Journal of Banking & Finance 37 (2013) 2665–2676

Contents lists available at SciVerse ScienceDirect

Journal of Banking & Finance

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

Is gold a safe haven or a hedge for the US dollar? Implications for risk management

Juan C. Reboredo *

Universidade de Santiago de Compostela, Departmento de Fundamentos del Análisis Económico, Avda. Xoán XXIII, s/n, 15782 Santiago de Compostela, Spain

ARTICLE INFO

Article history:
Received 5 December 2012
Accepted 23 March 2013
Available online 18 April 2013

JEL classification:
C52
C58
F3
G1

Keywords:
Gold
Exchange rates
Hedge
Safe haven
Copulas

ABSTRACT

We assess the role of gold as a safe haven or hedge against the US dollar (USD) using copulas to characterize average and extreme market dependence between gold and the USD. For a wide set of currencies, our empirical evidence revealed (1) positive and significant average dependence between gold and USD depreciation, consistent with the fact that gold can act as hedge against USD rate movements, and (2) symmetric tail dependence between gold and USD exchange rates, indicating that gold can act as an effective safe haven against extreme USD rate movements. We evaluate the implications for mixed gold-currency portfolios, finding evidence of diversification benefits and downside risk reduction that confirms the usefulness of gold in currency portfolio risk management.

1. Introduction

For many years strengthened gold prices in combination with US dollar (USD) depreciation has attracted the attention of investors, risk managers and the financial media. The fact that when the USD goes down as gold goes up suggests the possibility of using gold as a hedge against currency movements and as a safe-haven asset against extreme currency movements.[1]

Some studies have examined the usefulness of gold as a hedge against inflation (Chua and Woodward, 1982; Jaffe, 1989; Ghosh et al., 2004; McCown and Zimmerman, 2006; Worthington and Pahlavani, 2007; Tully and Lucey, 2007; Blose, 2010; Wang et al., 2011 and references therein), whereas other studies have examined gold's safe-haven status with respect to stock market movements (Baur and McDermott, 2010; Baur and Lucey, 2010; Miyazaki et al., 2012) and oil price changes (Reboredo, 2013a).[2] However, few studies have considered the role of gold as hedge or investment safe haven against currency depreciation. Beckers and Soenen (1984) studied gold's attractiveness for investors and its hedging properties, finding asymmetric risk diversification for gold's holding positions for US and non-US investors. Sjasstad and Scacciavillani (1996) and Sjasstad (2008) found that currency appreciations or depreciations had strong effects on the price of gold. Capie et al. (2005) confirmed the positive relationship between USD depreciation and the price of gold, making gold an effective hedge against the USD. More recently, Joy (2011) analysed whether gold could serve as a hedge or an investment safe haven, finding that gold has been an effective hedge but a poor safe haven against the USD. This paper contributes in two ways to the existing literature on gold as a hedge and/or safe haven against currency depreciation.

First, we study the dependence structure for gold and the USD by using copula functions, which provide a measure of both average dependence and upper and lower tail dependence (joint extreme movements). This information is crucial in determining gold's role as a hedge or an investment safe haven, provided the distinction between a hedge and safe-haven asset is made in terms of dependence under different market circumstances (see, e.g., Baur and McDermott, 2010; Joy, 2011). Previous studies have examined the behavior of the correlation coefficient between gold and the USD exchange rate (Joy, 2011), but only provide an average measure of dependence. Other studies have examined the marginal effects of stock prices on gold prices using a threshold regression model, with the threshold given

* Tel.: +34 881811675; fax: +34 981547134.
E-mail address: juancarlos.reboredo@usc.es

[1] Pukthuanthong and Roll (2011) showed that the price of gold is related with currency depreciation in every country. O'Connor and Lucey (2012) analyse the negative correlation between returns for gold and traded-weighted exchange returns for the dollar, yen and euro.

[2] Other studies analyse the relationship between gold, oil and exchange rates (see, e.g., Sari et al., 2010; Kim and Dilts, 2011; Malliaris and Malliaris, 2013) and between these variables and interest rates (Wang and Chueh, 2013).

0378-4266/$ - see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.jbankfin.2013.03.020

by a specific quantile of the stock returns distribution (Baur and McDermott, 2010; Baur and Lucey, 2010; Wang and Lee, 2011; Ciner et al., 2012); however, the correlation coefficient is insufficient to describe the dependence structure (Embrechts et al., 2003)—especially when the joint distribution of gold and exchange rates is far from the elliptical distribution—and the marginal effects captured by the threshold regression do not fully account for joint extreme market movements. Therefore, we propose the use of copulas to test gold's hedge and safe-haven ability, as they fully describe the dependence structure and allow more modeling flexibility than parametric bivariate distributions.

Second, since knowledge of gold and USD co-movement is useful for portfolio managers who want portfolio diversification and investment protection against downside risk, we investigated the implications of gold-USD market average and tail dependence for risk management by comparing the risk for gold-USD portfolio holdings to the risk for simple currency portfolios. We also evaluated whether an investor could achieve downside risk gains from a portfolio composed of gold and currency by studying the value-at-risk (VaR) performance.

Our empirical study of the hedge and safe-haven properties of gold against USD exchange rates covered the period January 2000–September 2012 and evaluated the USD exchange rate with a wide set of currencies and a USD exchange rate index. We modeled marginal distributions with an autoregressive moving average (ARMA) model with threshold generalized autoregressive conditional heteroskedasticity (TGARCH) errors and different copula models with tail independence, symmetric and asymmetric tail dependence. We provide empirical evidence of positive average dependence and symmetric tail dependence between gold and USD depreciation, with the Student-*t* copula as the best performing dependence model. This evidence is consistent with the role of gold as a hedge and safe-haven asset against currency movements. We also address the risk management consequences of the links between gold and USD depreciation, providing evidence for gold's usefulness in a currency portfolio—given that it shows evidence of hedging effectiveness in reducing portfolio risk—and for a VaR reduction and better performance in terms of the investor's loss function with respect to a portfolio composed only of currency.

The rest of the paper is laid out as follows: in Section 2 we outline the methodology and test our hypothesis. In Sections 3 and 4 we present data and results, respectively, and we discuss the implications in terms of portfolio risk management in Section 5. Finally, Section 6 concludes the paper.

2. Methodology

The role of gold as a hedge or safe haven with respect to currency movements depends on how gold and currency price changes are linked under different market circumstances. Following the definitional approach adopted in Kaul and Sapp (2006), Baur and Lucey (2010) and Baur and McDermott (2010), the distinctive feature of an asset as a hedge or safe haven is as follows:

- Hedge: an asset is a hedge if it is uncorrelated or negatively correlated with another asset or portfolio on average.
- Safe haven: an asset is a safe haven if it is uncorrelated or negatively correlated with another asset or portfolio in times of extreme market movements.

The crucial distinction between the two is whether dependence holds on average or under extreme market movements.[3] To distinguish between hedge and safe-haven properties we need to measure dependence between two or more random variables in terms of average movements across marginals and in terms of joint extreme market movements.

We used copulas to flexibly model the joint distribution of gold and the USD and then linked information on average and tail dependence arising from copulas to the hedge and safe-haven properties of gold against the USD. A copula[4] is a multivariate cumulative distribution function with uniform marginals U and V, $C(u, v) = \Pr[U \leqslant u, V \leqslant v]$, that capture dependence between two random variables, X and Y, irrespective of their marginal distributions, $F_X(x)$ and $F_Y(y)$, respectively. Sklar's (1959) theorem states that there exists a copula such that

$$F_{XY}(x,y) = C(F_X(x), F_Y(y)), \tag{1}$$

where $F_{XY}(x,y)$ is the joint distribution of X and Y, $u = F_X(x)$ and $v = F_Y(y)$. C is uniquely determined on $RanF_X x\ RanF_Y$ when the margins are continuous. Likewise, if C is a copula, then the function F_{XY} in Eq. (1) is a joint distribution function with margins F_X and F_Y. The conditional copula function (Patton, 2006) can be written as:

$$F_{XY|W}(x,y|w) = C(F_{X|W}(x|w), F_{Y|W}(y|w)|w), \tag{2}$$

where W is the conditioning variable, $F_{X|W}(x|w)$ is the conditional distribution of $X|W = w$, $F_{Y|W}(y|w)$ is the conditional distribution of $Y|W = w$ and $F_{XY|W}(x,y|w)$ is the joint conditional distribution of $(X,Y)|W = w$.

Consequently, the copula function relates the quantiles of the marginal distributions rather than the original variables. This means that the copula is unaffected by the monotonically increasing transformation of the variables. Copulas can also be used to connect margins to a multivariate distribution function, which, in turn, can be decomposed into its univariate marginal distributions and a copula that captures the dependence structure between the two random variables. Thus, copulas allow the marginal behavior of the random variables and the dependence structure to be modeled separately and this offers greater flexibility than would be possible with parametric multivariate distributions. Moreover, modeling dependence structure with copulas is useful when the joint distribution of two variables is far from the elliptical distribution. In those cases, the traditional dependence measure given by the linear correlation coefficient is insufficient to describe the dependence structure (see Embrechts et al., 2003). Furthermore, some measures of concordance (Nelsen, 2006) between random variables, like Spearman's rho and Kendall's tau, are properties of the copula.

A remarkable feature of the copula is tail dependence, which measures the probability that two variables are in the lower or upper joint tails of their bivariate distribution. This is a measure of the propensity of two random variables to go up or down together. The coefficient of upper (right) and lower (left) tail dependence for two random variables X and Y can be expressed in terms of the copula as:

$$\lambda_U = \lim_{u \to 1} \Pr\left[X \geqslant F_X^{-1}(u) | Y \geqslant F_Y^{-1}(u)\right] = \lim_{u \to 1} \frac{1 - 2u + C(u,u)}{1-u}, \tag{3}$$

$$\lambda_L = \lim_{u \to 0} \Pr\left[X \leqslant F_X^{-1}(u) | Y \leqslant F_Y^{-1}(u)\right] = \lim_{u \to 0} \frac{C(u,u)}{u}, \tag{4}$$

where F_x^{-1} and F_Y^{-1} are the marginal quantile functions and where λ_U, $\lambda_L \in [0,1]$. Two random variables exhibit lower (upper) tail dependence if $\lambda_L > 0$ ($\lambda_U > 0$), which indicates a non-zero probability of observing an extremely small (large) value for one series together with an extremely small (large) value for another series.

The copula provides information on both dependence on average and dependence in times of extreme market movements. Dependence on average (given by linear correlation, Spearman's rho or

[3] Baur and McDermott (2010) draw a distinction between strong and weak hedges and safe havens on the basis of the negative value or null value of the correlation, respectively.

[4] For an introduction to copulas, see Joe (1997) and Nelsen (2006). For an overview of copula applications to finance, see Cherubini et al. (2004).