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A note on the implied volatility spillovers between gold and silver markets

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ABSTRACT

While a large number of studies estimate the volatility spillover effects between gold and silver returns, none of them employs the implied volatilities of these two metal markets to assess such uncertainty transmission relationship. Our paper aims to fill this void in the existing literature. At the empirical stage, we make use of two different forms of the bivariate VAR-GARCH model to investigate the implied volatility spillovers between gold and silver markets. Our findings suggest that return and shocks significantly run from gold VIX (GVZ) to silver VIX (VXSLV), but not the other way around. In addition, we show that portfolio risk can be diversified if investors hold options in both gold and silver markets. Our findings are robust with respect to various VAR-GARCH models used in the empirical investigation.

1. Introduction

Investigating the volatility spillover effects among precious metal markets has received enormous attention in the recent literature. Assessment of such association is crucial, since understanding the uncertainty transmission relationship provides insights into means of building precise asset-pricing models and further aids in generating accurate forecasts of financial market volatility. Proper knowledge of volatility linkage across metal markets is also vital to implement active measures for financial stability perspective during the period of economic downturns. Besides, analyzing the cross-market connections in terms of asset return and volatility transmission is of paramount importance for outlining efficient business schemes and designing optimal portfolios (Arouri et al., 2015).

In this study, we intend to examine whether gold and silver markets send shocks and volatility to each other. Notable articles exploring the volatility dynamics of precious metal markets include Sari et al. (2009), Batten et al. (2010), Chen (2010), Hammoudeh et al. (2010), Morales and Andreosso-O'Callaghan (2011), Arouri et al. (2012), Cochran et al. (2012), Vivian and Wohar (2012), Sensoy (2013), Chen (2014), Demiralay and Ulusoy (2014), Bouri (2017a, b), Dutta (2017) and others. Among these articles, Batten et al. (2010), Hammoudeh et al. (2010), Morales and Andreosso-O'Callaghan (2011) and Sensoy (2013), specifically study the volatility transmission mechanism among precious metal returns. For example, Batten et al. (2010), when modeling the monthly price volatilities of four precious metals (gold, silver, platinum and palladium prices), find empirical evidence of volatility feedback among the precious metals. The authors further claim that precious metals are too distinct to be considered as a single asset class. Morales and Andreosso-O'Callaghan (2011), however, document that volatility significantly runs mainly from gold to other precious metal markets, while the opposite trend appears to be week. Similar findings are also reported by Sensoy (2013). The study reveals that gold has a unidirectional volatility shift contagion effect on all other precious metals and silver has a similar effect on platinum and palladium. The author also shows that platinum and palladium markets do not carry any significant implications in terms of volatility shift contagion.

The present study contributes to the existing literature in several aspects. First, unlike the previous researchers, our work aims to assess the relationship between the implied volatility indexes of gold and silver markets. This can be considered as an important contribution, since using the implied volatility index, as a measure of investor sentiment or risk aversion, could reveal more information than the traditional price series (Liu et al., 2013; Dutta et al., 2017). Moreover, Maghyereh et al. (2016) argue that the implied volatility linkages across markets are highly informative about the relation between market participants' expectations of future uncertainty. Yet, none of the earlier studies examines the relationship among precious metal markets employing the implied volatility series.

Second, at the empirical stage, we consider the application of bivariate VAR-GARCH model to estimate the return and volatility spillover effects between gold VIX and silver VIX. Adopting this methodology is beneficial, as it offers better statistical properties than other popular specifications such as BEKK or DCC models. For instance, one major limitation of the BEKK process is that using this model, we cannot estimate the return spillover effects between the markets under study, since the BEKK approach does not have a VAR attached to it. Furthermore, Arouri et al. (2011) show that the VAR-GARCH approach

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consistently outperforms other multivariate GARCH models including the dynamic conditional correlation (DCC)-GARCH, the constant conditional correlation (CCC)-GARCH, and the BEKK-GARCH by providing more accurate volatility measures.

Third, we make use of the estimated results of the bivariate VAR-GARCH model to analyze the portfolio risk. Specifically, we aim to find optimal portfolio weights to examine whether the combination of gold and silver options minimizes the portfolio risk. Thus the results of our study could be useful to hedge metal price volatility risk and take proper asset allocation decisions. This type of analysis might also assist investors in choosing appropriate portfolio management strategies with a view to minimizing risk during the period of uncertainty (Caporale et al., 2015).

The remainder of the paper is structured as follows. Section 2 will discuss the data and their statistical properties. We outline the VAR-GARCH models in Section 3. Results are discussed in Section 4. Section 5 concludes our study.

2. Data

In this paper, we examine the interaction between gold and silver markets using the implied volatility indexes of these precious metals. The gold and silver ETF volatility indexes (GVZ and VXSLV), published by Chicago Board of Options Exchange (CBOE), measure the market's expectation of 30-day volatility of gold and silver prices by applying the VIX methodology to the US options markets. Like other indexes, GVZ and VXSLV also use options spanning a wide range of strike prices.

Our sample period ranges from 16 March 2011 to 31 December 2016, yielding a total of 1512 daily observations. This time frame has been chosen depending on the commencement date of the volatility indexes. All the information is extracted from Thomson Reuters DataStream database.

Table 1 reports the descriptive statistics and unit root test results for volatility indexes (Panel A) and their logarithmic change (Panel B). The findings of Panel A reveal that the silver VIX is more volatile than the silver VIX as evidenced by the corresponding standard deviations. Fig. 1, where we have plotted these indexes, also support this statement. The results of both panels also demonstrate that all the indexes have kurtosis higher than 3, implying that each series has a leptokurtic distribution with asymmetric tails. Besides, all the indexes appear to be positively skewed. In addition, the Jarque-Bera test rejects the null hypothesis of normality on each occasion. Finally, the augmented Dickey–Fuller (ADF) and the Phillips–Perron (PP) tests suggest that each of the volatility series is stationary.

Table 1
Descriptive statistics and unit root test results.

Panel A: Levels	GVZ	VXSLV
Mean	18.76591	32.92886
Standard deviation	4.438271	9.165618
Skewness	1.469753	1.652732
Kurtosis	5.857260	6.866059
Jarque-Bera Test	1059.391***	1631.045***
ADF Test	− 5.089330***	− 50.62344***
PP Test	− 4.664524***	− 4.113994***
Panel B: Logarithmic change		
Mean	− 0.004130	− 0.014821
Standard deviation	2.362353	2.157452
Skewness	1.146614	1.897695
Kurtosis	10.556460	18.354650
Jarque-Bera Test	3928.613***	15760.720***
ADF Test	− 40.56249***	− 30.02209***
PP Test	− 45.12381***	− 43.27158***

Notes.
*** indicates statistical significance at 1% level.

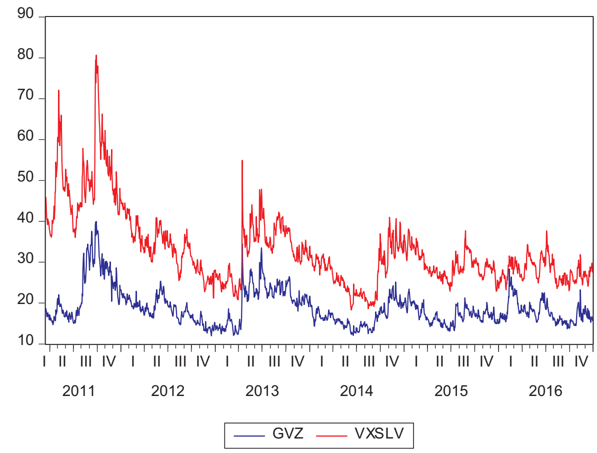

Fig. 1. GVZ and VXSLV for the whole sample period.

3. Methodology

In this section, we describe the VAR-GARCH methodology. Our analyses include two different forms of this bivariate GARCH specification. We first discuss the VAR-GARCH approach. The description of the VAR-AGARCH (i.e. VAR model combined with asymmetric GARCH) method will follow.

3.1. The VAR-GARCH approach

The bivariate VAR-GARCH approach, introduced by Ling and McAleer (2003), takes the following form:

$$R_t = L + \theta R_{t-1} + \varepsilon_t$$
$$\varepsilon_t = D_t^{1/2}\eta_t \tag{1}$$

Within this framework, R_t denotes a 2×1 vector of daily returns on the implied volatility indexes at time t, L refers to a 2×1 vector of constants, θ is a 2×2 matrix of parameters measuring the impacts of own lagged and cross mean transmissions between two options series, ε_t is the residual of the mean equation for the gold and silver index options at time t, η_t indicates a 2×1 vector of independently and identically distributed innovations and $D_t^{1/2} = diag(\sqrt{h_t^s}, \sqrt{h_t^g})$, where, h_t^s and h_t^g representing the conditional variances of silver and gold index returns respectively, are given as

$$h_t^s = l_s^2 + b_{11}^2 h_{t-1}^s + b_{21}^2 h_{t-1}^g + a_{11}^2 \varepsilon_{s,t-1}^2 + a_{21}^2 \varepsilon_{g,t-1}^2 \tag{2}$$

$$h_t^g = l_g^2 + b_{12}^2 h_{t-1}^s + b_{22}^2 h_{t-1}^g + a_{12}^2 \varepsilon_{s,t-1}^2 + a_{22}^2 \varepsilon_{g,t-1}^2 \tag{3}$$

Eqs. (2) and (3) allow us to estimate how shocks and volatility spill over across time as well as across the return indexes. Moreover, the conditional covariance between the gold VIX and silver VIX is estimated as follows:

$$h_t^{sg} = \rho_t \sqrt{h_t^s}\sqrt{h_t^g} \tag{4}$$

where, ρ_t denotes the conditional correlation between gold and silver market returns at time t.

Now, for the purpose of capturing the non-normality associated with gold and silver options, we apply the quasi-maximum likelihood estimation technique to estimate the parameters of our VAR(1)-GARCH (1,1) model. These findings are then used to analyze hedging effectiveness.

3.2. The VAR-AGARCH approach

The bivariate VAR–AGARCH model, proposed by McAleer et al. (2009), is often considered suitable as it is capable of capturing the