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Precious metals–exchange rate volatility transmissions and hedging strategies

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This study examines the conditional volatility and correlation dependency and interdependency for the four major precious metals (i.e., gold, silver, platinum and palladium), while accounting for geopolitics within a multivariate system. The implications of the estimated results for portfolio designs and hedging strategies are also analyzed. The results for the four metals system show significant short-run and long-run dependencies and interdependencies to news and past volatility. Furthermore, these results become more pervasive when the exchange rate and federal funds rate are included. Monetary policy also has a differential impact on the precious metals and the exchange rate volatilities. Finally, the applications of the results show the optimal weights in a two-asset portfolio and the hedging ratios for long positions.

1. Introduction

The literature on commodities has concentrated on price co-movements and their roles in transmitting information about the macroeconomy. The research covers a wide scope of commodities including agricultural commodities, base metals, industrial metals and energy. The existing research on precious metals focuses mainly on gold and silver. Much of the past research on industrial metals is less generous when it comes to examining the volatility of returns of the precious metals. It mainly employs univariate models of the GARCH family to analyze volatility. Previous studies focused on own shock and volatility dependencies, while ignoring volatility and correlation interdependencies over time. Thus, they do not examine precious metals' shock and volatility cross effects. This could be a major shortcoming when one considers such applications as hedging, optimal portfolio diversification, inter-metal predictions and regulations. In this regard, we are interested in ascertaining to what extent precious metal interdependencies exist and the roles of hedging and diversification among them. In addition to policy makers, traders and portfolio managers, manufacturers would be interested in this information because the metals have important and diversified industrial uses in jewelry, medicine, and electronic and autocatalytic industries, as well as being investment assets.

The broad objective of this study is to examine conditional volatility and correlation dependency and interdependency for the four major precious metals: gold, silver, platinum and palladium, using multivariate GARCH models with alternative assumptions regarding the conditional means, conditional variances, conditional covariances and conditional correlations. We include the vector autoregressive, moving average GARCH (VARMA-GARCH) model and the dynamic conditional correlation (DCC) model. We use the DCC-GARCH model as a diagnostic test of the results of the VARMA-GARCH model. This method enables us to examine the conditional

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volatility and correlations cross effects with meaningful estimated parameters and less computational complications that characterize these models. A second objective is to examine the volatility feedback effects between the four precious metals and the US dollar/euro exchange.[1] Almost all metals are sensitive to changes in the dollar exchange rates, particularly the dollar/euro rate, which is followed closely by currency and commodity practitioners and policy makers. We expect to have metals' volatility heighten when the dollar is weak and volatile because investors move to the safety of the dollar-priced precious metals. But we are also keen on knowing whether some precious metals volatility contributes to heightened volatility for the US dollar since both types of assets may be included in international foreign reserves. A third objective is to derive the implications of the estimated results on variances and covariances for effectuating optimal portfolio designs and hedging strategies.[2]

This paper is organized as follows. After the introduction, we present a review of the literature on precious metal volatility in Section 2. Section 3 provides the data and their descriptive statistics. Section 4 illustrates the VARMA-GARCH and DCC-GARCH methodologies. The empirical results are discussed in Section 5, while Section 6 provides implications of the estimates of the models. Section 7 concludes.

2. Review of the literature

Research on industrial commodities such as oil, copper and precious metals, among others, is much richer on explaining their co-movements and information transmissions than on illustrating their volatility and correlation dependency and interdependence. Moreover, research on volatility is more extensive for oil and energy than for precious metals. Within the precious metals, the research on volatility primarily employs univariate models of the GARCH family, addresses volatility dependency but not interdependency and focuses on one or two precious metals, neglecting other major ones such as platinum and palladium. Mackenzie, Mitchell, Brooks, & Faff (2001) explored the applicability of the univariate power ARCH volatility model (PARCH) to precious metals' futures contracts traded at the London's Metal Exchange (LME). They found that the asymmetric effects are not present and the model did not provide an adequate explanation of the data. Tully and Lucey (2007) used the univariate (asymmetric) power GARCH model (APGARCH) to examine the asymmetric volatility of gold. They concluded that the exchange rate is the main macroeconomic variable that influences the volatility of gold but few other macroeconomic variables had an impact. Batten and Lucey (2007) studied the volatility of gold futures contracts traded on the Chicago Board of Trade (CBOT) using intraday (high frequency) and interday data. They used the univariate GARCH model to examine the volatility properties of the futures returns and the alternative non-parametric Garman–Klass volatility range statistic (Garman and Klass, 1980) to provide further insights in intraday and interday volatility dynamics of gold. The results of both measures provided significant variations within and between consecutive time intervals. They also found slight correlations between volatility and volume.

In terms of nonlinearity and chaotic structure, Yang and Brorsen (1993) concluded that palladium, platinum, copper and gold futures have chaotic structures. In contrast, Adrangi and Chatrath (2002) found that the nonlinearity in palladium and platinum is inconsistent with chaotic behavior. They concluded that ARCH-type models with controls for seasonality and contractibility explained the nonlinear dependence in their data for palladium and platinum. They did not examine chaotic behavior of other precious metals.

In comparison with other commodities, Plourde and Watkins (1998) compared the volatility in the prices of nine non-oil commodities (including gold and silver) to volatility in oil prices. Utilizing several non-parametric and parametric tests, they found that the oil price tends to be more volatile than the prices of gold, silver, tin and wheat. They argued that the differences stand out more in the case of precious metals. Hammoudeh and Yuan (2008) included three univariate models of the GARCH family to investigate the volatility properties of two precious metals (gold and silver) and one base metal (copper). They found that, in the standard univariate GARCH model, gold and silver have almost the same volatility persistence, which is higher than that of the pro-cyclical copper. In the EGARCH model, they found that only copper has asymmetric leverage effect, and in the CGARCH model the transitory component of volatility converges to equilibrium faster for copper than for gold and silver. Using a rolling AR(1)-GARCH, Watkins and McAleer (2008) showed that the conditional volatility for two nonferrous metals, namely aluminum and copper, is time-varying over a long horizon.

In this paper, we include ARMA in the conditional mean equation to account for possible nonlinearity. Recent research has shown that ignoring this attribute may kill some of the dynamics of the relationships of the model.[3] The recent literature has used different ways to deal with nonlinearity. Pertinent articles on this subject can be found in the book edited by Schaeffer (2008). Other articles include Westerhoff and Reltz (2005) and Kyrtsou and Labys (2007).

3. Data description

We utilized daily time series data (five working days per week) for the four precious commodity closing spot prices (gold, silver, platinum and palladium), federal funds rate (*FFR*) and U.S. dollar/euro exchange rate from January 4, 1999 to November 5,

[1] In a classroom exercise on the historical correlations between the gold price and a group of dollar exchange rates and indices including dollar/euro, dollar/pound, dollar/yen, exchange rate index-broad and exchange rate index-major, the students found that the dollar/euro exchange rate has the highest correlation with the gold price over the daily period 1999–2009.

[2] Some recent research has focused on examining the optimal hedge ratios and hedging effectiveness under different model specifications (e.g., Choudhry, 2004, 2009; Demirer and Lien, 2003; Lien, 2005, 2009; Lien and Shrestha, 2008; McMillan, 2005).

[3] We thank a referee for bringing this point to our attention and for providing pertinent references.