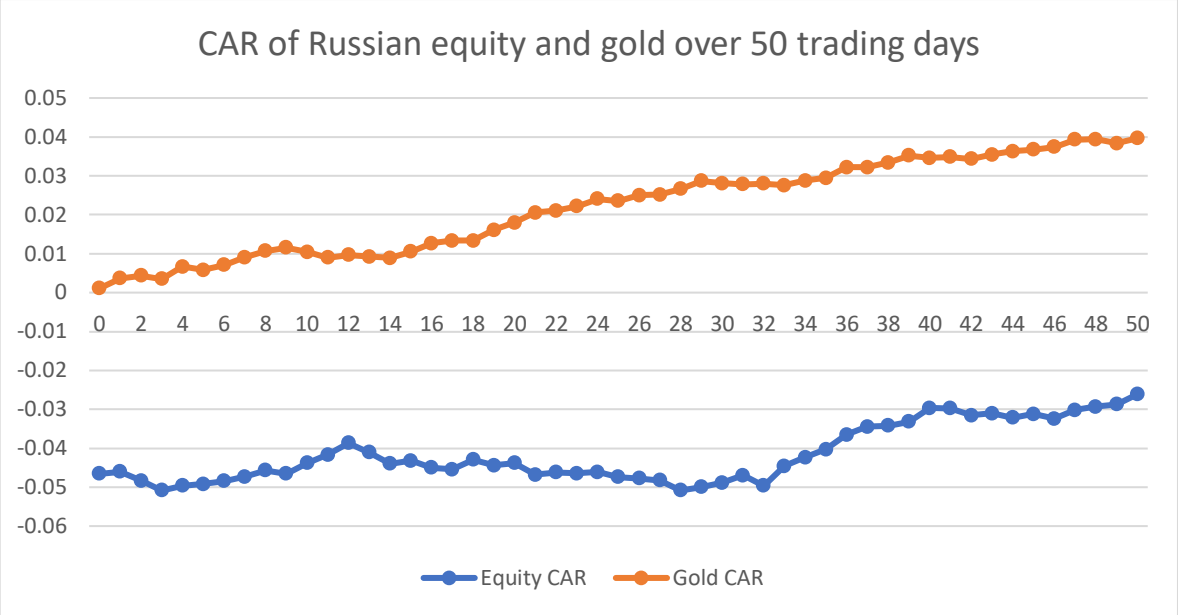
Figure 4 shows the cumulative average equity and gold returns (CAR) after an extreme negative shock in the Russian equity market. The extreme negative shock is defined as the fifth percentile of returns for the full sample.

Table 9: Russian subsample estimation results

Russia Subsample Analysis								
	Bull Market (30/06/2004 – 21/05/2008)		**Bear Market (21/05/2008 – 23/01/2009)**		**Bull Market (23/01/2009 – 21/01/2020)**		**Bear Market (21/01/2020 – 30/06/2020)**	
Gold	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**
b_1	0,0972	4,25	-0,0077	-0,21	-0,1197	-5,74	-0,4313	-3,71
	0,0229	(0,00)***	*0,0361*	(0,83)	*0,0209*	(0,00)***	*0,1162*	(0,00)***
$b_{2\ (5\%)}$	0,1308	2,07	0,1746	1,75	-0,0395	-0,58	0,2461	1,17
	0,0633	(0,04)**	*0,0998*	(0,08)*	*0,0685*	(0,56)	*0,2111*	(0,25)
$b_{2\ (2,5\%)}$	-0,1396	-1,73	-0,2631	-2,20	0,0395	0,46		
	0,0807	(0,08)*	*0,1195*	(0,03)**	*0,0854*	(0,64)		
$b_{2\ (1\%)}$	0,0937	1,30	-0,0888	-0,73	-0,0165	-0,24		
	0,0723	(0,19)	*0,1213*	(0,46)	*0,0686*	(0,81)		
c_1	0,2978	1,04	0,2059	1,30	-0,4810	-7,38	0,6302	1,47
	0,2858	(0,30)	*0,1581*	(0,19)	*0,0652*	(0,00)***	*0,4298*	(0,15)
$c_{2\ (5\%)}$	-0,4506	-0,47	-0,8503	-2,28	-0,2308	-0,83	0,9124	1,44
	0,9674	(0,64)	*0,3725*	(0,02)**	*0,2769*	(0,40)	*0,6351*	(0,15)
$c_{2\ (2,5\%)}$	-1,1777	-0,94	0,9716	2,08	0,0934	0,27		
	1,2583	(0,35)	*0,4661*	(0,04)**	*0,3388*	(0,78)		
$c_{2\ (1\%)}$	0,6277	0,63	-0,0264	-0,05	0,2097	0,95		
	1,0038	(0,53)	*0,5154*	(0,96)	*0,2241*	(0,35)		
	Conditional Volatility		**Conditional Volatility**		**Conditional Volatility**		**Conditional Volatility**	
α	$6{,}00_{x10^{-07}}$	1,64	0,0001	1,01	$4{,}21_{x10^{-06}}$	7,37	$2{,}04_{x10^{-05}}$	1,40
	$3{,}65_{x10^{-07}}$	(0,10)*	*0,0001*	(0,31)	$5{,}70_{x10^{-07}}$	(0,00)***	$1{,}46_{x10^{-05}}$	(0,16)
γ	0,0389	4,11	-0,0458	-14,41	0,0887	15,18	0,3036	3,10
	0,0095	(0,00)***	*0,0032*	(0,00)***	*0,0058*	(0,00)***	*0,0980*	(0,00)***
β	0,9566	89,41	0,6707	1,80	0,8809	109,66	0,6628	6,03
	0,0107	(0,00)***	*0,3731*	(0,07)*	*0,0080*	(0,00)***	*0,1098*	(0,00)***

*Note: *** indicates statistical significance at 1%, ** statistical significance at 5%, * statistical significance at 10%, values in italics are the standard errors, values in parenthesis are p-values*, $b_{2\ (5\%)}$, $b_{2\ (2.5\%)}$ *and* $b_{2\ (1\%)}$ *are the coefficient estimates for the lower quantiles 5% to 1% of the equity return series,* $c_{2\ (5\%)}$, $c_{2\ (2.5\%)}$ *and* $c_{2\ (1\%)}$ *are the coefficient estimates for the lower quantiles 5% to 1% of the bond return series.*

Figure 4: Cumulative average returns for Russian equity and gold returns



From Figure 4, it can be noted that the return for gold is positive over all 50 days following an extreme negative shock in the Russian equity market. Additionally, the CAR for Russian equities is negative for all 50 days following an extreme negative shock. The CAR for gold steadily increase over the full 50 days and do not reach zero, thus it can be noted that the safe haven property of gold is not eliminated in the 50 days after an extreme negative shock in Russian equity markets. Furthermore, the evolution of gold and stock returns indicates that the gold price increases steadily for the first 46 days after and extreme negative shock in the Russian equity market and begins to marginally fall thereafter.

4.2.4.1 Russia minimum variance portfolio

To further evaluate the practical implications of gold as a safe haven and a hedge for Russian equity and bond markets, the asset weightings were calculated for the two minimum variance portfolios containing gold, the Russian equity index and the Russian bond index, and the other portfolio excluding the Russian bond index. This section aims to determine the optimum weightings for each asset class over the entire sample period, the 2008 – 2009 global financial crisis as well as the first 6 months of 2020. Table 10 below reports the minimum variance portfolio results.

Table 10: Russia minimum variance portfolio results

	Full Sample Period	2008 – 2009	2020
Gold (weighting)	0.1594	0.3200	0.0651
Russia Equity (weighting)	0.0355	0.0586	0.0000
Russia Bonds (weighting)	0.8051	0.6214	0.9349
Annualised Std. Dev.	8.69%	17.18%	12.03%

	Full Sample Period	2008 – 2009	2020
Gold (weighting)	0.6667	0.8283	0.5497
Russia Equity (weighting)	0.3333	0.1717	0.4503
Annualised Std. Dev.	20.00%	26.76%	25.04%

The results in Table 10 show that holding a large portion of Russian bonds will provide a much lower standard deviation, as opposed to not including bonds in your portfolio, as a result of diversification. Inspection of portfolio 1 in Table 10 reveals that Russian investors should hold a large portion of gold in their portfolios and a small portion of Russian equity, but majority of the portfolio will be held in Russian bonds. During the 2008 – 2009 global financial crisis, Russian investors would have had to increase their weighting in gold and equities while decreasing their weight in bonds to provide the minimum variance portfolio for that period. This indicates that increasing the gold holdings in a portfolio of three assets during extreme market stress will minimise the effects of the falling equity prices. Inspection of portfolio 2 in Table 10 reveals the dominance of gold for Russian investors as there is a large weighting of the metal across all periods, further reflecting the positive benefits of holding gold to compensate for falling equity prices.

4.3 India Analysis

The data employed for the analysis of the characteristics of gold in India encompass daily price data of the NIFTY 50 (a proxy for the Indian equity market), S&P BSE India Bond index (a proxy for the Indian bond market) and US spot closing gold price converted to Indian Rupee (INR). The data covers the period 29 December 2006 to 30 June 2020.

4.3.1 India descriptive statistics

Figure 5 below shows the daily prices of the Indian bond index, Indian equity index and gold price in INR for the respective time period. There is an overall upward trend for all three graphs, with prices higher at the end of the sample period than the beginning. The first graph representing the Indian bond index shows steadily increasing prices, with few periods of declining prices. The second graph represents the equity market in India and the variability in the index values is more pronounced compared to the bond index graph. Paying close attention to the equity graph reveals a steep decline in the index price between 2008 and 2009, the period of global financial crisis. During this same period, there is a positive upward trend in the gold price, as seen in graph 3 of Figure 5. This indicates an inverse relationship between the Indian equity market and gold price, the same relationship was viewed between Brazil's equity index and the gold price in BRL. Further support of the inverse relationship is in the period of 2020, where the Indian equity index fell sharply, while the gold price continued to surge in the same time period. The steep decline in equity prices for the beginning of 2020 is attributable to the Corona Virus pandemic.

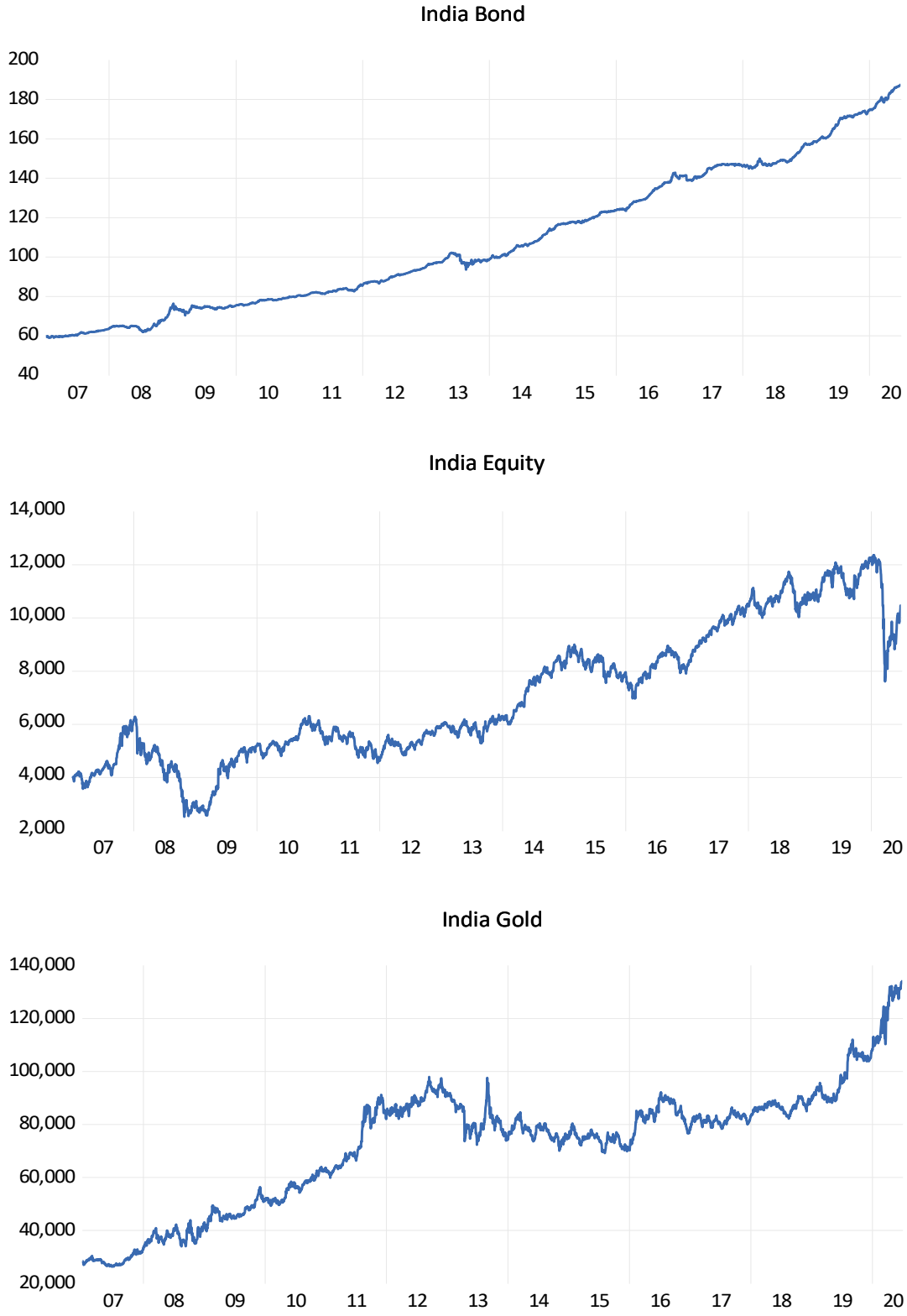
Table 11: Descriptive statistics for Gold, India equity and bond index

	Gold	**India Equity Index**	**India Bond Index**
Mean (%)	0,0444	0,0271	0,0326
Standard Deviation	0,0113	0,0140	0,0022
Kurtosis	8,2056	17,2136	28,8936
Skewness	-0,1262	-0,2784	-0,6794
Minimum	-0,0932	-0,1390	-0,0278
Maximum	0,0904	0,1633	0,0268
Observations	3522	3522	3522

Table 11 above is the descriptive statistics for daily Indian stocks, daily Indian bonds and the daily gold returns for Indian investors. Inspection of Table 11 reveals that the daily mean gold return is considerably higher than the daily Indian equity and bond mean return. While the mean return for gold is higher, the commodity also bears higher risk. This is deduced by the higher standard deviation compared to bonds and the large variation between golds minimum and maximum daily return. All three daily return distributions are negatively skewed and leptokurtic. The negative skewness and

leptokurtosis of Indian gold, equity and bond return series indicate the distributions have fat left tails. This means that there are more negative returns indicating large losses and higher risk.

Figure 5: Line graph representation of India price data



4.3.2 India tests results

Table 12 below is a presentation of the regression results for (1) and (2). The principal regression model given by (1) uses contemporaneous returns. As was the case previously, the Akaike and Schwarz information criteria was used to determine the optimal lag length. As can be seen in Table 12, no lags were selected for the Indian return distributions, thus contemporaneous returns are sufficient for India.

The coefficient estimates for b_1 represent the average effect of Indian stocks on gold. This coefficient estimate for the contemporaneous return is (-0,1207) and is highly statistically significant at the 1% level of significance. The negative sign of the coefficient shows that Indian stocks are negatively correlated with gold on average. Furthermore, the coefficient estimate for c_1 represents the effect of Indian bonds on gold. The contemporaneous return of Indian bonds has a coefficient estimate of (-0,3380) and is statistically significant at the 5% level of significance. This negative coefficients implies that gold is a hedge for bonds in India. Given these results, the theoretical framework suggests that gold acts as a hedge for Indian stocks on average and as a hedge for Indian bonds.

The safe haven variable can be ascertained by the summation of the coefficients of the independent variables. The safe haven variables for Indian equities are all negative. This indicates gold acts as a safe haven for all levels of market stress for Indian equities. However, only the most extreme level of stress is statistically significant. Thus, gold acts as a safe haven where Indian stock returns exhibit extreme negative returns that are in the 1% quantile. Additionally, in this instance, the gold price increases slightly in India. The safe haven characteristics of gold is not present for Indian bonds due to the sum of the coefficients being positive and not statistically significant.

Table 12: India estimation results

(1): $r_{gold,t} = a + b_1 r_{stock,t} + b_2 r_{stock,t(q)} + c_1 r_{bond,t} + c_2 r_{bond,t(q)} + e_t$
(2): $h_t = \alpha e_{t-1}^2 + \gamma e_{t-1}^2 D(e_{t-1} < 0) + \beta h_{t-1}$

India (INR)					
Gold	**Coef. Est.**	**Std. Err.**	**t-stat**	**p-value**	**Sum Coef.**
b_1	-0,1207	0,0239	-5,0361	0,0000***	
$b_{2\ (5\%)}$	0,0314	0,0824	0,3813	0,7030	-0,0893
$b_{2\ (2,5\%)}$	-0,0780	0,1072	-0,7271	0,4672	-0,1673
$b_{2\ (1\%)}$	0,1559	0,0866	1,8000	0,0719*	-0,0114
c_1	-0,3380	0,1445	-2,3390	0,0194**	
$c_{2\ (5\%)}$	0,5858	0,4245	1,3834	0,1666	0,2478
$c_{2\ (2,5\%)}$	-0,2700	0,2452	-0,5970	0,5505	-0,0222
$c_{2\ (1\%)}$	0,1031	0,4113	0,2505	0,8022	0,0809
Conditional Volatility					
α	$1{,}37_{x10^{-06}}$	$2{,}27_{x10^{-07}}$	6,0346	0,0000***	
γ	0,0580	0,0035	16,6981	0,0000***	
β	0,9311	0,0044	209,2930	0,0000***	

*Note: *** indicates statistical significance at 1%, ** statistical significance at 5%, * statistical significance at 10%. Coef. Est. stands for coefficient estimate, Std. Err. stands for standard error, Sum Coef. is the cumulative coefficient estimates showing the safe haven variable, $b_{2\ (5\%)}$, $b_{2\ (2.5\%)}$ and $b_{2\ (1\%)}$ are the coefficient estimates for the lower quantiles 5% to 1% of the equity return series, $c_{2\ (5\%)}$, $c_{2\ (2.5\%)}$ and $c_{2\ (1\%)}$ are the coefficient estimates for the lower quantiles 5% to 1% of the bond return series.*

4.3.3 India subsample analysis

In this section, the study will examine if the results based on the sample period are also valid in subsamples. Inspection of Figure 5 reveals two bull markets and two bear markets across the full sample period. The first Indian bull market runs until January 2008, where the equity market took a hit due to the global financial crisis. The market did pick up a year later and the second bull market ran from March 2009 to January 2020.

Table 13 presents the results of the subsample regressions run on the Indian equity, bond and gold returns. From this table it can be noted that the coefficient estimates for Indian equities are all negative, except for the first bull market. This indicates that gold is a hedge for Indian equities for both bull and bear markets. While this is still true, it is only applicable to the first bear market, and the second bull market. This is because these coefficients are statistically significant at the 5 and 1 percent levels. Additionally, gold is found to only be a hedge for Indian bonds during the second bull

market, with a coefficient estimate of (-0,3487) and statistically significant at the 1 percent level of significance.

The safe haven property of gold is identified in all market conditions for Indian equities, except the first bull market. The safe have property of gold is evident from Figure 3, that shows that when the equity market is falling, the gold price is rising, and continues to steadily increase for the rest of the period. However this result is not applicable to bonds as gold is not found to be a safe haven during bear markets for Indian bonds. This implies that bonds and gold move in the same direction in the Indian market.

The last bear market for Indian equities begins in January 2020. This bear market is caused by the Corona Virus pandemic. Visual inspection of Figure 5, shows the gold price surging while the equity prices have plummeted. Therefore, gold appears to be a hedge for Indian equities during the Corona Virus pandemic, however, the regression results are not statistically significant and no viable conclusion can be drawn from this. What is noteworthy, is the fact that in the most extreme negative return state, the 1% quantile has a statistically significant negative coefficient estimate of (-0,6363). This implies that gold is a hedge for Indian equities when they experience extreme negative returns.

Table 13: India subsample estimation results

India Subsample Analysis								
	Bull Market (29/12/2006 – 8/01/2008)		**Bear Market (8/01/2008 – 9/03/2009)**		**Bull Market (9/03/2009 – 17/01/2020)**		**Bear Market (17/01/2020 – 30/06/2020)**	
Gold	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**
b_1	0,0530	0,97	-0,1018	-2,02	-0,1584	-7,71	-0,0739	-1,27
	0,0545	(0,33)	*0,0503*	(0,04)**	*0,0206*	(0,00)***	*0,0580*	(0,21)
$b_{2\ (5\%)}$	-0,1165	-0,87	0,0601	0,43	-0,1178	-1,70	0,2125	1,65
	0,13331	(0,38)	*0,1414*	(0,67)	*0,0694*	(0,09)*	*0,1287*	(0,10)*
$b_{2\ (2,5\%)}$	0,0415	0,24	0,3913	1,91	0,1879	2,03	0,1509	0,83
	0,1755	(0,81)	*0,2052*	(0,06)*	*0,0924*	(0,04)**	*0,1814*	(0,41)
$b_{2\ (1\%)}$	0,0782	0,38	-0,3671	-1,81	-0,0848	-1,00	-0,6363	-3,44
	0,2047	(0,70)	*0,2025*	(0,07)*	*0,0846*	(0,32)	*0,1851*	(0,00)***
c_1	0,3691	0,76	-0,3575	-1,01	-0,3487	-2,86	-0,9791	-1,18
	0,4842	(0,45)	*0,3550*	(0,31)	*0,1221*	(0,00)***	*0,8298*	(0,24)
$c_{2\ (5\%)}$	0,9990	0,74	0,4434	0,46	-0,0620	-0,14	3,4938	1,19
	1,3482	(0,46)	*0,9652*	(0,65)	*0,4464*	(0,89)	*2,9329*	(0,24)
$c_{2\ (2,5\%)}$	-1,8725	-1,20	0,0860	0,06	0,8949	1,62	-1,4960	-0,34
	1,5620	(0,23)	*1,3346*	(0,95)	*0,5528*	(0,11)	*4,3824*	(0,73)
$c_{2\ (1\%)}$	-0,6607	-0,47	-0,1885	-0,15	-0,4482	-1,10	5,7618	1,39
	1,4044	(0,64)	*1,2335*	(0,88)	*0,4064*	(0,27)	*4,1592*	(0,17)
	Conditional Volatility		**Conditional Volatility**		**Conditional Volatility**		**Conditional Volatility**	
α	$3{,}82_{x10^{-06}}$	0,83	$1{,}03_{x10^{-05}}$	2,21	$1{,}41_{x10^{-06}}$	5,57	$3{,}84_{x10^{-06}}$	0,76
	$4{,}58_{x10^{-06}}$	(0,40)	$4{,}69_{x10^{-06}}$	(0,03)**	$2{,}53_{x10^{-06}}$	(0,00)***	$5{,}04_{x10^{-06}}$	(0,45)
γ	0,0631	1,92	0,0277	1,35	0,0472	15,86	0,1646	1,69
	0,0329	(0,05)**	*0,0205*	(0,18)	*0,0030*	(0,00)***	*0,0973*	(0,09)*
β	0,9033	13,05	0,8454	34,80	0,9378	208,91	0,8212	8,33
	0,0692	(0,00)***	*0,0272*	(0,00)***	*0,0045*	(0,00)***	*0,0986*	(0,00)***

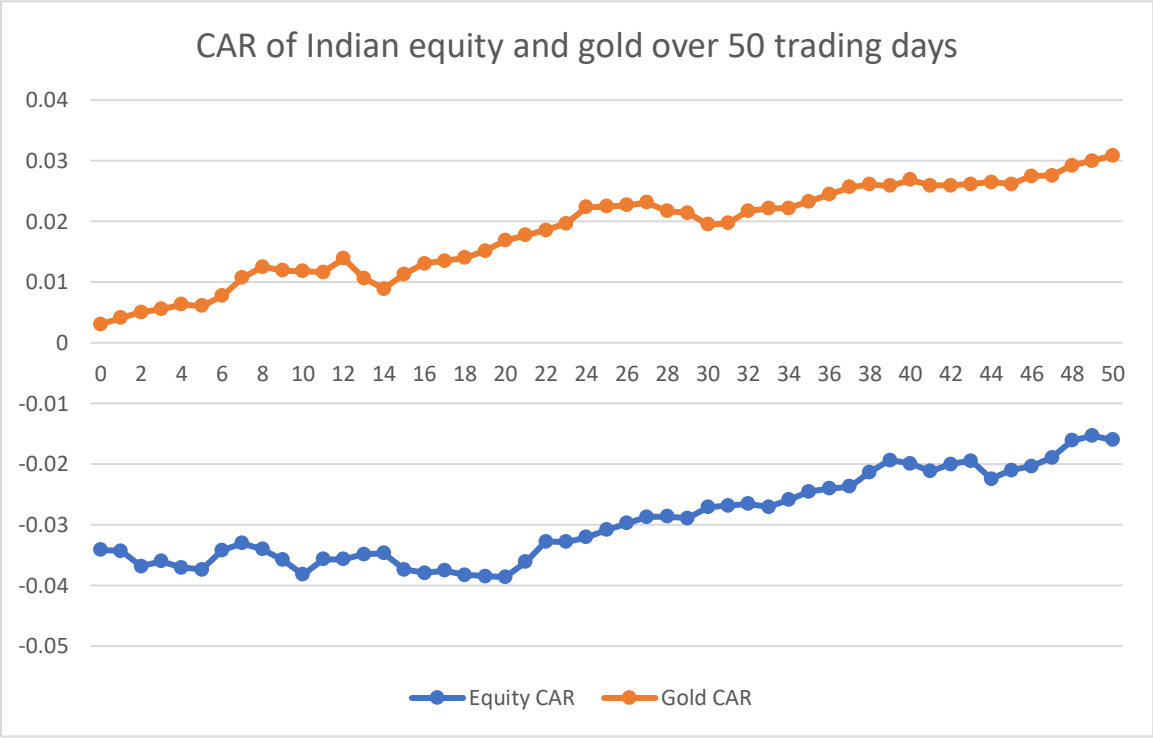
*Note: *** indicates statistical significance at 1%, ** statistical significance at 5%, * statistical significance at 10%, values in italics are the standard errors, values in parenthesis are p-values, $b_{2\ (5\%)}$, $b_{2\ (2.5\%)}$ and $b_{2\ (1\%)}$ are the coefficient estimates for the lower quantiles 5% to 1% of the equity return series, $c_{2\ (5\%)}$, $c_{2\ (2.5\%)}$ and $c_{2\ (1\%)}$ are the coefficient estimates for the lower quantiles 5% to 1% of the bond return series.*

4.3.4 India portfolio analysis

This section analyses the average cumulated returns for a portfolio that consists of gold and stocks for the period spanning 50 trading days after the occurrence of an extreme negative stock return in the Indian equity market. This allows the study to demonstrate the practical implications of the findings in the previous section and display the evolution of the stocks and gold returns through time in India.

Figure 6 below shows the cumulative average equity and gold returns (CAR) after and extreme negative shock in the Indian equity market. The extreme negative shock is defined as the fifth percentile of returns for the full sample.

Figure 6: Cumulative average returns for Indian equity and gold returns



From Figure 6 above, it can be noted that the return for gold is positive on all 50 days following an extreme negative shock in the Indian equity market. Additionally, the CAR for Indian equities decreases until day 20 where thereafter the CAR increase but still remains negative over the 50 trading days. The CAR for gold do not reach zero implying that the safe haven effect is not eliminated within 50 trading days of an extreme negative shock.

4.3.4.1 India minimum variance portfolio results

To further evaluate the practical implications of gold as a safe haven and a hedge for Indian equity and bond markets, the asset weightings were calculated for the two minimum variance portfolios containing gold, the Indian equity and bond index, and the second portfolio omitting the Indian bond index. This section aims to determine the optimum weightings for each asset class over the entire sample period, the 2008 – 2009 global financial crisis as well as the first 6 months of 2020. Table 14 below reports the minimum variance portfolio results.

Table 14: India minimum variance portfolio results

	Full Sample Period	**2008 – 2009**	**2020**
Gold (weighting)	0.0473	0.0623	0.0030
India Equity (weighting)	0.0142	0.0106	0.0060
India Bonds (weighting)	0.9385	0.9271	0.9910
Annualised Std. Dev.	4.15%	6.83%	3.05%

	Full Sample Period	**2008 – 2009**	**2020**
Gold (weighting)	0.5941	0.6695	0.7670
India Equity (weighting)	0.4059	0.3305	0.2330
Annualised Std. Dev.	15.72%	24.59%	20.72%

Inspection of the results in Table 14 above shows that holding large portions of Indian bonds will provide much lower standard deviation opposed to not including bonds in your portfolio. This is as a result of diversification benefits. Inspection of portfolio 1 in Table 14 reveals that gold is held with a larger weight than equities. This implies that gold provides better risk adjusted returns compared to Indian equities. Furthermore, in portfolio 2, the removal of Indian bonds allows for a higher weight to be held in gold. This increases the standard deviation of the portfolio, but also shows that during times of extreme market stress, increasing the weight of gold will minimise the effects of falling stock market prices.

4.4 China Analysis

The data employed for the analysis of the characteristics of gold in China include daily price data from Shanghai Composite index (a proxy for the Chinese equity market), S&P Chinese Government bond index (a proxy for the Chinese bond market) and US spot closing gold price converted to Chinese Yuan (CNY). The data covers the shortest period beginning 2 March 2009 and ending 30 June 2020.

4.4.1 China descriptive statistics

Table 15: China descriptive statistics

	Gold	China Equity Index	China Bond Index
Mean(%)	0,0232	0,0120	0,0139
Standard Deviation	0,0097	0,0136	0,0014
Kurtosis	9,0032	9,1516	10,6040
Skewness	-0,5551	-0,9218	-0,1938
Minimum	-0,0959	-0,0887	-0,0108
Maximum	0,0520	0,0594	0,0082
Observations	2956	2956	2956

Figure 7 below shows the daily prices of the Chinese bond index, Chinese equity index and the gold prices in CNY for the respective time period. There is an overall upward trend for the first graph, with few periods of small declining prices. The second graph, showing the Chinese equity prices is more volatile and no definitive pattern can be identified. The third graph displays similar behaviour to the Chinese equities graph. However, all three graphs do end with higher prices than what they started with. Visual inspection of the bottom two graphs indicate that Chinese stocks have an inverse relationship with gold. As the gold price increases in first third of the period, equity prices are declining, and the opposite is true for the next third. Table 15 above displays the descriptive statistics for Chinese stocks, bonds and gold returns for Chinese investors. From Table 15, it is evident that gold has the highest daily mean return, nearly twice that of Chinese equities. However, despite gold's higher daily mean return, it has lower risk compared to Chinese equities, as measured by daily standard deviation. Furthermore, Chinese equities, bonds and daily gold return distributions all display negative skewness and are leptokurtic. Given these results, it is evident that gold relatively riskier than bonds which is out of character for safe haven assets. Thus,

gold and bonds are not interchangeable, however, gold still may provide safe haven benefits during times of extreme market stress.

Figure 7: Line graph representation of China price data

4.4.2 China tests results

Table 16 below represents the regression results for equations (1) and (2). The principal regression model given by (1) uses contemporaneous returns. However, in the case that lagged returns increase the statistical significance of the variables, the regression will be re-run. The Akaike and Schwarz information criteria was used to determine the optimal lag length. Table 16 indicates that the aforementioned information criteria selected no lags for China. This means that contemporaneous returns are sufficient for this model.

The coefficient estimates for b_1 represent the average effect of Chinese stocks on gold. This coefficient estimate for the contemporaneous return is positive and not statistically significant. The positive sign of the coefficient indicates that gold is not a hedge for Chinese equities on average. Inspection of the coefficient estimate of c_1 reveals a nonpositive value, (-0,1584). This implies that gold is a hedge for Chinese bonds, however, the result is not statistically significant. The only nonpositive and statistically significant coefficient estimate is $b_{2\ (2,5\%)}$ at the 5% level of significance. This result implies that gold is a hedge for Chinese stocks during extreme market stress at the 2,5% quantile.

Further inspection of Table 16 reveals that the safe haven characteristic of gold is not applicable to Chinese bonds as the summation of the coefficient estimates result in all nonpositive estimates. The safe haven variables are positive for Chinese stocks at the lower two percentile levels. This result implies that gold does act as a safe haven asset for Chinese equity investors. However, this is only true for the second percentile, as this result is statistically significant.

To summarise the results for Chinese equity and bond markets, it can be noted that gold is not a hedge for Chinese equities and bonds. These results are replicated for the safe haven hypothesis, where bonds were all positive, thus signalling that bonds and gold move in the same direction during times of market stress. Furthermore, gold is seen to act as a safe haven for Chinese equities when the market experiences extreme market stress at the 2,5% quantile.

Table 16: China econometric results

(1): $r_{gold,t} = a + b_1 r_{stock,t} + b_2 r_{stock,t(q)} + c_1 r_{bond,t} + c_2 r_{bond,t(q)} + e_t$
(2): $h_t = \alpha e_{t-1}^2 + \gamma e_{t-1}^2 D(e_{t-1} < 0) + \beta h_{t-1}$

China (CNY)					
Gold	**Coef. Est.**	**Std. Err.**	**t-stat**	**p-value**	**Sum Coeff.**
b_1	0,0214	0,0207	1,0326	0,3019	
$b_{2\ (5\%)}$	0,0851	0,0537	1,5845	0,1132	0,1065
$b_{2\ (2,5\%)}$	-0,1654	0,0718	-2,3043	0,0213**	-0,0589
$b_{2\ (1\%)}$	0,0544	0,0613	0,8884	0,3744	-0,0045
c_1	-0,1584	0,1839	-0,8611	0,3893	
$c_{2\ (5\%)}$	0,7084	0,5060	1,4000	0,1616	0,55
$c_{2\ (2,5\%)}$	-0,2338	0,6378	-0,3666	0,7139	0,3162
$c_{2\ (1\%)}$	0,2680	0,5685	0,4714	0,6374	0,5842
Conditional Volatility					
α	$8{,}96_{x10^{-07}}$	$1{,}86_{x10^{-07}}$	4,8258	0,0000***	
γ	0,0547	0,0028	19,4750	0,0000***	
β	0,9370	0,0036	256,8403	0,0000***	

*Note: *** indicates statistical significance at 1%, ** statistical significance at 5%, * statistical significance at 10%. Coef. Est. stands for coefficient estimate, Std. Err. stands for standard error, Sum Coef. is the cumulative coefficient estimates showing the safe haven variable,* $b_{2\ (5\%)}$, $b_{2\ (2.5\%)}$ *and* $b_{2\ (1\%)}$ *are the coefficient estimates for the lower quantiles 5% to 1% of the equity return series,* $c_{2\ (5\%)}$, $c_{2\ (2.5\%)}$ *and* $c_{2\ (1\%)}$ *are the coefficient estimates for the lower quantiles 5% to 1% of the bond return series.*

4.4.3 China subsample analysis

This section will examine if the results based on the full sample period are also valid in subsamples. Inspection of Figure 7 revealed four bull markets and three bear markets over the full sample period for China. Table 17 below outlines all bull and bear markets, and reports their results.

Inspection of Tale 17 reveals that gold is not a hedge on average for Chinese equities in any bull and bear market. The only statistically significant result is in the first bear market, and the coefficient estimate is (0,0684). This result is positive, and does not indicate gold as a hedge for Chinese equities in that bear market. Gold was however found to be a hedge for Chinese bonds in the first bear market with a coefficient estimate of (-0,7036) but only at the 10% level of significance. Furthermore, the save haven property of gold is identified in the last three bull markets for Chinese equities. However, these results are not statistically significant. Furthermore, gold is only found to be a safe haven asset for Chinese bonds in the second bear market, and is the only statistically significant result from the subsample analysis.

Table 17: China subsample estimation results

China Subsample Analysis

	Bull Market (2/03/2009 – 4/08/2009)		**Bear Market (4/08/2009 – 21/06/2013)**		**Bull Market (21/06/2013 – 12/06/2015)**		**Bear Market (12/06/2015 – 28/01/2016)**		**Bull Market (28/01/2016 – 25/01/2018)**		**Bear Market (25/01/2018 – 3/01/2019)**		**Bull Market (3/01/2019 – 30/06/2020)**	
Gold	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**
b_1	0,0731	0,82	0,0684	2,02	0,0085	0,19	-0,0180	-0,61	0,0075	0,14	0,0244	0,73	-0,0336	-0,63
	0,0809	(0,41)	*0,0339*	(0,04)**	*0,0439*	(0,85)	*0,0296*	(0,54)	*0,0541*	(0,89)	*0,0333*	(0,46)	*0,0532*	(0,53)
$b_{2\ (5\%)}$	0,0101	0,04	0,1975	2,13	-0,0449	-0,28	-0,1735	-2,53	-0,2880	-1,74	-0,0812	-0,91	-0,0044	-0,03
	0,2657	(0,97)	*0,0929*	(0,03)**	*0,1607*	(0,77)	*0,0687*	(0,01)***	*0,1659*	(0,08)*	*0,0896*	(0,37)	*0,1637*	(0,98)
$b_{2\ (2,5\%)}$	-0,0878	-0,22	-0,3640	-2,98	0,0400	0,19	0,2421	2,82	0,2217	1,12	0,0629	0,58	0,1577	0,82
	0,3918	(0,82)	*0,1222*	(0,00)***	*0,2100*	(0,85)	*0,0858*	(0,01)***	*0,1978*	(0,26)	*0,1085*	(0,56)	*0,1930*	(0,41)
$b_{2\ (1\%)}$	0,1552	0,40	0,1886	1,69	-0,0572	-0,35	-0,0257	-0,23	-0,0529	-0,35	-0,1825	-1,77	-0,2257	-1,53
	0,3883	(0,69)	*0,1119*	(0,09)*	*0,1650*	(0,73)	*-0,1128*	(0,82)	*0,1534*	(0,73)	*0,1033*	(0,08)*	*0,1472*	(0,13)
c_1	0,7820	0,81	-0,7036	-1,87	0,0549	0,16	0,4958	0,79	0,3477	0,86	0,1093	0,41	0,0201	0,05
	0,9712	(0,42)	*0,3766*	(0,06)*	*0,3537*	(0,88)	*0,6258*	(0,43)	*0,4041*	(0,39)	*0,2652*	(0,68)	*0,3960*	(0,96)
$c_{2\ (5\%)}$	-1,9572	-1,01	-0,3555	-0,31	-0,0281	-0,02	1,2046	0,47	-0,1330	-0,13	-0,3682	-0,39	1,5543	1,23
	1,8932	(0,30)	*1,1422*	(0,76)	*1,1821*	(0,98)	*2,5494*	(0,64)	*1,0415*	(0,89)	*0,9416*	(0,70)	*1,2616*	(0,22)
$c_{2\ (2,5\%)}$	1,5580	0,68	1,1168	0,81	0,0268	0,02	-7,4526	-2,49	1,5162	1,16	-0,4372	-0,35	-0,2398	-0,15
	2,3052	(0,50)	*1,3720*	(0,42)	*1,5215*	(0,98)	*2,9912*	(0,01)***	*1,3023*	(0,24)	*1,2499*	(0,73)	*1,6531*	(0,88)
$c_{2\ (1\%)}$	-0,4092	-0,18	0,7550	0,74	0,5761	0,41	4,8063	1,93	-1,1921	-1,04	0,7484	0,62	0,7799	0,43
	2,2314	(0,85)	*1,0243*	(0,46)	*1,4034*	(0,68)	*2,2488*	(0,06)*	*1,1414*	(0,30)	*1,2154*	(0,54)	*1,8080*	(0,67)
	Conditional Volatility		**Conditional Volatility**		**Conditional Volatility**		**Conditional Volatility**		**Conditional Volatility**		**Conditional Volatility**		**Conditional Volatility**	
α	$5{,}61_{x10^{-06}}$	1,65	$8{,}26_{x10^{-06}}$	4,28	$4{,}64_{x10^{-06}}$	2,05	$6{,}17_{x10^{-06}}$	2,55	$2{,}57_{x10^{-07}}$	2,27	$4{,}67_{x10^{-06}}$	1,04	$3{,}44_{x10^{-06}}$	2,05
	$3{,}40_{x10^{-06}}$	(0,10)*	*$1{,}93_{x10^{-06}}$*	(0,00)***	*$2{,}26_{x10^{-06}}$*	(0,04)**	*$2{,}42_{x10^{-06}}$*	(0,01)***	*$1{,}13_{x10^{-07}}$*	(0,02)**	*$4{,}48_{x10^{-06}}$*	(0,30)	*$1{,}68_{x10^{-06}}$*	(0,04)**
γ	-0,1316	-3,31	0,0952	8,97	0,0471	2,71	-0,0765	-3,61	-0,0186	-3,02	0,0825	1,15	0,1301	3,59
	0,0397	(0,00)***	*0,0106*	(0,00)***	*0,0174*	(0,01)***	*0,0212*	(0,00)***	*0,0062*	(0,00)***	*0,0716*	(0,25)	*0,0362*	(0,00)***
β	1.0833	18,08	0,8394	37,61	0,9031	24,62	0,9905	40,60	1,010	129,17	0,7061	2,76	0,8277	15,98
	0,0599	(0,00)***	*0,0223*	(0,00)***	*0,0367*	(0,00)***	*0,0244*	(0,00)***	*0,0078*	(0,00)***	*0,2562*	(0,01)***	*0,0518*	(0,00)***

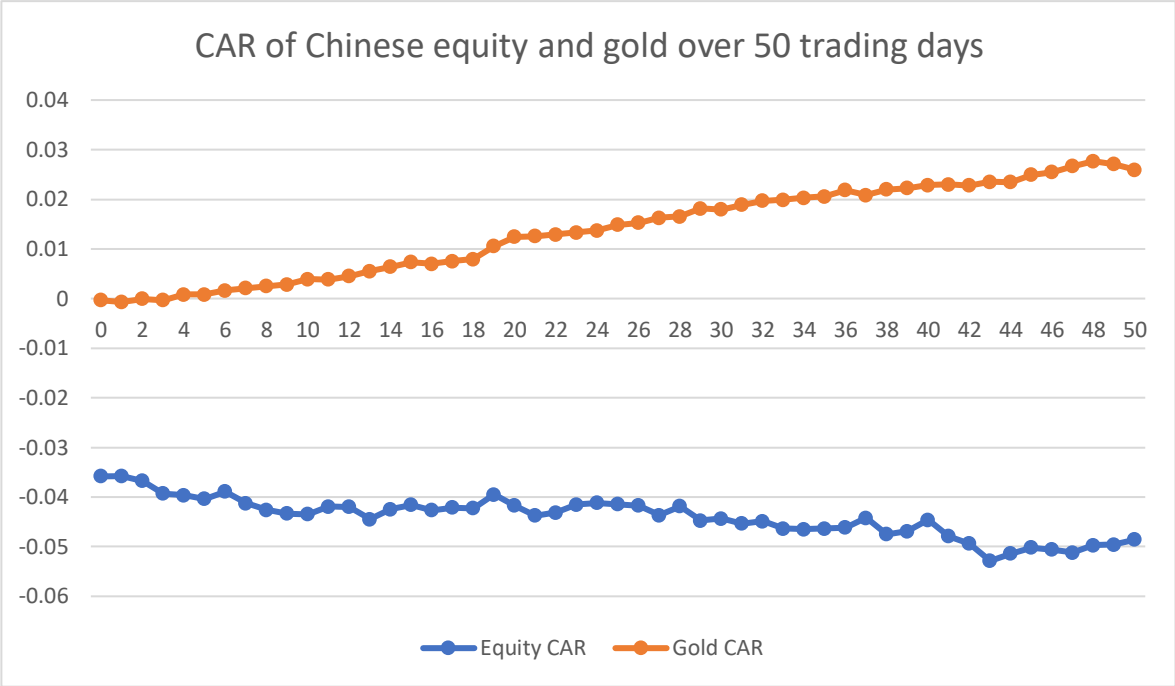
*Note: *** indicates statistical significance at 1%, ** statistical significance at 5%, * statistical significance at 10%, values in italics are the standard errors, values in parenthesis are p-values, $b_{2\ (5\%)}$, $b_{2\ (2.5\%)}$ and $b_{2\ (1\%)}$ are the coefficient estimates for the lower quantiles 5% to 1% of the equity return series, $c_{2\ (5\%)}$, $c_{2\ (2.5\%)}$ and $c_{2\ (1\%)}$ are the coefficient estimates for the lower quantiles 5% to 1% of the bond return series.*

4.4.4 China portfolio analysis

This section analyses the average cumulated returns for a portfolio that consists of gold and stocks for the period spanning 50 trading days after the occurrence of an extreme negative shock in the Chinese equity market. This will allow the study to demonstrate the practical implications of the findings in the previous section and display the evolution of stocks and gold returns through time.

Figure 8 below shows the cumulative average equity and gold returns (CAR) after an extreme negative shock in the Chinese stock market. The extreme negative shock is defined as the fifth percentile of returns for the full sample.

Figure 8: Cumulative average returns for Chinese equity and gold returns



Inspection of Figure 8 above shows that the return of gold is slightly positive on the day of the extreme negative shock and becomes slightly negative on one day after the shock. This implies that the safe haven effect of gold is eliminated after one trading day. These results differ to Brazil, Russia and India analysed in the previous sections. The CAR of Chinese equities become more negative over 50 trading days, while the CAR for gold increase from the 4th trading day. This shows that gold is a hedge for Chinese equities.

4.4.4.1 China minimum variance portfolio

To further evaluate the practical implications of gold as a safe haven and a hedge for Chinese equity and bond markets, the asset weightings were calculated for the two minimum variance portfolios containing gold, the Chinese equity and bond index and the second portfolio omitting the Chinese bond index. This section aims to determine the optimum weightings for each asset class over the entire sample period and the first 6 months of 2020. The 2008 – 2009 global financial crisis period will not be examined due to data availability only being from March 2009.

Table 18: China minimum variance portfolio results

Portfolio 1	**Full Sample Period**	**2020**
Gold (weighting)	0.0172	0.0013
China Equity (weighting)	0.0118	0.0478
China Bonds (weighting)	0.9710	0.9509
Annualised Std. Dev.	2.56%	2.98%

Portfolio 2	**Full Sample Period**	**2020**
Gold (weighting)	0.6648	0.5503
China Equity (weighting)	0.3352	0.4497
Annualised Std. Dev.	15.24%	17.66%

Looking at the results in Table 18 above shows that holding large portions of Chinese bonds will provide a much lower standard deviation as opposed to not including bonds in your portfolio. Inspection of portfolio 1 in Table 18 reveals that in 2020 Chinese investors should decrease their holdings in gold and increase their holdings in equities. This is the opposite result to the countries discussed previously, and can be attributed to the fact that China experienced rising stock market during the first half of 2020, whereas the other countries were impacted heavily by the Corona Virus pandemic. Inspection of portfolio 2 however, shows a larger weighting of gold in both the full period and in 2020, implying that gold provides better risk adjusted returns compared to Chinese equities. Furthermore, as in portfolio 1, gold weighting is decreased in 2020 and Chinese equities are held with a higher portion, showing that Chinese equities performed better in 2020 than the other BRICS countries.

4.5 South Africa Analysis

The data employed for the analysis of the characteristics of gold in South Africa include daily price data from ALSI (a proxy for the South African equity market), ALBI (a proxy for the South African bond market) and US spot closing gold price converted into South African Rand (ZAR). The data covers the period beginning 25 November 2004 and ending 30 June 2020.

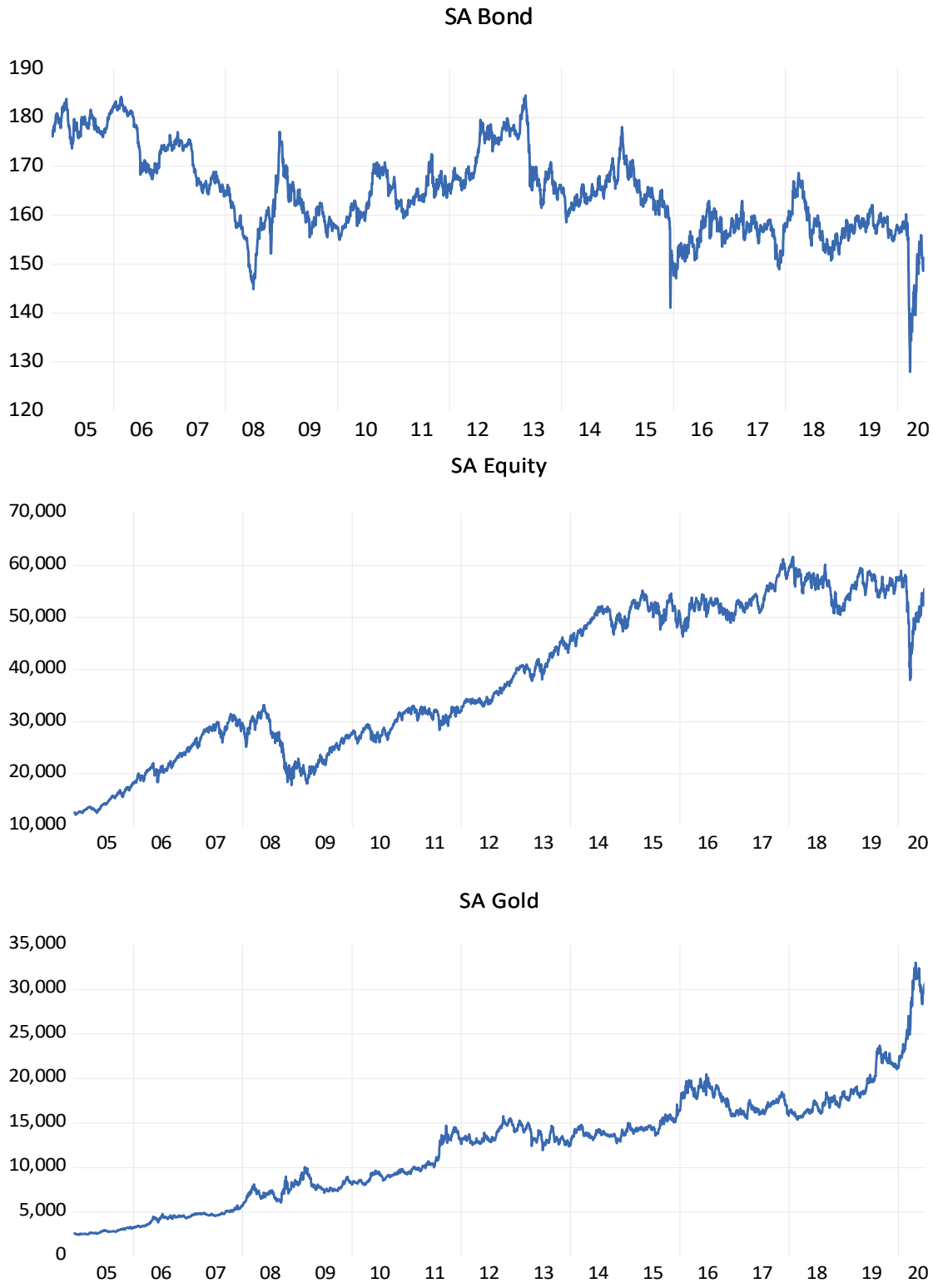
4.5.1 South Africa descriptive statistics

Figure 9 below shows the daily prices of the South African bond index, South African equity index and gold prices in ZAR for the respective time period. There is an overall upward trend for graphs two and three, with prices lower at the beginning of the period and higher at the end. The bond graph however, is the only graph to have prices lower at the end of the period. There is no definitive pattern in relation to the bond graph, with multiple periods of positive and negative spikes. Inspection of graphs two and three, reveal an inverse relationship between gold and South African equities, where there are declining equity prices in the period of 2008 to 2009 while gold prices increase. This relationship is further identified in 2020.

Table 19 preceding Figure 9, represents the descriptive statistics for South African stocks, bonds and the gold returns for South African investors. Inspection of the results for the table below reveal that gold has the highest daily mean return, nearly two times that of South African equities. Additionally, South African bonds show a negative mean daily return, which is expected for the sample period due to the decreasing prices shown in Figure 9. Inspection of the standard deviations indicate that daily gold returns for South African investors is more risky than South African equities and bonds. The return distribution for South African shares and bonds both display negative skewness and all distributions display leptokurtosis. The negative skewness and leptokurtosis of South African equity and bond return distributions indicate the series returns have fat left tails. This means that there are more negative returns indicating large losses and higher risk. Golds return distribution tells a different story, while leptokurtic, the return distribution displays positive skewness indicating positive returns while still displaying higher than normal risk. the fact that the gold return distribution for South Africa has

high risk but still displays positive returns through the positive skewness is indicative of the fact that gold is a hedge or a possible safe haven for stocks and bonds.

Figure 9: Line graph representation of South Africa price data



Observation of the minimum and maximum values indicate the largest positive return for gold is expectedly higher than South African bonds, bit also higher than South African equities. This observation combined with a large negative minimum return is representative of the high levels of riskiness that gold displays. This is consistent with the other BRICS countries results, which all show that golds level of high riskiness as an individual asset are an uncommon characteristic of safe haven assets.

Table 19: Descriptive statistics for South African price data

	Gold	**SA Equity Index**	**SA Bond Index**
Mean(%)	0,0602	0,0363	-0,0039
Standard Deviation	0,0134	0,0121	0,0048
Kurtosis	13,9488	9,1129	28,9600
Skewness	0,5680	-0,4126	-1,3011
Minimum	-0,1005	-0,1023	-0,0754
Maximum	0,1674	0,0726	0,0456
Observations	4068	4068	4068

4.5.2 South Africa tests results

Table 20 presents the regression results for equations (1) and (2). The principal regression model given by (1) uses contemporaneous daily returns. However, in the case that lagged returns increase the statistical significance of the variables, the regression will be re-run. The Akaike and Schwarz information criteria are used to determine the optimal lag length and GARCH model specification. Table 20 indicates that the aforementioned information criteria selected no lags for South Africa. This implies that contemporaneous returns are sufficient for the model.

The coefficient estimate for b_1 represents the average effect of South African stocks on gold. This coefficient estimate for the contemporaneous return is (0,0602). The positive sign of the coefficient implies that gold is not a hedge on average for South African equities. However, this estimate is not statistically significant. Furthermore, the coefficient estimate c_1 represents the effect of South African bonds on gold. The contemporaneous return for bonds coefficient estimate is (-0,7120) and it is highly statistically significant at the 1% level of significance. This result implies that gold is a hedge for South African bonds.

Inspection of the last column in Table 20 reveals the safe haven variable of gold. The safe haven variables for South African equities are negative for the 2,5 and 1 percent quantiles. This negative result indicates that gold is a safe haven for South African equities where the market experiences returns in 2,5% quantile and lower. However these results are not statistically significant. Similar conclusions can be made for gold as a safe haven for South African bonds, where the coefficients are negative at all levels, however they too are not statistically significant.

Table 20: South Africa estimation results

(1): $r_{gold,t} = a + b_1 r_{stock,t} + b_2 r_{stock,t(q)} + c_1 r_{bond,t} + c_2 r_{bond,t(q)} + e_t$
(2): $h_t = \alpha e_{t-1}^2 + \gamma e_{t-1}^2 D(e_{t-1} < 0) + \beta h_{t-1}$

South Africa (ZAR)					
Gold	**Coef. Est.**	**Std. Err.**	**t-stat**	**p-value**	**Sum Coef.**
b_1	0,0206	0,0301	0,6853	0,4932	
$b_{2\ (5\%)}$	0,0105	0,0917	0,1140	0,9092	0,0311
$b_{2\ (2,5\%)}$	-0,1202	0,1314	-0,9015	0,3603	-0,0891
$b_{2\ (1\%)}$	-0,1189	0,2167	-0,5487	0,5833	-0,2080
c_1	-0,7120	0,0635	-11,2129	0,0000***	
$c_{2\ (5\%)}$	0,3680	0,2286	1,6096	0,1076	-0,3440
$c_{2\ (2,5\%)}$	-0,0719	0,3178	-0,2264	0,8209	-0,4159
$c_{2\ (1\%)}$	0,1639	0,3098	0,5293	0,5967	-0,2520
Conditional Volatility					
α	$3{,}49_{x10^{-06}}$	$5{,}43_{x10^{-07}}$	6,4282	0,0000***	
γ	0,0837	0,0055	15,3540	0,0000***	
β	0,8954	0,0080	112,3948	0,0000***	

*Note: *** indicates statistical significance at 1%, ** statistical significance at 5%, * statistical significance at 10%. Coef. Est. stands for coefficient estimate, Std. Err. stands for standard error, Sum Coef. is the cumulative coefficient estimates showing the safe haven variable, $b_{2\ (5\%)}$, $b_{2\ (2.5\%)}$ and $b_{2\ (1\%)}$ are the coefficient estimates for the lower quantiles 5% to 1% of the equity return series, $c_{2\ (5\%)}$, $c_{2\ (2.5\%)}$ and $c_{2\ (1\%)}$ are the coefficient estimates for the lower quantiles 5% to 1% of the bond return series.*

To summarise the results of Table 20 above, it can be noted that gold is not a hedge for South African equities on average. However, gold was found to be a hedge for South African bonds. Additionally, gold was not found to be a safe haven for either South African return distribution. Lastly, according to Akaike and Schwarz information criteria, contemporaneous return distributions are sufficient for this model.

4.5.3 South Africa subsample analysis

This section the study will examine if the results based on the full sample period are also valid in subsamples. Inspection of the equity graph in Figure 9 reveals two bull markets and two bear markets over the full sample period for South Africa. The results of the regressions run on the subsamples can be found in Table 21 below.

Inspection of Table 21 reveals that gold is not a hedge for South African equities in either of the bull and bear markets. The only statistically significant result for the b_1 coefficient estimate is in the first bull market and it is (0,1874), indicating that gold is not a hedge for South African equities in that bull market. The coefficient estimates for c_1 are negative for all bull and bear markets. This implies that gold is a hedge for South African bonds in both bull and bear markets. However, this result is only statistically significant for the two bull markets, and the last bear market. It is worth noting that the last bear period does not include the 1% quantile return distributions for South African equities and bonds due to the model resulting in multicollinearity with them included for that bear period. Nonetheless, gold is found to be a hedge for South African bonds in the 2,5% quantile return distribution.

The safe haven property of gold is identified for South African equities in the first bear market and the second bull market. However, these results are not statistically significant. However, statistical significance results are observed in both bull markets where gold acts as a safe haven asset for South African bonds, as well as the last bear market.

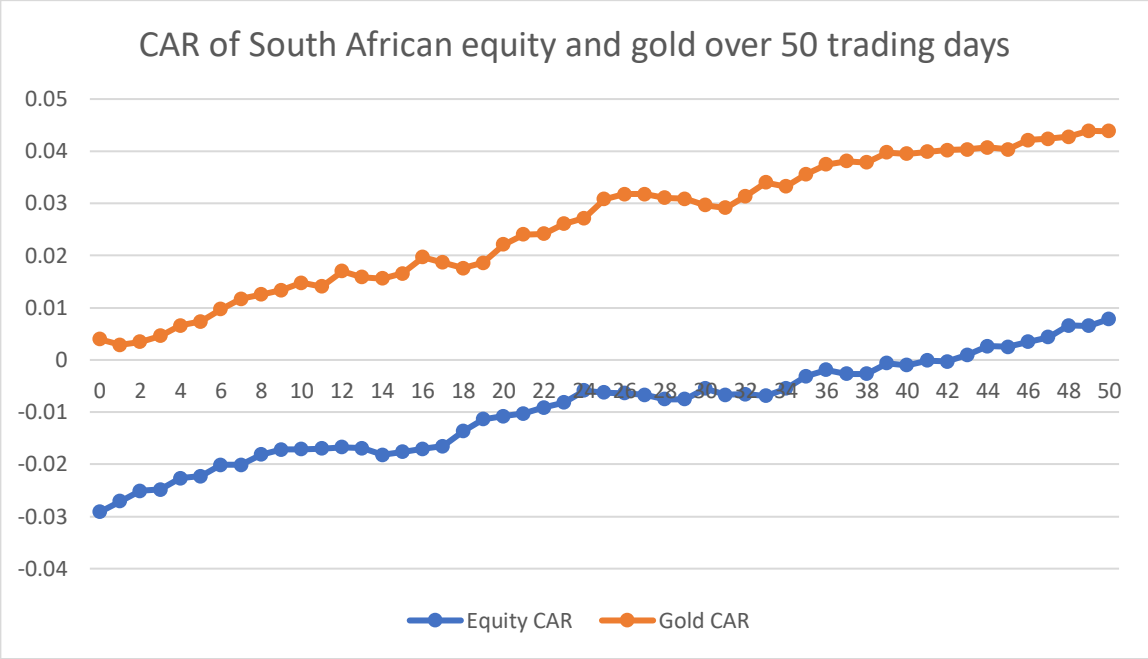
4.5.4 South Africa portfolio analysis

This section will analyse the average cumulated returns for a portfolio that consists of gold and stocks for the period spanning 50 trading days after the occurrence of an extreme negative stock return. This will allow the study to demonstrate the practical implications of the findings in the previous section and display the evolution of stocks and gold returns through time.

Figure 10 shows the cumulative average equity and gold return (CAR) after an extreme negative shock in the South African equity market. The extreme negative shock is defined as the fifth percentile of returns for the full sample.

From Figure 10 it can be noted that the return for gold is positive on all 50 trading days following an extreme negative shock in the South African equity market. The CAR for gold does approach zero one day after the extreme shock, but then increases upward for the rest of the time period. This in itself implies that the safe haven effect of gold is not eliminated over 50 trading days. The South African equity CARs increase after the negative shock and become positive 41 days later.

Figure 10: Cumulative average returns for South African equity and gold returns



4.5.4.1 South Africa minimum variance portfolio

To further evaluate the practical implications of gold as a safe haven and a hedge for South African equity and bond markets, the asset weightings were calculated for the two minimum variance portfolios containing gold, the South African equity and bond index, while the second portfolio omits the South African bond index. This section aims to determine the optimum weightings for each asset class over the entire sample period, the 2008 – 2009 global financial crisis as well as the first 6 months of 2020.

Table 21: South Africa subsample estimation results

South Africa Subsample Analysis								
	Bull Market (25/11/2004 – 22/05/2008)		**Bear Market (22/05/2008 – 10/03/2009)**		**Bull Market (10/03/2009 – 17/01/2020)**		**Bear Market (17/01/2020 – 30/06/2020)**	
Gold	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**	**Coef. Est.**	**t-stat**
b_1	0,1874	4,57	-0,0088	-0,10	-0,0136	-0,51	0,0593	0,71
	0,0410	(0,00)***	*0,0844*	(0,92)	*0,0268*	(0,61)	*0,0830*	(0,48)
$b_{2\ (5\%)}$	0,0413	0,33	-0,3664	-1,32	-0,1785	-2,20	-0,2658	-1,17
	0,1237	(0,74)	*0,2776*	(0,19)	*0,0810*	(0,03)**	*0,2268*	(0,24)
$b_{2\ (2,5\%)}$	-0,1898	-1,19	-0,4733	-1,29	0,0827	0,78	0,3938	2,08
	0,1592	(0,23)	*0,3665*	(0,20)	*0,1062*	(0,44)	*0,1892*	(0,04)**
$b_{2\ (1\%)}$	0,3893	2,70	-0,7478	-2,16	-0,2281	-2,22		
	0,1441	(0,01)***	*0,3461*	(0,03)**	*0,1028*	(0,03)**		
c_1	-0,9625	-5,94	-0,4221	-1,15	-0,7215	-12,13	-0,5796	-3,51
	0,1621	(0,00)***	*0,3678*	(0,25)	*0,0595*	(0,00)***	*0,1650*	(0,00)***
$c_{2\ (5\%)}$	-0,8570	-1,74	-1,8036	-1,73	0,3404	1,83	0,7237	1,33
	0,4914	(0,08)*	*1,0407*	(0,08)*	*0,1861*	(0,07)*	*0,5448*	(0,19)
$c_{2\ (2,5\%)}$	1,9308	2,88	2,9037	2,08	0,2568	1,06	-0,8538	-2,05
	0,6711	(0,00)***	*1,3932*	(0,04)**	*0,2424*	(0,29)	*0,4155*	(0,04)**
$c_{2\ (1\%)}$	-0,7718	-1,18	1,1334	0,84	-0,4571	-2,35		
	0,6535	(0,24)	*1,3524*	(0,40)	*0,1946*	(0,02)**		
	Conditional Volatility		**Conditional Volatility**		**Conditional Volatility**		**Conditional Volatility**	
α	$1{,}70_{x10^{-06}}$	1,92	$3{,}81_{x10^{-05}}$	1,66	$6{,}12_{x10^{-06}}$	6,13	$2{,}60_{x10^{-05}}$	0,93
	$8{,}88_{x10^{-07}}$	(0,06)*	$2{,}30_{x10^{-05}}$	(0,10)*	$9{,}99_{x10^{-07}}$	(0,00)***	$2{,}81_{x10^{-05}}$	(0,35)
γ	0,0537	3,61	0,1795	2,64	0,0810	11,67	0,0588	0,80
	0,0149	(0,00)***	*0,0680*	(0,01)***	*0,0069*	(0,00)***	*0,0733*	(0,42)
β	0,9355	50,26	0,7628	9,62	0,8709	67,06	0,8364	5,02
	0,0186	(0,00)***	*0,0793*	(0,00)***	*0,0130*	(0,00)***	*0,1666*	(0,00)***

*Note: *** indicates statistical significance at 1%, ** statistical significance at 5%, * statistical significance at 10%, values in italics are the standard errors, values in parenthesis are p-values, $b_{2\ (5\%)}$, $b_{2\ (2.5\%)}$ and $b_{2\ (1\%)}$ are the coefficient estimates for the lower quantiles 5% to 1% of the equity return series, $c_{2\ (5\%)}$, $c_{2\ (2.5\%)}$ and $c_{2\ (1\%)}$ are the coefficient estimates for the lower quantiles 5% to 1% of the bond return series.*

Table 22: South Africa minimum variance portfolio results

Portfolio 1	**Full Sample Period**	**2008 – 2009**	**2020**
Gold (weighting)	0.1570	0.0631	0.3724
South Africa Equity (weighting)	0.0575	0.0189	0.0000
South Africa Bonds (weighting)	0.7855	0.9180	0.6276
Annualised Std. Dev.	7.87%	8.34%	15.25%

Portfolio 2	**Full Sample Period**	**2008 – 2009**	**2020**
Gold (weighting)	0.4508	0.4596	0.6622
South Africa Equity (weighting)	0.5492	0.5404	0.3378
Annualised Std. Dev.	16.59%	24.93%	24.69%

Table 22 above reports the minimum variance portfolio results for South Africa. Looking at the results above reveals that holding a large portion of South African bonds will provide a lower standard deviation, as opposed to not including bonds in your portfolio (Portfolio 2). Inspection of portfolio 1 reveals that for the full sample period there is a much larger weight allocated to gold opposed to equities. This observation can be noted for the two periods (2008 – 2009 and 2020). This observation implies that South African investors holding gold in a three asset portfolio, will have better risk adjusted returns by holing higher portions of gold than South African equities. Furthermore, inspection of the 2020 column shows that South African investors would benefit more from holding 0% in South African equities and a substantial portion in gold. This is due to the large decline in equity prices during the first half of 2020 and a surging gold price that reached an all-time high. Inspection of portfolio reveals the same observation. However, for the full sample period, South African equities provide better risk adjusted returns, and hence a larger proportion is held in equities over gold.

4.6 Summary of Results

The findings from this study show that gold is a hedge on average for Brazil, Russia and India equity markets based on their contemporaneous return distributions. The findings for China reveal that gold is a hedge for Chinese equities when their equity market experiences returns lower than the 2,5% quantile. Contrary to the other BRICS countries, gold was not found to be a hedge for contemporaneous equity returns in South Africa. The safe haven effect of gold was only found to be applicable at the 1%

quantile for Chinese equity investors and the 2,5% quantile for Indian equity investors, while gold was found to not act as a safe haven asset for Brazil, Russia and South Africa equity investors. This result implies that investors in China and India will benefit by holding gold during extreme market stress of their equity markets, while gold will provide no benefit to investors in Brazil, Russia and South Africa when their respective equity markets experience extreme market stress.

Gold was found to be a hedge for Brazilian, Russian, Indian and South African bond markets, while gold was not found to be a hedge for Chinese bond markets, all of which were analysed with contemporaneous returns. This result implies that four of the five BRICS countries will benefit from holding gold for downward market movements in their respective bond markets. Chinese bond investors will not benefit from holding gold, as their bond market moves in the same direction as their gold price. This is to say that when gold price decreases so will the Chinese bond market, and they will move in the same direction when their prices increase too. Additionally, gold is not a safe haven for either of the BRICS countries bond markets. This result indicates that during extreme market stress, gold and BRICS bond markets move in the same direction.

Out of the five BRICS countries, lagged returns only improved the models for two countries. Brazil's model was improved using two lags while Russia's was improved using one lag. The results of their lagged returns show that gold is a hedge for both countries equity and bond markets, while the safe haven effect of gold is only applicable to Brazil's equity market. The safe haven effect for Brazils equity market after two lags implies that Brazilian investors that purchase gold, two days after an extreme negative shock in their equity market, will benefit from an increasing gold price.

The average cumulative returns for a portfolio consisting of gold and equities was examined for each of the BRICS countries. The results for all countries except China reveal that gold CARs remain positive for all 50 trading days following an extreme negative shock. This result implies that the safe haven effect of gold is not eliminated over the 50 trading days. The CAR results for China reveal that the safe haven effect

of gold for a portfolio consisting of gold and Chinese equities is eliminated 1 day after the extreme negative shock in the Chinese equity market. This result is consistent with Baur and Lucey (2010) and Seetharam and Bodington (2015), who found that the safe haven effect of gold is eliminated after 15 trading days in developed markets and 2 trading days in emerging markets.

The fact that gold is a hedge for BRICS equity and bond markets implies that the commodity will provide upside benefits when their equity and bond markets fall. This notion was further supported by the compilation of minimum variance portfolios for each country. The results show that by increasing the weight of gold in portfolios for Brazilian, Russian, Indian and South African investors during extreme market conditions can serve to minimise the effects of their respective falling equity prices. The minimum variance portfolio results for China showed a decrease in the weighting of gold during 2020, a period where their equity market prices increased. This result implies that when the opposite happens and their equity market declines, that an increase in the proportion of gold in their portfolio will provide relief to their falling equity market prices.

5 Conclusion

It is widely accepted that rational investors seek to minimise their losses, and given the volatility in BRICS markets it is important to source a suitable hedge or safe haven for these investors. This study examined whether the commodity gold could be considered a safe haven asset, a hedge or a diversifier for BRICS investors.

This paper finds that for contemporaneous return series, gold is a hedge on average for Brazilian, Russian and Indian equity markets, while gold is only a hedge for Chinese equities at the 2,5 percent quantile. Gold was found not to be a hedge for South African equities on average, the only one of the BRICS countries. These results imply that for BRICS investors, gold will provided positive benefits when their respective equity markets experience a decline in their price. The result for South African investors indicates that gold will not provide positive benefits when their equity market declines. Additionally, the model for Brazil and Russia was augmented with lagged returns and the results are consistent with their contemporaneous regression results.

The BRICS bond market was also examined against gold to see if the metal would be a safe haven, hedge or diversifier. The results of this study show that for contemporaneous return distributions, gold was found to be a hedge for Brazil, Russia, India and South African bond markets, whereas China was the only country where gold is not a hedge for their bond market. This result implies that when their bond markets are falling and the investors hold gold in their portfolio, that their losses will be minimised by the upward movement in the gold price. This however is not the case in China. The Brazilian and Russian models were augmented with lagged returns and their results are consistent with the contemporaneous regression results. This indicates that for Brazilian and Russian investors that added gold into their portfolio after their bond markets had fallen in price, gold would have still provided hedging benefits, and thus provided protection against their falling bond market.

The safe haven property of gold was not statistically and significantly found to be true in either of the BRICS countries for their contemporaneous equity and bond

distributions. These results imply that when the BRICS markets face extreme market turmoil, that gold will not provide any protection against their equity and bond markets.

This study further examined the evolution of gold and stocks after extreme negative shocks. The results from the plot of cumulative average returns of gold and stocks for each BRICS country show that the commodity experienced positive returns over all 50 trading days after an extreme negative shock in the respective countries' equity markets. This result implies that for a portfolio made up of gold and stocks in BRICS countries, that the safe haven effect of gold is not eliminated, should the metal be found to be a safe haven for that country. Furthermore, the safe haven effect of gold in China was eliminated just one day after the extreme negative shock, indicating the short-term safe haven effect gold has for a portfolio of gold and stocks in China. Additionally, minimum variance portfolios constructed for each BRICS country showed that in a two asset portfolio made up of gold and the respective countries equities, a large portion was held in gold, and during recessionary periods, the proportion held in gold was increased. This result shows the strength of gold to act as a hedge and a diversifier for BRICS investors, as the commodity provides upside benefits when each countries equity market is falling.

5.1 Areas for Future Research

Future areas of research around the characteristics of gold in BRICS markets could include analysing the effect of exchange rate effects on BRICS markets, which could lead to much higher gold prices, making it difficult for emerging markets to purchase large proportions of gold to offset their losses from their equity and bond markets. Additionally, it would be interesting to look at what the effects would be if one were to remove gold manufacturing companies from certain BRICS equity markets, and then ascertain if gold would be a safe haven, hedge or diversifier for those countries markets. Lastly, using a time and frequency domain analysis should be explored to ascertain richer yielding results.

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