Gold Jewellery Demand and Gold Price Volatility: A Global Perspective

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Original Research Article

ABSTRACT

Profound changes have occurred in the gold jewellery market which has experienced a secular decline in demand over the last twenty years. Despite the apparent growth in gold jewellery demand in India and China in the previous two decades, there has been a more than a compensatory decline in demand for gold jewellery in the rest of the world. This indicates that the industrial uses of gold have been in decline with other traditional uses, such as, dentistry declining even more rapidly than that of jewellery. As a result, the investment of gold in the form of gold bars, coins and Exchange-Traded Funds (ETFs) have had to absorb the increased supply that resulted from the price boom of 2011-2012. The paper argues that the demise of gold jewellery demand along with other traditional uses has resulted in a significant increase in the long-term gold price volatility.

Keywords: Gold; jewellery; price volatility.

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1. INTRODUCTION & BACKGROUND

The global market for gold has undergone a fundamental and profound change stemming from the rise of India and China as key markets. More importantly, there is a rapid and secular decline in gold jewellery demand in the rest of the world over a period of twenty years as depicted in Figs 1 and 2 [1]. The decline has been driven by a shift in demand for luxury goods by Millennials [2] away from gold jewellery consumption (GFMS Thomson Reuters, 2017; Williams, 2017; World Gold Council, 2016; World Gold Council 2016a, Zheng, 2017). This decline, while certainly not as pronounced is even true in the traditional Asian markets, where urban elites in first-tier cities have recently shown an increasing preference for other luxury products, much like that being experienced in more developed countries. This, together with the decrease in the gold demand , as an outcome of changes in dentistry and other static demand in electronics has indicated that total manufacturing demand is decreasing over the last twenty years (GFMS Thomson Reuters, 2017). A number of studies have noted the decline in industrial demand for gold in developed as well as in many developing countries (Krijger, 2011; Liu, 2016; Marchia, Leeb, & Gereffic, 2013).

The purpose of this paper is to examine the impact on gold price volatility of the decline in gold jewellery demand and the concomitant increase in investment demand for gold. As we shall see below, much of the discussion of gold price volatility addresses the issue of short term fluctuations whereas this paper is concerned primarily with long term trends. This new long term focus on volatility has been driven, in part, by the argument that even small differences in long-term commodity demand lead to huge differences in the market dynamics over time that may exceed the impact of transitory cyclical change. Therefore, the economic implications in terms of multiplier effects are arguably more important.

Fig. 2 shows the trend in gold jewellery demand both globally and in the two largest markets of India[3] and China. Following the abandonment of the gold standard in 1973 there has been a long term decline in global gold demand especially from Central Banks Starr (2008). It is evident that aggregated gold demand for industrial and manufacturing uses is in steady state decline just as depicted in Fig. 1. The decrease was particularly pronounced in the wake of the 2008-09 crisis when there was a step-wise decline in demand from which there has yet to be a recovery (World Gold Council, 2017). This is a result of the twin effects of the economic crisis post-2009 and the rise in gold jewellery prices over the period. What have compensated for the decline in demand in ROW demand have been the rising demand in China and the steady and moderately rising demand in India. In most developed as well as relatively advanced developing countries like Turkey, the trend has been for a decrease in demand even in investment.

The geographic distribution of consumer demand for gold has also changed. Five countries together are responsible for 65% of global consumer demand. China and India together represent 51% of world consumer demand for gold. With the rise of India and China, the market has shifted significantly towards Asia over the past 20 years. While most other sources of gold demand have been in progressive decline, it has been the surge in investment demand in the form of bars and coins that has buoyed the overall demand for gold over the last decade. In no small measure the decline in demand has been caused by a structural shift in demand for jewellery outside India and China. Even in India and China, a younger generation of urban 'Millennials' is entering the market and have a greater range of possible luxury goods to consume than previous generations. As a result

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[1] Aggregate data for the twenty years period 1997-2016 is only available from the World Gold Council. However disaggregated data which includes India and China is only available from the World Gold Council from 2000 onwards.

[2] There is no formal definition of what constitutes a Millennial but it is generally understood to mean someone born between the early 1980's and the early 2000's. They are also referred to as generation Y.

[3] Indian data on gold usage is inflated and unreliable because of the phenomenon of round tripping caused by incentives given the Indian government to the jewellery manufacturing sector Round tripping' is the act of exporting gold, be it jewellery bars or coins, with the sole purpose of melting it down before re-importing it back to the original exporting country. The process results in a circular flow of gold between different countries, serving to inflate trade statistics. The levels involved can be significant and this is one reason why trade statistics should not be taken at face value.' – World Gold Council. (2016). India's Gold Market: Evolution and Innovation. Page 41.

of this structural change the position of gold is becoming more precarious.

There has been considerable debate in the literature in Minerals Economics as to whether the long bull market that occurred in many commodities in the first decade of the current century has been part of a commodity price super-cycle stemming from an increased intensity of use of commodities stemming in turn from the transition of China to a developed economy. While this may be the case with regard to base metals, the evidence of an increased intensity of gold use does not exist but suggests that the global intensity of gold use for industrial purposes for the period 1997-2016, actually halved per dollar of global GDP. This is depicted in Fig. 3. Disaggregated data on a country basis does exist from GFMS and it demonstrates that while the intensity of use remained largely unchanged in China over the period it has declined dramatically in India falling to one third of 2003 levels. It should be noted that 2016 was a particularly bad year for gold demand and usage is widely expected to increase in the coming years as India recovers from the imposition of value added taxes and other measures applied in the gold sector.

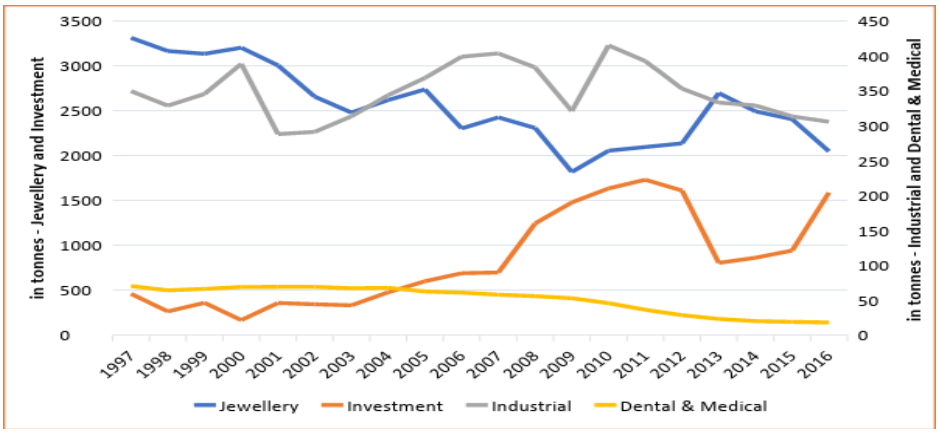

Fig. 1. Composition of gold demand (1997-2016)

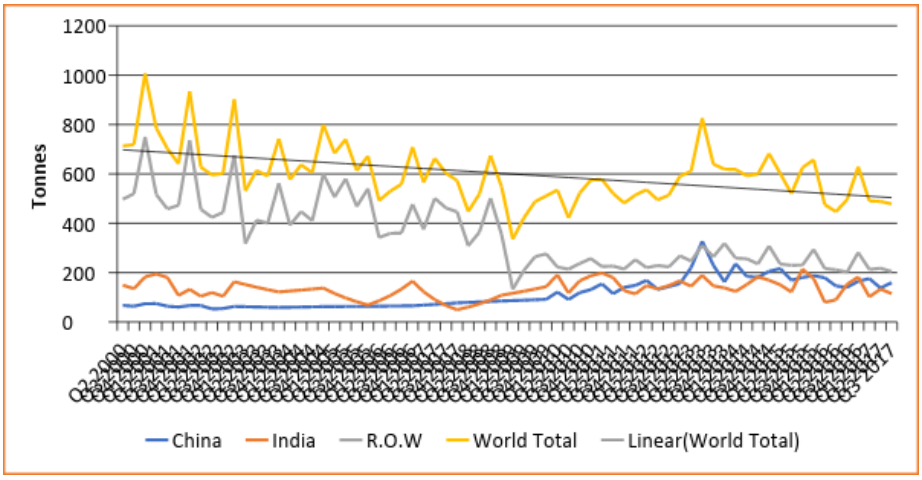

Fig. 2. Gold usage in the production of jewellery
Source: World Gold Council and author's estimates.

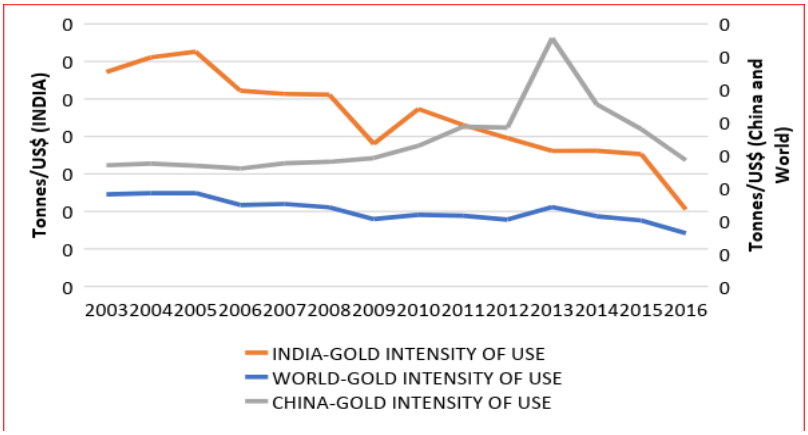

Fig. 3. Intensity of Gold Use in Manufacturing (tonnes/ GDP)

***Source**: GFMS Thompson Reuters Annual Gold Survey, various years and authors' estimates. It should be noted that GFMS and WGC data are not always consistent. GFMS data is only available from 2003 onwards*

According to other researchers in this area (Bernanke, 1983; Dixit & Pindyck, 1994; Pindyck, 1991), the price volatility affects the global economy in two broad ways. Firstly, developing countries that are heavily dependent on the primary industry are adversely affected in terms of their income and their terms of trade. This will ultimately have adverse implications towards economic agents' consumption and investment decisions. Second, commodities from the primary industry play a pivotal role as inputs in the manufacturing sector, and persistent price volatility may trigger an increase in the production cost in the manufacturing sector.

The gold price has increased from USD 35.00 per ounce under the Bretton Woods system to USD 631.10 per ounce in 1980 and reached a peak o USD 1917.90 per ounce in 2011 t. This high price was mainly attributed to the downgrade of the S&P rating on US Treasury bond from AAA to AA+ (Hashim, Ramlan, Razali & Nordin, 2017) though the structural change in the market caused by very substantial increase in demand from liberalised markets in India and China strengthened the bull market. This downgrade in the midst of the recession caused many investors to lose confidence in US currency, and subsequently they shifted their investment towards gold. However, the gold price has experienced a sharp decline since the 2011 peak.

By 2016, jewellery and other industrial uses had decreased to 55% of gold usage and the balance made up by the demand for financial instruments (bars, coins, ETF and net official purchases)[4]. The structural shift in the demand for gold from a commodity in industrial processes (thirty years ago) to more speculative end uses, which suggests that there will be an increase in volatility of demand and price. This issue of the shifting composition of gold demand and its impact upon gold price volatility is of great significance that needs further attention to find out how it is affecting gold price volatility as consumers change preferences with new uses of gold and other competing luxuries.

Gold is considered widely as being an economic hedge against risks (for example inflation). Today's advancement in financial markets and money has led to gold's prominence in 'investment'. 'Investment' differs due to the different methods that people demand or hold gold with the major difference being cultural motive. In certain countries, demand for gold is done via the acquisition of jewellery as is the case in India and China where gold jewellery collections are considered a sign of wealth.

In other parts of the world, the demand for gold is commonly in the form of gold bars or bullion. Today gold is traded on several exchanges that include among others: the London Over the Counter (OTC) market, Commodity Exchange (COMEX - New York), Shanghai and in Dubai.

[4] GFMS Thompson Reuters (2017). *GFMS GOLD SURVEY 2017*. Thomson Reuters. UK, London.

Based on the GFMS calculations, Over the Counter (OTC) transactions nudged up slightly in 2016, but in general, remained in a sideways trend when considered over the last decade. Gold trading on COMEX on the other hand has gained considerable traction over the years, jumping in 2016 by 38% to represent almost one third of annual OTC trading activity; the highest on record. However, not all of this demand is of actual gold but speculation on gold prices. As mentioned above, gold is an asset traded globally, which leads to the question of whether there is a relationship between price volatility and several aspects of demand, among others.

The concern of gold price volatility has led researchers to investigate the determinants. However, fromthe discussion above the structural change of consumption and the downward trend of consumption of gold jewellery are evident. One of the principle driving factors has been rising in the price. However, given the nature of this precious metal a better understanding of the factors affecting price or its volatility are integral as that would then shed more light in understanding how a commodity of such allure could be in such decline, especially in terms of Jewellery., The inclusion of other uses apart from jewellery in analysing the structural shift and declining demand adds on several practical uses of gold. The main objective is to examine the determinants of gold price volatility resulting from structural shift in demand and the downward trend of consumption of gold jewellery globally. To observe it and how demand or consumption of gold jewellery affects price volatility of gold, and to observe any spillover effects or contagion from the stock markets to gold price volatility.

The rest of the paper is organised as follows: the second part presents the literature review on volatility in general and gold price volatility in particular. The methodology is presented in the third section and lastly the results and conclusion.

2. LITERATURE REVIEW

The theoretical analysis of commodity price volatility normally revolves around the issues of economic uncertainty and therefore tends to be focused on short-term price volatility. While these are considered, this paper is focused on the long term determinants of price volatility which is not commonly the subject of economic theorizing.

According to Bernanke (1983), Pindyck (1991), Dixit and Pindyck (1994), price volatility increases economic volatility which hampers investment decisions and thus negatively affecting the macroeconomic fundamentals. This view is also embedded in the 'real options' channel that argues that persistent commodity price volatility causes fluctuations on economic fundamentals , that increases uncertainty over expected future cash-flows. This triggers a wait and see approach where entities may defer investment as risk increases (Bloom, 2009). Moreover price volatility has negative implications on the demand. This is attributed to the reasoning that persistent volatility increases uncertainty of future prices which may impede the macroeconomic fundamentals through a diametrical effect on consumer demand. In analysing volatility and more specifically gold price volatility, the Autoregressive Conditional Heteroskedastic/Generalized Autoregressive Conditional Heteroskedastic (ARCH/GARCH) models are particularly popular for measures of volatility. Their range varies and specific models in the family are better suited to different data and objectives being pursued. The variation with the models used to construct volatility model and is illustrated in studies by Tully and Lucey (2007), who used an Asymmetric Power GARCH (APGARCH) model (of which they were the first to use an APGARCH investigation of the gold price as they investigated macroeconomic influences on gold). Toraman et al., (2011) used a Multivariate GARCH (M-GARCH) model and Harper et al., (2013), used a host of models from the ARCH family, namely, GARCH (1, 1), an Exponential GARCH (EGARCH), (1, 1), and a Threshold GARCH (TGARCH), (1, 1).

With respect to empirical literature on gold price volatility, Lin (2016) argued that while gold has been extensively studied by economists over many decades, little is known about its consumption characteristics: reasons for purchasing gold and the qualities consumers desire, etc.. This study seeks to understand the long-term structural shift of gold demand, particularly in jewellery as it pertains to gold price volatility and seeks to shed light on the phenomenon with variables that explain to an extent consumption characteristics and/or trends that affect the gold price volatility.

Tully and Lucey (2007) investigated the macroeconomic influences on gold price volatility using the asymmetric power GARCH model (APGARCH) in which the power term in the

model was estimated within the model rather than specified by the authors. To estimate the goodness of fit of each model, likelihood ratio tests were used to assess the significance of each model and provide the best fit for the data. They found that the APGARCH model was a good fit for investigating the conditional volatility of gold prices in the UK. Furthermore, among the other variables studied, the US dollar was the only one found to significantly impact the gold price. In the same vein, Domanski and Heath (2007) echoed how commodities have attracted interest as financial instruments over time. In their article, 'financial investors and commodity markets', they discussed some factors behind the growing appeal of commodities to investors and assess the extent to which market characteristics, such as price volatility have changed. They find that it is not clear that growing investor activity can have a systematic direct effect on inventory decisions. They suggest that it is more likely that financial investors could indirectly affect inventory decisions through futures prices. However, they find that they remain open, depending on how spot prices respond to possible inventory decisions. They concluded that while physical characteristics, such as inventory levels and marginal costs of production remain important, commodity markets have become more like financial markets in terms of the motivations and strategies of participants.

Toraman et al., (2011) modelled the conditional variance of US gold price using M-GARCH model for the period 1992 to 2010, in which monthly data were used. They found, a significantly negative relationship between the return of gold and the return of USA Dollar, with the rest of the variables found to have no significant relationship with the return of gold.

Harper et al., (2013), examined the price volatility in the silver spot (cash) market. A host of models from the ARCH family were used to analyse and gain a better understanding of the volatility of silver prices. The TGARCH (1,1) model indicated that both positive and negative shocks do not have a significant effect on volatility in the silver spot market, while both the GARCH (1,1) and EGARCH (1,1) models indicated that past silver spot price volatility is significant and that volatility is observed to be not constant over time. The results provided evidence that both good and bad news have no significant effect on silver price volatility.

Gencer and Musoglu (2014) investigated the shock and volatility transmission mechanisms between gold, and stock/bond markets in Turkey, applying bivariate BEKK-GARCH modeling for gold-stocks and gold bonds pairs respectively. Overall, they observed some significant shock and volatility transmissions at varying magnitudes.

Ayele et al., (2017) modelled and forecasted the gold price volatility using the exponentially weighted moving average (EWMA) and the generalized autoregressive conditional heteroscedasticity (GARCH) models for the period from 1998 to 2014 in Ethiopia. Among the GARCH-type models, GARCH-M (2, 2) with Student's t distribution, for the residuals was found to be the best-fit model. The results indicated that exchange rate, saving interest rate and price of crude oil had a significant effect, while inflation was found to be insignificant in determining price. Additionally, previous prices from the last two months were also found to be significant in determining the current prices. The risk premium effect was found to be positive and statistically significant, suggesting increased volatility was followed by a higher mean.

Natchimuthu et al., (2017) sought to determine whether gold price volatility in India was leveraged [5]. Their study also examined the impact of US gold price return on the volatility of gold price in India. The results suggested that conditional volatility of gold price in all the six cities in India carried volatility clustering features. They also found that the United States gold returns had a significant influence on the gold price volatility in five out of six Indian cities studied.

The literature has thus provided several effects of gold price volatility. However, there is no consensus on the determinants of gold price volatility. The veracity of this needs to be determined with further empirical work. Examining the underlying long term factors is important to develop well-tailored policy instruments in a volatile market environment. Examining the determinants of gold price volatility is therefore imperative.

[5] Leverage – In this context the use of leverage means the use of various financial instruments or borrowed capital to increase the return of an investment. Gold importation in India is subsidized as a measure to spur the development of the jewellery sector.

3. METHODOLOGY

This paper is principally concerned with changes in the demand for gold. There are a number of different drivers that influence this demand. According to the literature (Hashim et al; 2017), the demand for gold is determined by activities that use gold (jewellery, medals, electrical components, etc.) and the asset/investment demand for gold. To examine the determinants of gold price volatility, the study adopts the gold price volatility function of Hashim et al., (2017) which is stated in equation 1. This gold price volatility function encompasses both the uses of gold and investment demand of gold. Limitations of the model include its inability to disaggregate the various uses of gold due to data limitations. The paper uses quarterly time series data from quarter one of 1998 to quarter three 2017. The period is chosen not only because of data considerations but because it also covers the full trade cycle for gold including the nine year bull run from 2002-2011 as well as the long subsequent decline in gold prices. The quarterly data has been used purposefully as it avoids the daily fluctuations in gold prices which are not the subject of this analysis. E-views (Econometric Views) statistical package is used for all the analysis. The data used was collected from various sources including the World Gold Council (WGC), the Federal Reserve Bank of St. Louis, S&P Global and the Bullion vault. The gold price, Jewellery demand and gold uses were extracted from the World Gold Council; the price of silver from the Bullion vault; the Dow Jones Index from S&P Global; whereas, the treasury holdings (that represents quantitative easing) used data from the Federal Reserve Bank of St. Louis.

$$lnGPVol_t = \beta_0 + \beta_1 lnJDD_t + \beta_2 lnQE + \beta_3 lnINV_t + \beta_4 lnPSIL + \beta_5 lnDJI_t + \beta 6 lnCDDt + \xi t \quad (1)$$

Where:

- $GPVol$ -Gold price volatility
- JDD- Total world jewellery demand
- QE - Quantitative easing
- INV- Gold for investment use
- PSIL-Silver price
- DJI-Dow Jones Index
- CDD-China gold demand
- ξ - Error term

Economic theory suggests that β_1 is expected to be negative. An increase in jewellery demand is expected to stabilise the gold price volatility while the impact of increased demand for gold for investment purposes would have a positive sign. Whereas, the rest of the parameters can carry any sign.

Most macroeconomic time series data have been found to have a unit root which means that they are non-stationary and therefore their variances increases with time. If these data are used in regression equations, they yield spurious results. So it is imperative to pre-test all the variables for unit roots before doing any analysis. In this study the Augmented Dickey Fuller (ADF) test was used to test for the stationarity of the variables and the variables were found to be all stationary at first difference. Results are tabulated in Table 1.

The ARCH and GARCH models have become the mostly used tools for measuring or analysing volatility. The ARCH model has certain limitations. Brooks (2008) stated that it might be difficult to decide the number of the squared residual lags to include in the model and non-negativity constraints might be violated. Hence, the GARCH model, an extension of the ARCH that allows the conditional variance to be dependent on both the lagged squared residual terms and its own past lags is preferred

Table 1. Unit Root Test

Variable	Unit Roots Augmented Dickey-Fuller (ADF)			Degree of Integration
	Level	1st Difference	0.05 Critical Value	
JDD	-2.21	-11.34	-2.90	1
QE	-0.57	-4.48	-2.90	1
INV	-2.30	-9.59	-2.90	1
PSIL	-0.82	-6.90	-2.90	1
DJI	-0.82	-6.90	-2.90	1
CDD	-0.60	-8.94	-2.90	1

GARCH Measure of Volatility

(Brooks, 2008). In measuring gold price volatility, the study uses an extension of the ARCH model, the Generalised Autoregressive Conditional Heteroscedasticity (GARCH) model, which incorporates moving average processes. A $GARCH(p,q)$ model is specified as:

$$\sigma^2(\varepsilon_t) = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \cdots + \alpha_q\varepsilon_{t-q}^2 + \beta_1\sigma_{t-1}^2 + \cdots + \beta_p\sigma_{t-p}^2$$
$$= \alpha_0 + \sum_{i=1}^{q}\alpha_i\varepsilon_{t-i}^2 + \sum_{i=1}^{p}\beta_i\sigma_{t-i}^2$$

Where, p is the order of the GARCH terms σ² and q is the order of the ARCH terms ε².
To model a GARCH process, first of all the gold price series is run as an Autoregressive Process (AR) in order to obtain the residuals that are used to generate the volatility series. To determine the appropriate lag length for the model, we use the general to specific methodology, where we start with a lag length of 4 and then trim down the model by the t-test and also using the Akaike Information Criterion (AIC). The AR (p) process is of the form:

$$Goldprice_t = \alpha_0 + \alpha_1 Goldprice_{t-1} + \alpha_2 Goldprice_{t-2} + \cdots + \alpha_p Goldprice_{t-p}$$

From the Table 2 above, it is evident that gold price series can be modelled as an AR (2) process. The second stage is to estimate several low order GARCH estimates of the gold price process and compare their goodness of fit statistics and significance levels. The results are outlined in Table 3 below:

From the above table, gold price volatility can be modelled as a GARCH (1, 1) process which is stated as $\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \beta_1\sigma_{t-1}^2$. These results are summarised in the Table 4. :

The sum of the ARCH and GARCH terms are the ones that reveal the magnitude of volatility in a model (α+β). The rule of thumb as laid by Chowdhury (2005):

- $\alpha + \beta$ is close to unity (1), then volatility is present and persistent.
- $\alpha + \beta < 0.5$ it indicates that there is no volatility.

Table 2. Gold Price Autoregressive Process

Coefficients	AR (4)	AR (3)	AR (2)
α_1	1.29 (10.81)**	1.29 (10.99)**	1.29 (10.64)**
α_2	-0.319(-1.63)*	-0.322 (-1.71)*	-0.30 (-2.73)**
α_3	0.00881 (0.041)	0.015 (0.13)	-
α_4	-0.005 (0.0045)	-	-
AIC	11.10	11.06	11.03

Table 3. GARCH Estimates

Coefficients	GARCH (1,0)	GARCH (1,1)	GARCH (1,2)	GARCH (2,1)
α_1	0.52 (0.03)**	0.24 (0.13)	-0.36 (0.13)	0.3 (0.21)
α_2	-	-	-	-0.11 (0.66)
β_1	-	0.82 (0.0000)**	0.084 (0.75)	0.0.86 (0.000)**
β_2	-	-	0.65 (0.06)*	-
AIC	10.96	10.53	10.53	10.76

Table 4. GARCH Model Results for gold price volatility

	Coefficient	***Std Errors***	***Z-Statistics***	***Prob.***
Constant (c)	*12.97*	*36.15*	*0.36*	*0.7196*
ARCH (α)	*0.24*	*0.16*	*1.51*	*0.1318*
GARCH (β)	*0.83*	*0.12*	*7.1*	*0.0000***
α + β	***1.02***			
R^2	*0.985``````*			
`tg bnm,	*1.94*			

*** , * indicates significance at the 1% and 5% level respectively*

It is evident from the table above that the sum of ARCH and GARCH coefficients (α+β) is around unity (1.07), this indicates that gold price is volatile and furthermore the volatility is persistent. The results of the long –run specification of the equation to analyze the determinants of gold price volatility as expressed in equation in (1) are given in the Table 6.

Prior to the empirical estimation, descriptive statistics are presented in Table 5 to provide further insights on the variables used in the study. According to the Jarque-Bera test, there exists sufficient evidence to support the hypothesis that a majority of the series are normally distributed. This is also evidenced by the reported skewness statistics that are fairly close to zero. The kurtosis statistics reveal that on average the distribution is flat (platykurtic) relative to the normal.

3.1 Empirical Results and Discussion

After deriving the volatility series, the model in equation 1 was estimated to examine the determinants of gold price volatility. The results are reported in Table 6. From the general statistics it can be observed that the value of the F-statistics is 117.28 Prob > F = 0.0000 shows that the overall fit of the regression is good. Moreover, it indicates that the model is significant at 1% significance level, thus, we can proceed with analysis as the parameters are jointly statistically significant. Table 6 reports that the goodness of fit is relatively high, as given by the R^2 of about 93%. The majority of the variables are also significant at 5% significance level.

The estimated results suggest that there is an inverse relationship between gold price volatility and jewellery demand, 1% decrease in total jewellery demand will lead to an increase in gold price volatility by about 1.32%, ceteris paribus. This indicates that a decline in jewellery demand will exacerbate the gold price volatility while the increases in the investment use of gold will also increase volatility. A current decline in global jewellery demand is therefore among the factors that exacerbates gold price volatility. Whereas, a positive relationship was reported from quantitative easing, the Dow-Jones index, silver price, demand for gold by China and gold investment demand. The results of the modelling suggest that neither the effects of QE nor the impact of Dow-Jones as a proxy for alternative financial instruments are statistically significant in explaining long-term gold price volatility.

Table 5. Descriptive statistics

	lnVolatility	LNJDD	LNQE	LNINV	LNPSIL	LNDJI	LNCDD
Mean	7.621045	6.390253	13.94821	2.951134	2.498539	9.348861	4.547674
Median	8.017348	6.389569	13.57555	3.147472	2.593263	9.304668	4.371727
Maximum	9.780756	6.914036	14.71781	3.863584	3.657389	9.788277	5.789769
Minimum	5.372570	5.817111	13.07101	2.034420	1.460164	8.930305	3.960813
Std. Dev.	1.505763	.194094	0.579543	0.493528	0.686116	0.208646	0.475660
Skewness	-0.152674	0.181002	0.194007	-0.395827	-0.111000	0.398334	0.768862
Kurtosis	.326277	4.080421	1.404199	1.872136	1.805585	2.630110	2.351000
Jarque-Bera	7.115860	3.191792	6.630459	4.667869	3.628283	1.896601	6.848409
Observations	59	59	59	59	59	59	59

Table 6. Long –run regression estimates

Dependent variable: Gold price volatility				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LNJDD	-1.322198	0.527378	-2.507117	0.0153
LNQE	0.078099	0.331181	0.235821	0.8145
LNINV	0.766444	0.332546	2.304777	0.0252
LNPSIL	0.686479	0.263082	2.609369	0.0118
LNDJI	0.254708	0.677248	0.376092	0.7084
LNCDD	0.798522	0.443450	1.800702	0.0776
C	3.373015	6.063228	0.556307	0.5804
R-squared	0.931187	Durbin-Watson stat		0.739572
F-statistic	117.2784	Prob(F-statistic)		0.000000

Based on the statistically insignificant constant term, the study further estimated the model without a constant term (Table 7). It is evident that excluding the constant term improves the number of significant variables. As before, a decrease in jewellery demand is associated with an increase in gold price volatility, however, this is significant at 10% significance level. The model without a constant term indicates that quantitative easing, investment demand for gold and Chinese demand for gold are the main drivers of gold price volatility. This new finding supports the hypothesis that quantitative easing puts commodity prices under strain by increasing their volatility (Bernanke, 2012). According to Bernanke (2012), quantitative easing would be beneficial if it provides financial accommodation. However, volatility has intensified since the implementation of quantitative easing. Therefore, we find evidence to support Bernanke (2012) arguments that quantitative easing is often associated with destabilising effect by intensifying volatility.

Similar to quantitative easing effect, higher investment demand for gold in countries like India and China, as gold plays an important role in their cultures, also led to the rise in gold price volatility. The World Gold Council (WGC) estimates that jewellery and investment demand from these countries represented about 40 per cent of total global demand in 2010, and that demand from India and China is expected to grow overtime. This is evidenced by the findings in Table 7 where a 1% increase in China gold demand is associated with by a more than 1% increase in gold price volatility.

When it comes to gold price volatility, investment demand is a critical component. The proxy used in the analysis (demand for coins and bars) is only a fraction of what is normally understood to constitute investment demand for gold which would include speculative as well as physical demand. The findings of the study still suggest that investment demand is significant in explaining volatility.

Furthermore, the findings of jewellery demand and Chinese demand are of considerable important as these perspectives are commonly discussed in the literature but have not been addressed empirically to any extent. The finding in regard to Chinese demand, suggest increases in Chinese demand exacerbate gold price volatility. This is an interesting finding given that Chinese cultural practices, coupled with the belief that the Chinese gold market is more of a physical market in comparison to other markets (BullionStar, 2018) and is therefore not predominantly speculative (which the results suggest). However, given that the gold market in China is not entirely liberalized, speculative practices of the Millennial generation could be the reason behind the findings in both estimates (see Tables 6 and 7).

In comparison to a study by Starr (2008), this study did two things differently. Starr looked at the effects that certain factors had on physical gold demand [] This study looked at the effects on gold price volatility. Starr combined jewellery and investment to come up with a composite variable – consumer demand. This study looked specifically at jewellery and investment as two different components having two different effects and therefore, estimated them separately to see what effect they would have on gold price volatility and not physical gold demand. Therefore Starr's results differed from those of this study. His composite variable was found to have an "appreciable relationship" with the physical demand of gold though he asserted that "factors needed to be controlled for to determine whether the impression is right". This study on the other hand, having jewellery and investment as separate components found different effects as is discussed above and has been illustrated in Tables 6 and 7.

Comment [Ed2]: Mention the citation number

Table 7. Long –run regression estimates without a constant term

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNJDD	-0.658222	0.353033	-1.864480	0.0678
LNQE	0.446959	0.159367	2.804597	0.0070
LNINV	0.770812	0.205874	3.744097	0.0004
LNPSIL	0.636068	0.201773	3.152398	0.0027
LNDJI	-0.350303	0.314387	-1.114243	0.2702
LNCDD	1.100360	0.232941	4.723776	0.0000
R-squared	0.934486	Mean dependent var		7.621045

Table 8. Normality test

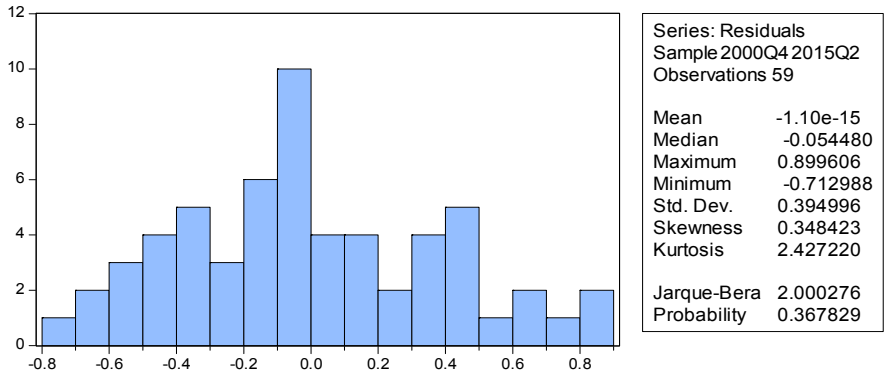

Table 9 and 10. Autocorrelation and Heteroskesdasticity Test

Table 9. Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	17.39546	Prob. F(2,50)	0.0000
Obs*R-squared	24.20854	Prob. Chi-Square(2)	0.0000

Table 10. Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.423104	Prob. F(6,52)	0.2236
Obs*R-squared	8.321612	Prob. Chi-Square(6)	0.2155
Scaled explained SS	4.612869	Prob. Chi-Square(6)	0.5943

The analysis does not, like many previous studies focused on short term price volatility but a long term structural change in the composition of gold demand. The statistically most significant factors in explaining long term volatility are China's gold demand, global investment demand and the demand of gold for jewellery consumption. India is not included stems from the unreliability of Indian gold and jewellery data which is in turn driven by round tripping.

3.2 Post estimation Analysis

The residual diagnostic tests for normality, autocorrelation and heteroscedasticity are reported in Table 8, 9 and 10, respectively. Table 8 depicts that the normality assumption of the residual term has been supported. However, the model suffers from autocorrelation as evidenced from the d-statistics as shown in Table 6 and the Breusch-Godfrey Serial Correlation LM Test as presented in Table 9. To address the problem of autocorrelation the study uses the Newey-West standard errors that are robust to auto correlation. There is however no evidence of the presence of heteroscedasticity as presented in Table 10.

4. CONCLUSIONS

The results of the analysis confirm that the long term decline of gold jewellery demand over the last twenty years has a statistically significant and adverse effect on gold price volatility. The move away from gold uses in terms of jewellery by the current generation of Millennial consumers in a range of countries will mean that the demand for gold will become increasingly dependent upon the investment demand. There exists a positive relationship between investment demand for gold and the gold price volatility. This implies that a shift in uses of gold demand towards investment demand will lead to an increase in volatility of gold prices. Similarly, the implementation of quantitative easing has intensified the volatility of gold prices. Although quantitative easing is essential to stimulate economic recovery, its implementation should, if used in future, be properly guided to ensure that the resulting negative effect is mitigated. The most statistically significant gold price volatility driving factors are declining global jewellery demand and investment demand, gold demand of China and the quantitative easing. The underlying impression here is that the current

macroeconomic environment of oscillating jewellery and gold demand has negatively affected the gold price volatility. The long-term consequences of such volatility cannot be overemphasised. Persistent volatility increases the down side risk of commodity market and further weakens the economic growth of commodity-depended developing countries.

The emphasis which gold industry stake-holders (such as the World Gold Council and the mining industry) in general have traditionally placed on promoting gold jewellery consumption is therefore entirely justifiable. However, it is increasingly difficult in light of the changing patterns of luxury good consumption. Clearly an enhanced and vigorous marketing strategy by key players lead by the World Gold Council and private investors in the gold jewellery sector is now essential to avoid exacerbating gold market instability. This paper has contributed to the economic literature on gold pricing by examining volatility in gold prices as well as identifying the determinants of such volatility that have not been emphasised in the past literatures (e.g. jewellery demand and the influence of China's gold demand). The limitation of the paper includes the inability to disaggregate the analysis between developing and developed countries. It is proposed that future research should focus on identifying the intervention policies and strategies to enhance gold price stability in both developing and developed countries.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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