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UNDERSTANDING THE GOLD-INFLATION NEXUS IN MALAYSIA: HEDGE AND SAFE HAVEN PERSPECTIVES

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ABSTRACT

The main objective of this study is to examine the roles of gold as a hedge or a safe haven against inflation in Malaysia. We propose the standard and quantile techniques in the volatility models, with a time-varying conditional variance of regression residuals based on TGARCH specifications. We found that gold only plays a minor role as a hedge and safe haven against inflation since their returns do not evolve at the same pace as inflation. On the other hand, the rolling regression results reveal that shelter incidents against purchasing power loss only occasionally occur at different times and not consistently across holding periods. We conclude that gold does not have the ability to secure Malaysian investment during high inflationary periods and at all times. Thus, Malaysian investors should hold a well-diversified portfolio to earn sustainable returns and protection from purchasing power loss.

Keywords: Gold, Inflation, Hedge, Safe Haven, Quantile, Rolling Regression

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1. INTRODUCTION

The high prices of gold can be linked to “fear” trade; to wit, the gold price rises due to investors’ fear of the overall economic performance. This may include higher inflation due to lax central bank policies, and purchases of gold motivated by “fear” occurs anytime but are unlikely to happen in the same month every year.

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Researches on the inflation-hedging properties of gold are mostly restricted to the long-term perspective (e.g., McCown & Zimmerman, 2006; Narayan et al., 2010) and focused on the hedging ability of gold on average (Adrangi et al., 2003; Taylor, 1998). Such approaches, however, have failed to address the length of the effect and have not dealt with the purchasing power of gold under high inflation conditions. Thus, this study addresses the issue by utilizing large shocks to trigger safe haven purchases since large shocks convey more information and cause different reactions by investors compared to the small and normal shocks. To this end, this study uses q% upper quantiles, i.e., 80%, 85%, 90%, and 95%, to represent various sizes of high movements in inflation distribution to obtain more precise empirical findings. Furthermore, this study contributes to the previous research by utilizing the rolling regression technique to examine the time-varying hedge relationships and the efficient holding period when gold can protect against purchasing power loss.

In other words, the above studies do not capture the issue of gold as a safe haven in times of high inflation conditions. If the gold price increases in a larger magnitude during high inflation, this indicates that the real price of gold the investor faces increases during the same period, and it is thus better to invest in gold. The results are essential since, in reality, investors would be interested in knowing how gold performs during periods in which their real livelihood income could be at risk. This study is also crucial to economic policymakers. Suppose the findings are inclined to suggest the favorable feature of gold as a hedge and safe haven against inflation. In that case, the government's initiative in introducing gold as an investment driver for preserving wealth should be supported.

Theoretically, this study extends the previous works (e.g., Bampinas & Panagiotidis, 2015; Hoang et al., 2016) by incorporating the measure of inflation's "upside risks" in the theory of interest model. Inflation risks arise from the uncertainty surrounding the realization of inflation. There is a consensus that "upside risks" are related to the event of inflation exceeding certain thresholds (Kilian & Manganelli, 2008). In other words, this study explains the "worst-case scenarios" for investment and behavioral interpretation concerning investors' decisions during periods of inflation turmoil. The inclusion of behavioral beta in this model could potentially derive new understanding in the field and, in turn, improve the ability to make better decisions.1

In addition, this research contributes to the existing literature by examining gold's properties as a hedge and safe haven against inflation in a small emerging market, i.e., Malaysia. Most studies show that gold quoted in London or New York is a good hedge against inflation of the United States (US) dollar, but a poor hedge when quoted in other currencies; inter alios, Hoang (2012), Narayan et al. (2010), and Wang et al. (2011). This is due to the fact that each country has its own economic characteristics, and the gold price moves in tandem with dollar inflation. While there is abundant evidence about the effectiveness of gold as a hedge against inflation in developed countries, with the exception of Ghazali et al. (2015a) and Khair-Afham et al. (2017), lack of academic studies to date investigates this issue from the rapidly developing economy point of view, to justify whether or not gold is a store of value in currencies other than the US dollar. This

1 Focusing on the upper quantiles allows estimating potential losses under high inflation conditions, i.e., at the tail of inflation distribution. It is crucial for investors to have an asset that can rise in value (i.e., has a positive correlation in the highest quantiles) to offset the "upside risks" of inflation.

indicates that the empirical evidence on the relationship between gold returns and inflation is still in infancy.

Malaysia is chosen due to the deep interest in gold shown by Malaysian policymakers, academicians, and practitioners in the face of the 1997-1998 Asian financial crisis, as it is seen as a stable and profitable tool for successful investments. In this regard, on 17 July 2001, Malaysia became the 12th country globally that issued its own official gold bullion coins, the *Kijang Emas*. This was followed by the issuance of the gold dinar by the Royal Mint of Malaysia in 2003, the Kelantan State Government on 20 September 2006, and the Perak State Government on 28 February 2011.

On the other hand, many commercial banks have also introduced gold investment accounts as their investment products. On 7 October 2013, Bursa Malaysia Derivatives, for the first time, has launched Gold Futures (FGLD), a small-sized Malaysian ringgit-denominated gold futures contract. Besides, a number of blockchain-using platforms have recently started operating in Malaysia. For example, HelloGold, a fintech investment company that follows *Shariah*-compliant finance standards, backed by auditable allocated gold vaulted in Singapore, launched in 2015.

Along with these practical initiatives, creating awareness and educating the masses is ongoing, with several high-profile seminars and a series of international conferences organized on gold and the gold dinar. The recent crises, inflation risk, and the gold price's attendant strength also lead to a profound interest in Malaysia's precious metal. Thus, based on this country's background, answering the question of the role of gold as a hedge or a safe haven would provide valuable information to Malaysia's investors.

In conclusion, studies investigating these issues are infrequent and relatively scarce. Thus far, the lack of previous studies in the most existing empirical literature has applied quantile analysis in examining the gold-inflation relationship even though the technique is of high practical importance. These arguments, therefore, provide a strong incentive and motivation for researchers to investigate these issues in greater depth.

This research is structured into six sections, including this introductory section. Section two focuses on a brief overview of gold and consumer prices in Malaysia. Section three discusses a brief review of the related literature. The fourth section emphasizes the data and methodology used in this study. Section five reports the empirical results, concentrating on the analysis of the performance of gold against inflation in the average and time-varying manner, as well as during high inflation conditions. Section six aims to conclude the study.

2. GOLD PRICES AND THE CONSUMER PRICE INDEX (CPI)

Figure 1 shows the monthly gold prices and CPI in Malaysia. An important point to note is that, during the early 1980s, gold returns seemed to be higher due to the global economic recession that affected the developed world in the late 1970s and early 1980s.

Generally, the gold price series appeared to have a prolonged period of relative tranquillity from 1982 until 2001. Nevertheless, gold prices increased after the dot-com and internet bubble bursting from 2001 - 2002. The FED has continuously raised the interest rate since September 2005, and the gold price has gone up at the same time due to the bearish in the stock markets. Throughout mid-2006 and late 2011, gold prices have shown dramatic movements due to the prolonged war in Iraq in 2006 and the European debt crisis of the summer of 2011. The movements are more ostensible from mid-2008 until 2009, driven by the weak dollar, the global financial crisis and inflationary fears, and monetary expansion, during which investors purchase and sell gold at a higher pace, most likely due to distress.

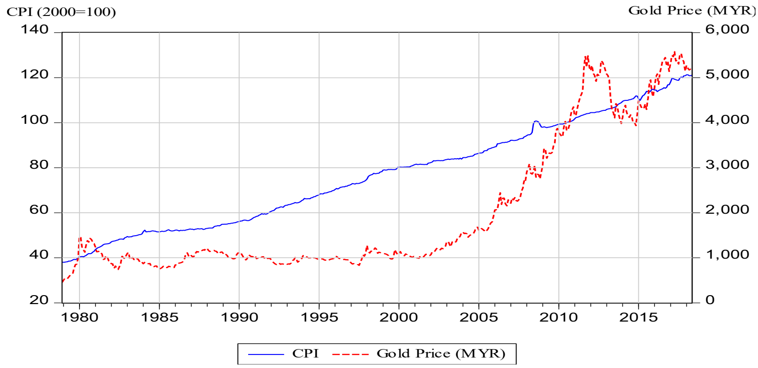
On the other hand, CPI has an increasing shape over the study period. Generally, the CPI is relatively constant due to government control, except in some years, e.g., 1981, 1998, 2008, and 2017. Malaysia experienced an episode of high prices in the early 1980s due primarily to external factors, whereby the oil prices rose by 47% and 66% in 1979 and 1981, respectively. The higher inflation in the OECD countries (due to rising wages and low productivity) inevitably led to higher CPI in Malaysia through increases in import costs. As a result, inflation accelerated from 3.6% in 1979 to 6.7% and 9.7% in 1980 and 1981, respectively. Simultaneously, industrial raw materials and investment goods prices also increased rapidly.

Inflation was high in 1998 because of the sharp ringgit depreciation of over 40% due to the Asian financial crisis, which pushed the cost of imported food higher. The inflation exceeded 4% in February 1998 and continued its upward trend, peaking at 6.21% in June 1998. However, the prudent and immediate action taken by the government in September 1998 to effectively fix the nation's currency to the US dollar at US$1 = RM 3.80 has had some controlling effect on inflation in the country.

In 2008, although the global financial crisis did not directly impact Malaysia, the sharp rise in the crude oil price to US$140 per barrel increased petrol and diesel prices, thus, sent the cost of food and transport soaring. In addition, the electricity tariff was also revised upwards. As a result, inflation reached a peak of 8.5% in July 2008. In February 2017, the substantial rise in petrol and diesel price announced by the government caused the CPI to increase by 4.5% to the corresponding month of the preceding year.

It is seen that the consumer prices, generally, move concomitantly in most years with the gold prices; and move in the opposite direction in other periods (e.g., from 2012-2015). This suggests that the connexion between gold prices and CPI is not constant. Obviously, the periods in which gold prices and the CPI move in the same directions are consistent with gold as a hedge against CPI changes.

Figure 1: Time Series Plots of CPI and Gold Prices



3. LITERATURE REVIEW

Lipschitz and Otani (1977) conducted early research on this issue in multi-country analysis. They discover that inflation is significantly positive in influencing the demand for speculation and hoarding of gold, hence, causing a rise in the gold price. Koutsoyiannis (1983) investigates the issue in the US and finds a positive relationship between inflation and gold prices. Jaffe (1989) estimates the relations between inflation and gold returns in the US, Canada, and South Africa. He finds that, on average, a 1% movement in inflation is associated with a 2.95% change in gold return.

McCown and Zimmerman (2006) show that gold has a strong positive correlation of 0.445 with the CPI. Although the correlation decreases as the time horizon decreases, it remains positive. Using Johansen's cointegration test, they find a long-term relationship between both variables. Levin and Wright (2006) and Michaud et al. (2006) also find that gold retains inflation hedging properties in the long-term, despite considerable short-term fluctuations.

Narayan et al. (2010) build a conceptual framework that, when the oil price rises, it creates inflationary pressures that translate into higher gold prices since gold is also considered a good. Theoretically, this relationship's motivation is rooted in investors using the gold market as an inflationary hedge, which results from a shock in oil prices leads to a rise in oil prices. Employing Gregory-Hansen's cointegration test, they support the role of the gold market as a hedge against inflation in the long-run.

Likewise, Artigas (2010) indirectly highlights the linkage between the global money supply to gold in the US, Eurozone and the UK, India, and Turkey. The results show that each country's money supply growth positively correlates with the percentage change in the gold price. Artigas (2010) reveals that a change in the US money supply has the most considerable impact on the gold price, whereas changes in the money supply in countries where gold has a dominant cultural role, e.g., India, is essential. The study of Artigas (2010) is supported by Singh and Joshi (2019) in India, where they find that gold and CPI are cointegrated. Besides, the study also finds long-run causality from CPI to gold prices.

On the other hand, mixed evidence of gold's hedging abilities can be discovered in Jastram and Leyland’s (2009) study. They find that gold maintains its purchasing power over long periods, albeit over shorter periods, it has fluctuated significantly. Pre-1971, gold lost value during inflationary spirals, while it appreciated during major deflations since gold is fixed in price. Nevertheless, post-1971, when gold was set free to fluctuate, the gold price rises when inflation increases and drops when deflation hits.

Similar results were obtained by Laurent (1994), who examined the connexion between the gold price and the general prices. These two variables correspond quite closely over an extended period from 1800 to 1992. Nevertheless, the gold price displays much more volatile movements in the short-term than the general price level. He concludes that, while gold is no longer a currency, it still plays a significant position in the monetary system since it can indicate inflation because of its positive correlation.

Wang et al. (2011) find that gold is only partially effective in hedging against inflation in Japan in the long-run. Gold is unable to hedge against inflation in Japan and the US in the short-run, during periods of low momentum regimes. In contrast, gold can hedge against inflation in the US during periods of high momentum regimes. Hoang et al. (2016), on the other hand, find evidence that gold is not a hedge against inflation in the long-run in the developed and large gold markets (the US, the UK, Japan) and small and emerging gold markets (France, China, India). However, gold is an inflation hedge only in the US, the UK, and India in the short-run.

A current study by Ghazali et al. (2018) involves hedge and safe haven of gold against Malaysian inflation. In the full sample (2001-2014), gold as a store of value against inflation is not justified since gold only serves, at best, as a weak hedge and weak safe haven. The shorter sample (2010-2014), designed to accommodate the gold account and specific investigation on the Euro sovereign debt bond crisis, accounts for some supports for the strong hedge features for gold, demonstrating that the role of gold changed through time.

Some empirical studies yield contradictory findings. For instance, Baillie (1989) investigates the commodity price index's long-run ability to hedge against inflation and finds no cointegration evidence between these two variables. Hoang's (2012) study involves short-run and long-run gold hedging against inflation using data from France. The author finds that the correlation parameters are very low and insignificant, while the regression analysis's beta coefficients are not significant. These findings are consistent with the long-run findings, where the study identifies no cointegration between gold prices and CPI. Similar results can be found in Malaysia by Ghazali et al. (2015a). Although gold return and inflation are positively correlated and have positive betas, no significant evidence is observed between gold return and inflation, gold return and expected inflation, and gold return with unexpected inflation.

A recent study by Salisu et al. (2020) finds that gold investment defies Fisher’s hypothesis. They suggest that the US investors will have a good hedge against inflation by holding the stock asset and real estate and not by holding gold. Similarly, Chen (2020) examines whether gold can simultaneously hedge on the stock market and inflation since the market boom often comes with moderate inflation, which creates a puzzle in gold price dynamics and its hedging property.

However, the author finds that gold fails to hedge both the stock market and inflation simultaneously over time.

The findings of prior studies have proven that the effective inflation hedge of gold against inflation is inconsistent, contradictory, and not always guaranteed. Most notably, there is a limitation in the research technique applied since prior researches utilize gold's hedging ability on average, which does not consider the length of the effect. In other words, the analysis does not capture the issue of gold as a haven in times of high inflation conditions. This issue is further investigated in this study.

4. DATA AND METHODOLOGY

4.1. Econometric Model

4.1.1. Hedge Analysis

A widely adopted view in the economics literature is that an asset is a reliable hedge against inflation if the Fisher effect holds true. Therefore, Fama and Schwert (1977) translate the Fisher identity into an empirical equation for an asset's hedging potential by the restriction that the conditional expected real return is constant. Thus, the form of regression used to determine if an asset is a hedge against inflation is as follows:

$$r_{g,t} = \alpha_0 + \alpha_1 r_{g,t-1} + \alpha_2 \pi_t + \alpha_3 \pi_{t-1} + \varepsilon_t \quad (1a)$$

$$h_t = \delta + \alpha \varepsilon_{t-1}^2 + \vartheta d_{t-1} \varepsilon_{t-1}^2 + \rho h_{t-1} + \in_t \quad (1b)$$

$$r_{g,t} = \alpha_{0,t} + \alpha_{1,t} r_{g,t-1} + \alpha_{2,t} \pi_t + \alpha_{3,t} \pi_{t-1} + \varepsilon_t \quad (1c)$$

$$h_t = \delta_t + \alpha_t \varepsilon_{t-1}^2 + \vartheta_t d_{t-1} \varepsilon_{t-1}^2 + \rho_t h_{t-1} + \in_t \quad (1d)$$

where Equations (1a) and (1c) represent the mean equations for static threshold generalized autoregressive conditional heteroscedasticity (TGARCH) regression and rolling TGARCH regression, respectively. This rolling regression framework permits us to determine gold's role during varying phases of time and identify its efficient holding period. $r_{g,t}$ and $r_{g,t-1}$ denote gold return at time t and t-1, respectively. π_t and π_{t-1} are ex-post inflation at time t and t-1, respectively. ε_t is a disturbance term or innovation following a TGARCH process (Equations (1b) and (1d) are the variance equations for static TGARCH and rolling TGARCH, respectively). α_0 and $\alpha_{0,t}$ are the constant terms for the static and rolling regression models, respectively. α_1 and $\alpha_{1,t}$ are the coefficients of lagged gold return for both models, while α_2 (as well as $\alpha_{2,t}$) and α_3 (as well as $\alpha_{3,t}$) are the parameters of contemporaneous and lagged inflation, respectively. Our reason for doing so is that predictions are normally based on models including lagged values. Besides, macroeconomic data are published with a time delay. α_2 ($\alpha_{2,t}$) and α_3 ($\alpha_{3,t}$) are the hedging coefficients that denote how well gold investment could hedge against inflation.

Gold is a strong hedge for inflation if α_2 ($\alpha_{2,t}$) or α_3 ($\alpha_{3,t}$) are positive and statistically significant. Gold return is deemed a perfect hedge against inflation if α_2 ($\alpha_{2,t}$) or α_3 ($\alpha_{3,t}$) is equal to one. This is classified as a full Fisher relationship. If α_2 ($\alpha_{2,t}$) or α_3 ($\alpha_{3,t}$) is larger than one, the hedge is more than complete. Gold return that provides a partial hedge will yield an α_2 ($\alpha_{2,t}$) or α_3 ($\alpha_{3,t}$) within the range of zero and one. A partial hedge can still be considered a strong hedge due to two reasons. First, both variables' positive relationship indicates that gold returns compensate for rising inflation (Hoang et al., 2016). Second, even if gold does not provide a perfect or more than perfect hedge, a stable and positive relation with inflation can still make the asset valuable and durable since both variables share a common trend (Arnold & Auer, 2015). On the other hand, gold is a weak hedge for inflation if α_2 ($\alpha_{2,t}$) or α_3 ($\alpha_{3,t}$) are positive but statistically insignificant. In contrast, a negative α_2 ($\alpha_{2,t}$) or α_3 ($\alpha_{3,t}$) suggests that gold is a perverse hedge against inflation.

4.1.2. Safe Haven Analysis

In order to analyze the behavior of gold with respect to inflation, this study assumes that the relationship is not constant but conditional on inflation being at the upper end of the distribution. Equations (2a) and (2b) present the regressions model used to analyze the safe haven property of gold:

$$\pi_{t(q)} = \theta_{(q)} + \mu_{t(q)} \tag{2a}$$

$$r_{g,t} = \beta_0 + \beta_1 r_{g,t-1} + \beta_2 \left[D\pi_{t(q)}(\pi_t)\right] + \mu_t \tag{2b}$$

$$h_t = \delta + \alpha \varepsilon_{t-1}^2 + \vartheta d_{t-1} \varepsilon_{t-1}^2 + \rho \mathrm{h}_{\mathrm{t}-1} + \epsilon_t \tag{2c}$$

To obtain the high inflation values, we estimate inflation's threshold values via quantile regression, as in Equation (2a). Equation (2b) models the relationship between gold and inflation, where $r_{g,t}$ denotes gold return at time *t*. The return is regressed on a constant β_0 and the error term is given by μ_t, which follows the TGARCH process. The term $D\pi_{t(q)}(\pi_t)$ accounts for the high inflation movements and is included to focus on rising inflation.

Specifically, this paper implicitly analyzes gold's role in times of inflation stress and includes regressors that contain inflation in the q% upper quantiles (80%, 85%, 90%, and 95%). If the inflation exceeds a specific (upper tail) threshold given by the q%, the value of the dummy variable $D\pi_{t(q)}(\ldots)$ is one, and zero otherwise.

If β_2 in highly rising inflation is positive and statistically significant, gold acts as a strong safe haven asset for inflation since they are positively correlated. Like the inflation hedge notion, the gold return is a perfect safe haven against inflation if β_2 is equal to one. If β_2 is larger than one, the safe haven is more than complete. Gold returns that provide an incomplete safe haven will yield a β_2 between zero and one. On the other hand, if β_2 in highly rising inflation is positive and statistically insignificant, gold serves as a weak safe haven asset for inflation since they are weakly correlated. Contrary, a negative β_2 suggests that gold serves as a perverse safe haven against inflation.

4.2. Sample Data

The data are monthly, from December 1978 until March 2018. All data are converted to a continuously compounded rate. The CPI (in the 2000 base index) is used to proxy inflation. The data were obtained from the International Financial Statistics (IFS). The monthly gold prices were collected from the World Gold Council (WGC). The US gold prices are used as the base value and then converted to the local country currency, i.e., Malaysia ringgit (MYR), using the monthly average exchange rate.

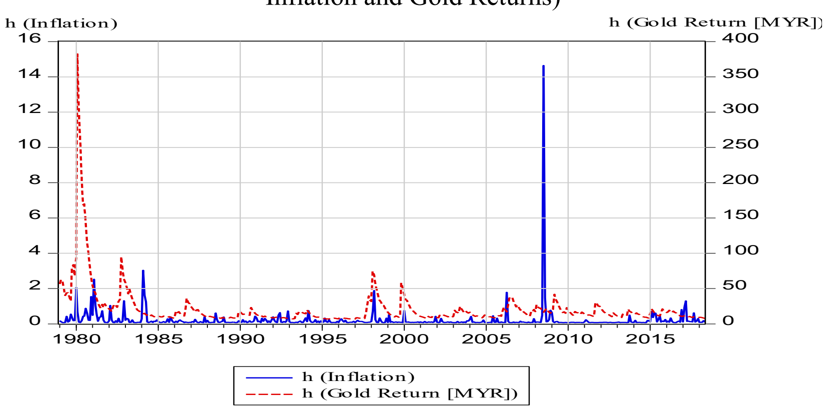
5. EMPIRICAL RESULTS

5.1. Descriptive Statistics

Figure 2 illustrates the time-varying volatility of the respective inflation and gold return series. Generally, the conditional variance is not constant but instead clusters and changes over time. These figures provide clear insights that conditional variance and price (Figure 1) of gold move in tandem in times of turbulence, e.g., during the global economic recession in the early 1980s. This effect is related to the hedge and safe haven characteristics of gold in times of economic instability (the relatively high volatility of gold returns coincides with the period of large movements in gold prices shown in Figure 1). On the other hand, the opposite direction between gold prices and the conditional variance of gold returns indicates that the usual condition for volatility, e.g., volatility in the stock market, can be seen as well in the gold market, which might weaken the effectiveness of gold as a hedge and haven (e.g., between 2010-2015).

Based on the CPI series in Figure 1, the conditional variance of inflation is relatively volatile, particularly in the early 1980s and 2008, wherein this period the inflation volatility has a positive correlation with the CPI. The relatively tranquil conditional variance corresponds to the periods of stability in the CPI (Figure 1).

Figure 2: The Evolution of Conditional Variance (TGARCH (1,1) Estimates for Inflation and Gold Returns)



Note: *h* denotes conditional variance

The descriptive statistics (Table 1) generally show that, on average, the unconditional results of gold return significantly outperform inflation over the sample period. The average inflation is approximately 0.245% a month, while the gold return is 0.513%. The volatility (risk) of gold return, on the other hand, is significantly higher than inflation. Meanwhile, gold return exhibits more extreme positive and negative values than inflation. Kurtosis indicates a leptokurtic distribution. As clearly shown by the Jarque-Bera test statistics, the gold return and inflation series are not normal at the 1% significance level. Table 1 also shows the average monthly correlation in the total period. Although the correlation coefficient is positive, it is minimal and insignificant, suggesting that gold is a poor hedge against inflation.

Table 1: Descriptive Statistics of Inflation and Gold Return

Variable	Obs.	Mean	Max.	Min.	Std. Dev.	Skew.	Kurtosis	J-B	*p*-value
Inflation	473	0.245	3.864	-1.522	0.419	1.610	15.979	3524.402	0.000
Gold Return	473	0.513	39.493	-16.380	4.581	1.564	15.039	3049.348	0.000
Correlation (*t*-statistic)					0.001 (0.010)				

Note: Obs., Max., Min., Std. Dev., Skew., and J-B are observation, maximum, minimum, standard deviation, skewness, and Jarque-Bera, respectively.

The descriptive statistics of both variables by quantiles of inflation are presented in Table 2. The results show that the monthly gold returns do not always outperform inflation during high inflation movements. For instance, the gold returns outstrip inflation in 85% and 95% quantiles, but the returns are lower than inflation in 80% and 90% quantiles. In all quantiles, gold exhibits more extreme positive and negative values compared to inflation.

Table 2: Descriptive Statistics of Inflation and Gold Returns during High Inflation Conditions

		Mean	Max.	Min.	Std. Dev.
Panel A					
Inflation > 80% Quantile	Inflation	0.833	3.864	0.495	0.423
	Gold Return	0.777	39.493	-11.445	6.258
Panel B					
Inflation > 85% Quantile	Inflation	0.931	3.864	0.586	0.449
	Gold Return	1.035	39.493	-11.445	6.965
Panel C					
Inflation > 90% Quantile	Inflation	1.063	3.864	0.714	0.494
	Gold Return	1.050	39.493	-11.445	8.228
Panel D					
Inflation > 95% Quantile	Inflation	1.315	3.864	0.919	0.602
	Gold Return	1.560	39.492	-11.445	10.556

Note: Max., Min., Std. Dev. are maximum, minimum, and standard deviation, respectively.

Analyzing the correlations sorted by the quantiles of inflation (Table 3), an unambiguous pattern appears. Gold is not a safe haven in the face of purchasing power losses because of inflation due to statistically insignificant negative coefficients in all quantiles (the parameters lying within the range of -0.019 to -0.120). Based on this correlation, gold appears to offer a poorer safe haven, i.e., gold returns are more negatively correlated with inflation in times of significant rise inflation.

Table 3: Conditional Correlation Analysis (Conditional on High Inflation Shocks)

	Gold Return
Panel A: Inflation > 80% Quantile	
Inflation	-0.019
	(-0.184)
Panel B: Inflation > 85% Quantile	
Inflation	-0.056
	(-0.462)
Panel C: Inflation > 90% Quantile	
Inflation	-0.070
	(-0.474)
Panel D: Inflation > 95% Quantile	
Inflation	-0.120
	(-0.567)

Note: The number in the parentheses denotes *t*-statistics.

Then, we test the occurrence of non-linearity in the considered time series using the BDS test (see Broock et al., 1996). This test has a null hypothesis that follows a standard normal distribution, i.e., the data are pure noise (completely random) and can detect various departures from randomness, e.g., linear or non-linear stochastic processes, deterministic chaos, etc. The findings are summarized in Table 4, which show strong evidence of non-linearity, as they reject the null hypothesis of independent and identical distribution (*i.i.d*). The results suggest that gold return and inflation are non-linear dependence, which is one indicator of chaotic behavior. Such an outcome justifies the TGARCH-type process's usefulness for examining the non-linear dependence characteristics of gold return and inflation.2

Table 4: The BDS Test Based on the Ordinary Residuals of the Gold Return and Inflation

Dimensions	$m = 2$	$m = 3$	$m = 4$	$m = 5$	$m = 6$
Gold Return					
BDS Statistics	0.019***	0.040***	0.054***	0.062***	0.064***
(SE)	(0.004)	(0.006)	(0.008)	(0.008)	(0.008)
Inflation					
BDS Statistics	0.036***	0.059***	0.069***	0.073***	0.071***
(SE)	(0.004)	(0.007)	(0.008)	(0.009)	(0.008)

Notes: The asterisk (***) indicates rejection of the null of the residuals recovered from the ordinary least squares (OLS) models being *i.i.d* at the 1% level of significance. *m* denotes the embedding dimension of the BDS test, while SE in the parentheses denotes standard error.

5.2. Econometrics Model

5.2.1. Hedge Analysis

Table 5 presents the estimation results of the hedge analysis as specified in Equation (1a). The results demonstrate that gold denominated in the Malaysian ringgit does not work as a hedge since the contemporaneous hedging parameter is statistically insignificant and negative (-0.182),

2 TGARCH (1,1) is one of the most popular approaches since it fits many data series well. The TGARCH (1,1) framework will be sufficient to capture the volatility clustering or volatility pooling in the data, and rarely is any higher-order model estimated or even entertained in the academic finance literature (Brooks, 2008). Previous researchers have used the model in order to capture the variation in the conditional variance of gold data (e.g., see Ciner et al., 2013; Gürgün & Ünalmış, 2014; Hillier et al., 2006).

indicating that gold return does not increase along with an increasing inflation rate. On the other hand, the once-lagged coefficient meets the requirement of a weak hedge characteristic against inflation in light of a statistically insignificant and positive parameter (0.286).3 The gold status failure as a store of value is due to currency difference since the gold price is expressed in the local currency. Since changes in gold returns may occur due to change in gold prices in international markets denominated in the US dollar or due to change in exchange rates of the local currency against the US dollar, the relationship of inflation and gold returns may, therefore, be difficult to establish for this market (Iqbal, 2017).4

Table 5: Estimation Results of the Hedge Analysis

		Mean Equation			Variance Equation			
	Constant	$r_{g,t-1}$	π_t	π_{t-1}	δ	α	ϑ	ρ
Coefficient	0.386*	0.148***	-0.182	0.286	0.821***	0.169***	-0.141***	0.848***
(SE)	(0.231)	(0.047)	(0.545)	(0.434)	(0.239)	(0.025)	(0.035)	(0.026)
$Q(20)$ = 15.194 [0.765]								
ARCH(20) = 22.447 [0.317]								
Dimensions		m = 2	m = 3		m = 4	m = 5		m = 6
Standardized Residuals								
BDS Statistics		0.004	0.004		0.003	0.004		0.004
(SE)		(0.004)	(0.006)		(0.007)	(0.007)		(0.007)

Notes: The asterisks (***) and (*) indicate statistical significance at the 1% and 10% levels, respectively. SE in the parentheses denotes standard error. $Q(20)$ is the Ljung-Box statistic for serial correlation in the model residuals computed with 20 lags. ARCH(20) is Engle's LM test for the ARCH effect in the residuals up to the 20th order. P values (in square brackets) below 0.05 indicate a rejection of the null hypothesis. The results show that neither autocorrelation nor ARCH effects remained in the residuals. m denotes the embedding dimension of the BDS test. The BDS results show non-rejection of the null of the standardized residuals is *i.i.d* at the 1% level of significance, thus indicating that the proposed model is adequate in detecting the non-linear of the series (Caporale et al., 2005).

5.2.2. Time-Variation Analysis

Based on the results in Table 5, we assess the stability of the model's parameters and capture the potential time-varying behavior of gold with respect to inflation as specified in Equation (1c). Figure 3 exhibits betas estimate of the gold return's rolling window regressions procedure on the contemporaneous inflation. The length of the in-sample period used to estimate the model is fixed so that the start date and end date successively increase by one observation. The regressions are based on a window length of 12 until 120 monthly observations, which approximately represent one to 10 calendar years of holding periods, to illustrate the manner in which the betas change through time. Gold can be treated as a hedge against inflation if the time-varying beta lines are above zero.5

Generally, as expected, the results demonstrate that the longer rolling window sizes tend to yield smoother rolling window estimates over time than shorter sizes. Regardless of the window sizes, the time-varying betas confirm the changing relationship between both variables. The findings

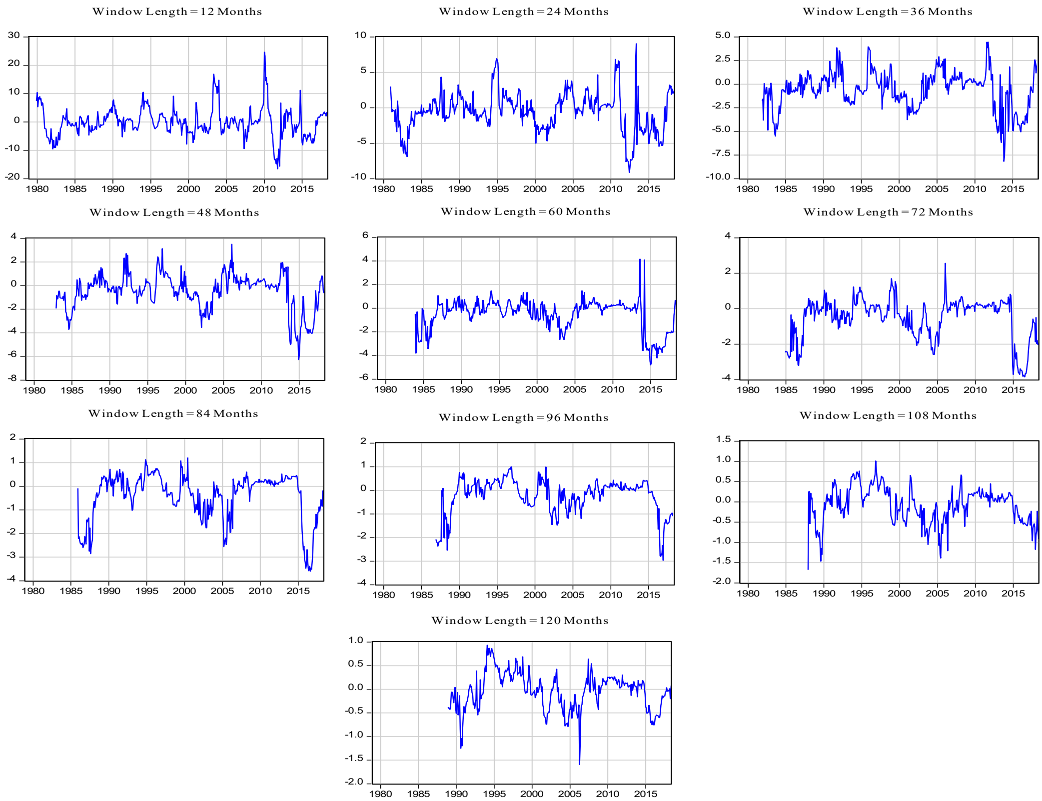
3 We also estimate further lags of our explanatory variables. Nonetheless, the values were never in line with strong hedge characteristics. The results are available upon request.

4 Since this study's objective is to investigate the issue of hedge and safe haven of gold, we do not discuss the variance equation. A detailed discussion of gold's volatility status can be seen in Ghazali and Lean (2015).

5 This research avoids the term safe haven as the one- to 10-year windows are too long to test for the existence of a safe haven.

show that gold is a hedge only at certain times. The plots reveal that most of the contemporaneous betas are below zero, in line with the hedge analysis in Table 5.

Figure 3: The Evolution of the Time-Varying Betas of Gold Return with Respect to Inflation. The Rolling Estimation Windows are Based on a Length of 12 to 120 Monthly Observations



Model: $r_{g,t} = \alpha_{0,t} + \alpha_{1,t} r_{g,t-1} + \alpha_{2,t}\pi_t + \alpha_{3,t}\pi_{t-1} + \varepsilon_t$

Note: The left vertical axis denotes betas of gold returns with respect to inflation.

The 'true' or strong hedge status is shown in Table 6. Columns 2-10 show the number of times gold serves as a strong hedge over the stated periods (five-year periods, on average). Column 11 indicates the total number and percentage of time gold could work as a strong hedge against inflation. While the last column shows the total number and percentage of time the hedging parameters ($\alpha_{2,t}$) equal and greater than one. On the other hand, every row shows rolling periods, i.e., 1- until 10-year, to capture the efficient holding period of gold based on the highest number and percentage of time gold acts as a strong hedge.

Generally, gold provides inconsistent strong hedge status over time and across different windows. The incidents of strong hedge against purchasing power loss only occur occasionally, mainly when the overlapping samples include the period of January 1991–December 1995, January 1996–December 2000, and January 2016-May 2018 coincide with the 1998 Asian financial crisis and the substantial rise in the price of petrol and diesel in 2017. At best, gold could provide a strong hedge of only about 7.778% of the time from the total overlapping samples, i.e., when the holding period lasts for two years. Out of this percentage, gold fully compensates and beats inflation in only 7.333% of cases. Giving more weights to more past observations in the rolling windows does not improve the efficiency of gold holding (the evidence of a strong hedge deteriorates with the longer horizon holding periods).

Table 6: The Number and Percentage of Time When Gold Serves as a Strong Hedge against Inflation ($\alpha_{2,t}$)

Holding Period	Dec 1978 – Dec 1980	Jan 1981 - Dec 1985	Jan 1986 - Dec 1990	Jan 1991 – Dec 1995	Jan 1996 – Dec 2000	Jan 2001 – Dec 2005	Jan 2006 – Dec 2010	Jan 2011 – Dec 2015	Jan 2016 - May 2018	Total number and percentage of SH	Total number and percentage of $\alpha_{2,t} \geq 1$
1-year	1	2	2	10	0	4	2	1	7	29 (6.277%)	29 (6.277%)
2-year	0	0	1	13	6	2	5	1	7	35 (7.778%)	33 (7.333%)
3-year	0	0	0	5	9	0	0	4	5	23 (5.251%)	23 (5.251%)
4-year	0	0	1	0	9	0	1	3	0	14 (3.286%)	13 (3.052%)
5-year	0	0	1	1	0	0	0	1	0	3 (0.725%)	2 (0.483%)
6-year	0	0	2	0	0	0	2	0	0	4 (0.995%)	2 (0.498%)
7-year	0	0	0	0	0	0	0	0	0	0 (0%)	0 (0%)
8-year	0	0	2	0	0	0	0	0	0	2 (0.529%)	0 (0%)
9-year	0	0	0	1	0	0	0	0	0	1 (0.273%)	0 (0%)
10-year	0	0	0	1	0	0	0	0	0	1 (0.282%)	0 (0%)
Total	1	2	9	31	24	6	10	10	19		

Notes: SH = strong hedge. $\alpha_{2,t} \geq 1$ indicates the total number and percentage of time gold acts as a perfect hedge ($\alpha_2 = 1$) and more than perfect hedge ($\alpha_2 > 1$) against inflation.

Model: $r_{g,t} = \alpha_{0,t} + \alpha_{1,t} r_{g,t-1} + \alpha_{2,t}\pi_t + \alpha_{3,t}\pi_{t-1} + \varepsilon_t$

5.2.3. Safe Haven Analysis

Table 7 presents the estimation results of gold with respect to sizeable inflation shocks as specified in Equations (2a)-(2c). Again, this shiny metal loses its luster during periods of high inflation since its returns do not evolve with the same rhythm as inflation. That is to say, gold acts as a weak safe haven or not a safe haven in the phase of rising inflation in Malaysia due to the insignificant positive or negative of the parameters in all quantiles (the values lie within a range of -0.198 to 0.169). These results support the argument that gold acts better as a crises hedge than an inflation hedge (see, e.g., Baur & Smales, 2018; Ghazali et al., 2018; Ghazali et al., 2020; Iqbal, 2017).

Three reasons can expound the weakness of gold's position as a secure asset against inflation in Malaysia: 1) Gold is a globally traded commodity. In order to influence the gold price, enormous trading volumes would be required. Given this factor, one would only expect gold to serve as a shelter for Malaysia during periods of coincident high inflation risk. 2) These findings also suggest that while it is well-known that the global market scenarios influence the domestic stock market (systematic risk), inflation in Malaysia is mainly due to domestic cost factors.6 For example, the increases in petrol and diesel prices will increase the transportation and construction project costs resulting in the rise of inflation. In addition, the changes in consumption tax policy also have a significant effect on inflation. As Malaysia's inflation is less connected by global risks, it is also less related to the gold returns; thus, gold denominated in Malaysian currency fails to work as a protection tool.7 3) The failure of gold status as a store of value in Malaysia is also due to currency differences. The US dollar is equivalent to gold during the Bretton Woods era. Hence, it remains to have a strong link with gold price and is even one of the fundamental determinants of gold prices (Hoang, 2012). Thus, the US dollar inflation directly impacts gold prices, as they are expressed in the US dollar. In this case, when the value of the US dollar is devalued, people lose confidence in the currency and turn to gold as a safe haven. Therefore, when inflation in the US increases, the price of gold increases, which is not the case for Malaysia's inflation.

Table 7: Estimation Results of Safe Haven Analysis

		Mean Equation			Variance Equation			
		Constant	$r_{g,t-1}$	$D\pi_{t(q)}(\pi_t)$	δ	α	ϑ	ρ
Panel A:	Coeff.	0.441**	0.150***	-0.198	0.820***	0.169***	-0.145***	0.849***
π > 80% quantile	(SE)	(0.191)	(0.047)	(0.552)	(0.235)	(0.025)	(0.035)	(0.026)
Q(20) = 14.765 [0.790]								
ARCH(20) = 22.041 [0.338]								
Panel B:	Coeff.	0.439**	0.150***	-0.276	0.861***	0.174***	-0.147***	0.843***
π > 85% quantile	(SE)	(0.186)	(0.048)	(0.579)	(0.247)	(0.026)	(0.035)	(0.027)
Q(20) = 14.700 [0.793]								
ARCH(20) = 21.783 [0.352]								
Panel C:	Coeff.	0.436**	0.150***	-0.347	0.854***	0.172***	-0.147***	0.844***
π > 90% quantile	(SE)	(0.184)	(0.047)	(0.608)	(0.243)	(0.026)	(0.035)	(0.026)
Q(20) = 14.573 [0.800]								
ARCH(20) = 21.830 [0.350]								
Panel D:	Coeff.	0.409**	0.150***	0.169	0.759***	0.163***	-0.142***	0.857***
π > 95% quantile	(SE)	(0.183)	(0.047)	(0.714)	(0.219)	(0.024)	(0.033)	(0.025)
Q(20) = 14.723 [0.792]								
ARCH(20) = 22.831 [0.297]								

Notes: (***) and (**) denote significant at 1% and 5% levels, respectively. SE in the parentheses and π denote standard error and inflation, respectively. Q(20) is the Ljung-Box statistic for serial correlation in the model residuals computed with 20 lags. ARCH(20) is Engle's LM test for the ARCH effect in the residuals up to the 20th order. *P* values (in square brackets) below 0.05 indicate a rejection of the null hypothesis. The results show that neither autocorrelation nor ARCH effects remained in the residuals.

6. CONCLUSION

This study examines the characteristics of gold against inflation risk, how it has changed during different periods of the year, and how these changes shed light on the role of gold as an investment.

6 Source: Central Bank of Malaysia.

7 In their empirical work, Karim et al. (2010) have mentioned that changes in Malaysia's inflation are influenced by the output gap but not by foreign inflation. Cheng and Tan (2002) opine that Malaysia's inflation is influenced by the rest of the ASEAN's inflation, which does not significantly impact gold price if compared to the US or China inflation. In contrast, the stock market in Malaysia is more influenced by the global market scenarios, the reason why gold performs better as a stock hedge (although the characteristic is short-lived) than an inflation hedge (Ghazali et al., 2013; Ghazali et al., 2015b; Ibrahim & Baharom, 2011).

Although many proponents of gold allege that gold is adequate protection against inflation, the facts do not support this statement.

The key results of this study are summarized as follows:

1. Gold performs poorly as a hedge. The incidents of strong hedge against purchasing power loss only occasionally occur at different times and not consistently across holding periods demonstrating that different markets, economic situations, and inflation measurements influence both variables' relationship.
2. With regard to safe haven properties, this shiny metal plays a minor role when inflation enters an increasing path. Thus, although gold value increases in times of crisis and can be used as a hoarding vehicle, it is not a store of value in Malaysia.

This study has several implications for investors and companies. Gold should not be bought alone as an investment for Malaysian investors as its return does not beat inflation. Thus, investors should hold a well-diversified portfolio for protection against inflation. The authorities, on the other hand, need to regulate and monitor the gold and gold-related financial products so that it is not only seen as a window of opportunity to exploit the rising trend of gold demand but, more importantly, it should be able to provide a more competitive return on investment.

A further examination needs to be carried out to validate the US dollar's importance in the analyses. When the US dollar appreciates against other currencies, the price of gold generally tends to drop, and vice versa. The key reason for this is that gold is freely traded in international markets, and prices are quoted in US dollars. Foreign investors will purchase gold with the US dollars; thus, when the US dollar depreciates, they will have more purchasing power, and demand for gold increases. Similarly, when the US dollar appreciates, investors have less buying power, and gold becomes more expensive, muting demand and sending gold prices lower.

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