Finance Research Letters 000 (2017) 1–8

Contents lists available at ScienceDirect

Finance Research Letters

journal homepage: www.elsevier.com/locate/frl

Dynamic correlation of precious metals and flight-to-quality in developed markets

Tony Klein

Faculty of Business and Economics, Technische Universität Dresden, 01062 Dresden, Germany

ARTICLE INFO

Article history:
Received 3 April 2017
Accepted 5 May 2017
Available online xxx

JEL Classification:
C10
C32
C58
C61
G15

Keywords:
Dynamic correlations
Precious metals
Stock markets
Asymmetry
Long memory

ABSTRACT

A flexible modification of the DCC model that accounts for asymmetry and long memory in variance is proposed. This model is applied on precious metals and indexes of developed countries to revisit the flight-to-quality phenomenon. Market turmoil and shocks are covered by asset-specific variance models. I identify Gold and partly Silver as safe haven while this status seems to be dissipating in the recent years. Interestingly, Platinum shows signs of a surrogate safe haven. The practical difference between the standard DCC and the model proposed herein is significant, which stems from a more realistic variance modeling within the framework.

1. Introduction

In the last century, industrialization, digitalization, and the technological advance increased the industrial demand for metals and rare earths. The four main precious metals focused on in this article—Gold, Silver, Platinum, and Palladium—soar both in supply and demand as worldwide exploitation seeks to meet the increasing demand. The application of these metals differ. Platinum and Palladium are mainly used for industrial purposes. Over 40% of exploited Platinum of the last decade was used in the automobile industry, especially as catalyst for waste gas purification in Diesel engines (Alonso et al., 2012). Palladium mainly serves a similar purpose for gasoline engine catalytic converters. The future demand for these metals is projected to rise dramatically with China as the main exporter (Massari and Ruberti, 2013). Gold and Silver, on the other hand, are considered investment assets which outweighs their industrial usage. Gold in particular plays an important stabilizing role for financial systems (Baur and McDermott, 2010) and in a vast amount of literature, it is oftentimes referred to as hedge or safe-haven in times of turmoil. The phenomenon of increasing demand for Gold in crash-like environments is termed *flight-to-quality* (Hammoudeh et al., 2010). Baur and Lucey (2010) further distinguish this characterization and formulate the following definition: "*A safe-haven is defined as an asset that is uncorrelated or negatively correlated with another asset or portfolio in times of market stress or turmoil,*" highlighting the temporal component. We implement this definition.

E-mail address: tony.klein@tu-dresden.de

http://dx.doi.org/10.1016/j.frl.2017.05.002

In their work, Gold is more likely identified as safe-haven than as hedge. A discussion on volatility transmission is found in Hood and Malik (2013) and Gold is identified to be a weak safe haven, inferior to the VIX as safe haven investment.

We approach precious metals in the context of time-varying correlation or dynamic hedging ratios and modify the *Dynamic Conditional Correlation* (DCC) model by Engle (2002). In its original form, it employs GARCH (Bollerslev, 1986) for each variance component. However, it is well known from literature that precious metals feature distinct properties such as asymmetry or long memory in variance (Arouri et al., 2012; Chkili et al., 2014; Chkili, 2016; Hammoudeh et al., 2010). Gold and Silver are also found to couple and show similar persistence in variance (Hammoudeh and Yuan, 2008). We confirm these findings with recent data; Gold and Silver are dominated by asymmetric effects while Palladium and Platinum feature a more pronounced long memory. This is our motivation to adjust the DCC model to account for these asset-specific properties.

Chkili (2016) examines the correlation of BRICS countries and Gold with a DCC variant and identifies a safe-haven status. Sensoy (2013) models shifts in precious metals and includes them in a DCC model based on a heavy tailed distribution. Their results suggest that Silver and Platinum could improve diversification of portfolios. Mensi et al. (2017) implement a DCC-FIAPARCH for the interconnectedness of BRICS and developed markets. We further modify their DCC approach and revisit the connection of developed markets and precious metal prices. This includes an a priori choice of the idiosyncratic variance models and an iterative estimation procedure, similar to an EM algorithm (Dempster et al., 1977).

The remainder is structured as follows: Section 2 introduces the fundamentals of the DCC and its adjustment to different stylized facts, Section 3 includes data description and preliminary testing of the returns of precious metals and indexes, results are outline and discussed in Section 4, and Section 5 concludes this work.

2. Methodology

2.1. Dynamic conditional correlation (DCC)

Let $Y_t = \left(y_{1,t}, \dots, y_{k,t}\right)$ denote the k-sized vector of observations at time t. The total number of observations is $n \in \mathbb{N}$. The dynamic conditional correlation model of Engle (2002) reads

$$\begin{aligned} Y_t &= \mu_t + \varepsilon_t, \quad \text{with } \varepsilon_t = \mathbf{H}_t^{1/2}\zeta_t, \\ \mathbf{H}_t &= \mathbf{D}_t\mathbf{R}_t\mathbf{D}_t, \\ \mathbf{D}_t &= \operatorname{diag}\left(\sqrt{h_{11,t}}, \dots, \sqrt{h_{kk,t}}\right), \end{aligned} \tag{1}$$

where μ_t is the k-dimensional conditional mean structure, $\mathbf{H}_t$ denotes the $(k \times k)$-sized conditional variance matrix $\left[h_{ij,t}\right]_{i,j=1}^{k,k}$, ζ_t is a k-dimensional vector of i.i.d. random variables with zero mean and unit variance, $\mathbf{R}_t$ is the dynamic correlation matrix of size $(k \times k)$ from which we obtain the time-varying correlation coefficient estimates, and $\mathbf{D}_t$ is a diagonal matrix with idiosyncratic conditional variances as entries. We assume $\zeta_t \sim \text{St-}t_\nu(0, I_k)$. The succeeding derivation loosely follows that of Celik (2012). Let $\xi_{i,\,t}$ denote the standardized residual with respect the idiosyncratic volatility given as $\xi_{i,t} = \varepsilon_{i,t}/\sqrt{h_{ii,t}}$. The dynamic correlation matrix then decomposes to

$$\mathbf{R}_t = (\operatorname{diag}\mathbf{Q}_t)^{-1/2}\mathbf{Q}_t(\operatorname{diag}\mathbf{Q}_t)^{-1/2}, \tag{2}$$

where $\mathbf{Q}_t$ denotes the covariance matrix of the standardized residuals $\xi_t = \left(\xi_{1,t}, \dots, \xi_{k,t}\right)$. Engle (2002) introduces a GARCH(1,1)-like structure on the elements of $\mathbf{Q}_t = \left[q_{ij,t}\right]_{i,j=1}^{k,k}$ with

$$\begin{aligned} q_{ij,t} &:= \overline{\rho}_{ij} + \alpha\left(\xi_{i,t-1}\xi_{j,t-1} - \overline{\rho}_{ij}\right) + \beta\left(q_{ij,t-1} - \overline{\rho}_{ij}\right) \\ &= \overline{\rho}_{ij}(1-\alpha-\beta) + \alpha\xi_{i,t-1}\xi_{j,t-1} + \beta q_{ij,t-1}, \end{aligned} \tag{3}$$

which is mean-reverting as long as $\alpha + \beta < 1$[1] and where $\overline{\rho}_{ij}$ is the unconditional expectation of $q_{ij,\,t}$ with $\overline{\rho}_{ii} = 1$ for all $i = 1, \dots, k$. An estimator for the dynamic correlation is then obtained by calculating

$$\begin{aligned} \rho_{ij,t} &= \frac{q_{ij,t}}{\sqrt{q_{ii,t}q_{jj,t}}} \\ &= \frac{\overline{\rho}_{ij}(1-\alpha-\beta) + \alpha\xi_{i,t-1}\xi_{j,t-1} + \beta q_{ij,t-1}}{\sqrt{1-\alpha-\beta+\alpha\xi_{i,t-1}^2+\beta q_{ii,t-1}}\sqrt{1-\alpha-\beta+\alpha\xi_{j,t-1}^2+\beta q_{jj,t-1}}}. \end{aligned}$$

Rearranging the terms in Eq. (3) in matrix notation yields

$$\mathbf{Q}_t = \mathbf{S}(1-\alpha-\beta) + \alpha\xi_{t-1}\xi_{t-1}' + \beta\mathbf{Q}_{t-1}, \tag{4}$$

[1] Note that Celik (2012) uses ψ and ζ while Mensi et al. (2017) denote the DCC parameters by κ_1 and κ_2.

Please cite this article as: T. Klein, Dynamic correlation of precious metals and flight-to-quality in developed markets, Finance Research Letters (2017), http://dx.doi.org/10.1016/j.frl.2017.05.002