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Risk management of precious metals☆

Shawkat Hammoudeh[a], Farooq Malik[b,*], Michael McAleer[c,d]

[a] LeBow College of Business, Drexel University, United States
[b] College of Business Sciences, Zayed University, United Arab Emirates
[c] Econometric Institute, Erasmus School of Economics, Erasmus University Rotterdam and Tinbergen Institute, The Netherlands
[d] Department of Economics and Finance, University of Canterbury, New Zealand

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ABSTRACT

This paper examines volatility and correlation dynamics in price returns of gold, silver, platinum and palladium, and explores the corresponding risk management implications for market risk and hedging. Value-at-Risk (VaR) is used to analyze the downside market risk associated with investments in precious metals, and to design optimal risk management strategies. We compute the VaR for major precious metals using the calibrated RiskMetrics, different GARCH models, and the semi-parametric Filtered Historical Simulation approach. The best approach for estimating VaR based on conditional and unconditional statistical tests is documented. The economic importance of the results is highlighted by assessing the daily capital charges from the estimated VaRs.

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1. Introduction

Financial and commodity markets have been highly volatile in recent years. Volatility brings risk and opportunity to traders and investors, and should therefore be examined. There are many reasons for volatility to occur in commodity markets. Political unrest or extreme weather conditions in commodity producing countries' can cause supply disruptions which can create volatility in commodity prices. Introduction of new financial innovations, such as futures, options, exchange-traded funds (ETFs), and use of precious metal as collateral for trading can affect precious metals volatility. Selling and buying of gold by the International Monetary Fund (IMF) and central banks can also change volatility. Changes in demand for the product of an industry that uses commodities as an input may lead to fluctuations in prices of commodities. Market participants form different expectations of profitable opportunities, perform cross-market hedging across different asset classes, process information at different speeds, and build and draw inventories at different levels. These factors contribute to volatility of commodities over time and across markets.

In addition to policy makers and portfolio managers, manufacturers are also interested in this information because precious metals have important and diversified industrial use in jewellery, medicine, electronic and auto catalytic industries. Quantification of the predictable variations in precious metals' price changes is fundamental in designing sensible risk management strategies. Value-at-risk (VaR) has become an important instrument within financial markets for quantifying and assessing the portfolio market risk associated with financial asset and commodity price movements. There is a cost of inaccurate estimation of the VaR in financial markets which affects efficiency and accuracy of risk assessments. Widespread evidence suggests that precious metals should be part of a well diversified portfolio. Since the prices of these precious metals have been very volatile, so financial market participants are interested in knowing the downside risk of holding precious metals in their portfolios. The VaR measure directly answers this important question and surprisingly there is no study on the analysis of VaR for precious metals. One of the primary purposes of the paper is to fill this void in the risk management literature.

Specifically, we compute VaR for gold, silver, platinum and palladium using RiskMetrics, the GARCH model (using normal and *t*-distribution), and the recent Filtered Historical Simulation (FHS) approach. The out-of-sample forecast performance indicates that the GARCH with *t*-distribution produces a VaR with the most accu-

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* Corresponding author.
E-mail address: farooq.malik@zu.ac.ae (F. Malik).

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rate and robust estimates of the actual VaR thresholds for all four precious metals. The unconditional coverage test of Kupiec (1995) and the conditional coverage test of Christoffersen (1998) are used to assess the performance of the various models in regards to VaR, and different risk management strategies based on the empirical results are discussed. The economic importance of the estimation results is highlighted by calculating the capital requirements using different VaR models to assess market risk exposure for all precious metals.

2. Review of literature

The commodities literature is expanding and gaining importance as a result of the increasingly significant role that commodities play in international financial markets and economies. More ETFs are being created for specific commodities. The most recent promising ETFs have been created for platinum and palladium which suggests that financial market participants are very interested in these metals. Although the commodities literature is focusing more now on important issues but the coverage remains narrow on commodity risk management, particularly in relation to precious metals like platinum and palladium. In this section, we present a review of existing studies and highlight the economic significance of the relatively sparse literature related to precious metals.

Jensen, Johnson, & Mercer, 2002 find that commodity futures substantially enhance portfolio performance for investors, and show that the benefits of adding commodity futures accrue almost exclusively when the Federal Reserve is following a restrictive monetary policy. Overall, their findings indicate that investors should gauge monetary conditions to determine the optimal allocation of commodity futures within a portfolio. Draper, Faff, & Hillier (2006) examine the investment role of precious metals in financial markets using daily data for gold, silver and platinum. They show that all three precious metals have low correlations with stock index returns, which suggests that these metals may provide diversification within broad investment portfolios. They also show that all three precious metals have hedging capability for playing the role of safe havens, particularly during periods of abnormal stock market volatility.

Hammoudeh and Yuan (2008) apply univariate GARCH models to investigate the volatility properties of two precious metals, gold and silver, and one base metal, copper. Using the standard GARCH model, they find that gold and silver had almost the same volatility persistence, while the persistence was higher for the pro-cyclical copper.

Conover, Jensen, Johnson, & Mercer (2009) present new evidence on the benefits of adding precious metals (gold, silver and platinum) to U.S. equity portfolios. They evaluate different weights (from 5% to 25%) of these metals in a typical portfolio and find that adding a 25% allocation of precious metals in a portfolio consisting of equities substantially improves the portfolio performance. They report that gold relative to platinum and silver has a better stand-alone performance and appears to provide a better hedge against the negative effects of inflationary pressures. They also show that while the benefits of adding precious metals to an investment portfolio varied somewhat over time, they prevailed throughout much of the 34-year period. Chng (2009) examines cross-market trading dynamics in futures contracts written on seemingly unrelated commodities that are consumed by a common industry. He finds such evidence in natural rubber, palladium and gasoline futures markets. The paper offers new insights into how commodity and equity markets relate at an industry level and documents implications for multi-commodity hedging.

Khalifa, Miao, & Ramchander (2011) suggest that the characterization of return distributions and forecasts of asset-price variability plays a critical role in the analysis of financial markets. They estimate different measures of volatility for gold, silver and copper. They find that the return distributions of the three markets are not normal and the application of financial time sampling techniques is helpful in obtaining a normal distribution. Using the autoregressive distributed lag approach, Sari, Hammoudeh, & Soytas (2010) examine the co-movements and information transmission among the spot prices of four precious metals (gold, silver, platinum and palladium), oil price, and the US dollar/euro exchange rate. They find evidence of a weak long-run equilibrium relationship, but strong feedbacks in the short-run. They conclude that investors may diversify a portion of the risk by investing in precious metals, oil, and the euro. Hammoudeh, Yuan, McAleer, & Thompson (2010) using multivariate GARCH models examine the conditional volatility and correlation dependence and interdependence of four major precious metals (gold, silver, platinum and palladium), while accounting for geopolitics within a multivariate system. The results indicate significant short-run and long-run dependencies and interdependencies to news and past volatility. The empirical results become more pervasive when exchange rate and federal funds rate are included. Baur and Lucey (2010) examine relations between international stocks, bonds and gold returns to evaluate gold as a hedge and a safe haven. They find that gold is a hedge against stocks, on average, and a safe haven in extreme stock market conditions.

In recent years, the variance (volatility) in prices of precious metals has increased relative to its sample mean. The volatile precious metal price environment requires market risk quantification. VaR has become an essential tool within financial markets for quantifying and assessing portfolio market risk, that is, the risk associated with price movements [see Christoffersen (2009) for a detailed overview of VaR]. VaR determines the maximum loss a portfolio can generate over a certain holding period, with a pre-determined probability value. Therefore, VaR can be used, for instance, to evaluate the performance of portfolio managers by providing risk quantification, together with portfolio returns. Moreover, VaR can help portfolio managers to determine the most suitable risk management strategy for a given situation.

One can estimate VaR using information obtained from univariate or multivariate models. Most studies [see, for example, Giot and Laurent (2004) and Kuester, Mittnik, & Paolella (2006)] analyze VaR forecasting performance for univariate models, while others [see, for example, McAleer and da Veiga (2008a)] have used multivariate models to check for the impact of volatility spillovers on estimating VaRs. Berkowitz and O'Brien (2002) conclude that a simple univariate model is able to improve the accuracy of portfolio VaR for large US commercial banks. Brooks and Persand (2003) also concluded that there are no gains from using multivariate models while, more recently, McAleer and da Veiga (2008b) found mixed evidence regarding volatility spillovers across financial assets. Christoffersen (2009) argues that univariate models are more appropriate if the purpose is risk measurement as in computing VaR forecasts, while multivariate models are more suitable for risk management as in portfolio selection.

VaR has become a standard measure of downside market risk and is widely used by financial intermediaries and banks [see Basel Committee on Banking Supervision, (1988, 1995, 1996); Perignon & Smith, 2010], equity markets [McAleer and da Veiga, 2008a,b; McAleer, 2009; McAleer, Jimenez-Martin, & Perez-Amaral, 2009; McAleer, Jimenez-Martin, & Perez-Amaral, 2010], energy markets [see Cabedo and Moya (2003)], among others. As mentioned above, despite the importance of precious metals and their volatile nature, there is no study of VaR using precious metals. One of

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