Journal of
Risk and Financial Management

Article

Optimal Portfolio Allocation between Global Stock Indexes and Safe Haven Assets: Gold versus the Swiss Franc (1999–2021)

Marco Tronzano

Department of Economics, School of Social Sciences, University of Genoa, Via Vivaldi 5, 16126 Genoa, Italy; tronzano.marco@gmail.com or marco.tronzano@unige.it; Tel.: +39-010-2095226

Abstract: This paper contributes to the literature on safe haven assets, analyzing gold and the Swiss Franc's defensive properties inside various global stocks portfolios. The analysis relies on monthly data extending over the last two decades. Drawing on Multivariate Garch DCC models, the hedging effectiveness of bivariate Swiss Franc-hedged portfolios is found to be notably higher than that of gold-hedged portfolios. Value-at-Risk simulations, assuming equal or "optimal" portfolio weights, confirm these results inside a multivariate asset framework, while a regression approach with quantile dummies provides further support in this regard. Since the better hedge and safe haven properties of the Swiss Franc are likely to persist in the future, the main policy implication of the paper concerns asset allocation strategies giving relatively more weight to the Swiss currency in global stock portfolios.

Keywords: stock prices; safe haven assets; optimal asset allocation; hedging effectiveness; gold; Swiss Franc

JEL Classification: C22; G15

check for updates

Citation: Tronzano, Marco. 2022. Optimal Portfolio Allocation between Global Stock Indexes and Safe Haven Assets: Gold versus the Swiss Franc (1999–2021). *Journal of Risk and Financial Management* 15: 241. https://doi.org/10.3390/jrfm15060241

Academic Editors: Yonggan Zhao and Shigeyuki Hamori

Received: 15 April 2022
Accepted: 24 May 2022
Published: 27 May 2022

1. Introduction

The Expected Returns-Variance of Returns (EV) rule represents the cornerstone of Modern Portfolio Theory. According to this modern approach to finance, the EV-rule implies a rational diversification among alternative financial assets—at least "*for a large and presumably representative range of expected returns and assets covariances*" (Markovitz 1952, p. 89).

Since Markovitz's (1952) seminal contribution, optimal portfolio allocation has become a crucial topic in the financial literature for both researchers and market participants, together with other relevant issues, such as hedging strategies, portfolio risk management, and asset prices forecasts.

The benefits from portfolio diversification, however, have significantly reduced during the last two decades, particularly regarding equity markets, due to sharp increases in cross-market linkages related to many financial crises episodes. These increases in stock return co-movements reflect the Forbes and Rigobon (2002) definition of financial contagion: a sudden and sustained increase in assets' conditional correlations. A wide strand of literature documents that this feature was particularly strong during the 2007–2008 Great Financial Crisis (e.g., Syllignakis and Kouretas (2011), Dimitriou and Simos (2014)) and the 2010–2012 Eurozone Debt Crisis (e.g., Dua and Tuteja (2016), Nitoi and Pochea (2019)); further contagion effects are detected during the latest financial turmoils (2015 Chinese Stock Market Crisis, 2018 Turkish Financial Crisis, see Tronzano (2021)).

The lower advantages from stocks portfolio diversification have stimulated a vast research effort into the defensive properties of safe haven assets—namely, those financial assets providing hedging benefits during periods of market stress. The literature identifies various categories of these assets, which include: gold and other precious metals (silver, platinum, and palladium), key international currencies (Swiss Franc, Japanese Yen, US Dollar, Euro), top-rated government bonds at various maturities (US short-term Treasury Bills and US 10-Year Government Bonds), and defensive stocks (i.e., stocks related to utilities, healthcare, and consumer goods companies). More recently, due to the extensive financialization process and the introduction of digital currencies, the set of safe haven assets includes financial instruments related to agricultural and energy commodities, as well as the most representative cryptocurrencies (Bitcoin, Ethereum, and Tether).

Although a large body of empirical literature documents that both gold and the Swiss Franc retained their safe haven status during recent years, one major drawback of recent research is that the optimal asset allocation of the Swiss Franc, in the context of international portfolio diversification, has never been discussed (see literature review in Section 2).

This paper addresses the above gap in existing research, and it extends the portfolio management literature analyzing gold and Swiss Franc defensive properties inside various international stock portfolios. For each risk-adjusted portfolio, the optimal weights of equity and the safe haven asset, the optimal hedge ratio, and the dynamic pattern of hedging effectiveness are computed. Moreover, in the perspective of a global international investor, the paper focuses on four aggregate stock market indexes, reflecting the world's most representative macroeconomic areas (United States, Europe, Japan, and Emerging Markets).

This paper contributes to the literature in two main respects.

First, it provides a thorough comparison of gold and the Swiss Franc's defensive properties inside global stock portfolios. Second, it provides a comprehensive assessment of these properties during all financial turmoil occurring over the last two decades, since the sample size is much larger than that employed in existing contributions.

The outline of the paper is as follows. Section 2 contains a critical survey of the literature. Section 3 covers the main methodological issues presenting the data set, providing some basic statistics, and estimating two Multivariate Garch DCC models, respectively, for gold/stocks portfolios and Swiss Franc/stocks portfolios. Section 4 focuses on optimal portfolio allocations between global stocks and each safe haven asset, as well as discusses how optimal portfolio weights, optimal hedge ratios, and hedging effectiveness vary over time, with particular reference to all financial crises that occurred over the sample period. The final part of this section compares two risk-adjusted stock portfolios: the former hedged through gold and the latter hedged through the Swiss Franc. In this context, the Value at Risk (VaR) of these portfolios is compared, assuming either equal weights for all assets or the previously computed optimal weights. Section 5 further explores gold and Swiss Franc safe haven features, analyzing their properties during extreme negative stock market conditions. Section 6 concludes.

2. Literature Review

A significant share of recent research, on optimal portfolio allocation and the hedging effectiveness of safe haven assets, is devoted to gold and other precious metals. Existing contributions involving the Swiss Franc, on the other hand, while reiterating the safe haven properties of the Swiss currency, display some significant limitations.

Focusing on gold, recent contributions confirm the defensive properties of the yellow metal emerging from previous seminal papers (see, e.g., Baur and McDermott (2010), Hood and Malik (2013)); these contributions, moreover, discuss optimal asset allocation issues of various stock portfolios, including a gold component, at a sectorial, national, and international level.

At a sectorial level, Beckmann et al. (2019) find weak significant tail dependence between gold and Chinese stocks, thus confirming gold's role as a safe haven asset; moreover, they document that adding gold to Chinese stock portfolios helps to reduce their risks. At a national level, a portfolio analysis on the MSCI China index, using competing Multivariate Garch models, shows that stock investment risk can profitably be hedged, taking short positions in the gold future market (El Hedi Arouri et al. (2015)); an analogous investigation on the US SP500 index reveals that gold is the best hedge, providing better results than US bonds and oil, in terms of dynamic hedging effectiveness (Abid et al. (2020)). These results are confirmed when the analysis is extended to global stock portfolios of different countries incorporating gold to mitigate downside risk: see, respectively, Chkili (2016), regarding gold/stock pairs relative to BRICs countries; Mensi et al. (2017a) for a similar analysis, relative to five major stock market indexes (SP500, Stock600, TSX, Nikkey 225, DJASIA); Hussain Shazad et al. (2020) for a similar analysis, relative to individual G7 stock indices and the MSCI G7 Aggregate Index. Further, more recent evidence about the good safe haven and hedging effectiveness properties of gold, in various global stock portfolios, are provided in Dong et al. (2021), using a trivariate dynamic conditional correlation model, and in Wang et al. (2021), using a time-frequency domain connectedness approach.

The recent COVID-19 pandemic prompted further research about gold properties during this highly unstable period: in most cases, this research confirms that gold remained a robust safe haven asset (Ji et al. 2020; Sikiru and Salisu 2021; Salisu et al. 2021; Yousaf et al. 2021; Tarchella and Dhaoui 2021), although some authors obtain slightly less favorable results (Akhtaruzzaman et al. 2021).

Turning to the Swiss Franc, many empirical contributions confirm earlier results, which provided large support to this currency as a safe haven asset in equity portfolios (see e.g., Kugler and Weder 2004; Campbell et al. 2010; Ranaldo and Söderlind 2010).

Danthine and Danthine (2017) maintain that long-run, Swiss-based, international investors benefit from the secular appreciation tendency of the Swiss currency, and this more than compensates for the traditional under-performance of Swiss-denominated asset returns. Lee (2017) applies Markov regime-switching vector autoregressive models to test whether six important currencies (Swiss Franc, Japanese Yen, British Pound, Euro, Canadian Dollar, and Norwegian Krone) are negatively related to risky assets (and whether this negative relation is stronger during "crisis" periods) and concludes that only the Swiss Franc and the Japanese Yen qualify as strong "safe havens". Chan et al. (2018) rely on a bivariate regime-switching model and find that the Swiss Franc, the U$ Dollar, and the Japanese Yen have positive co-skewness (i.e., they appreciate when stock markets become more volatile), thus providing protection against stock markets turbulences. Balcilar et al. (2020) use a two-factor, regime-based volatility spillover model to analyze the effects of global and regional stock market shocks. They find that, while precious metals (including gold) display positive exposure to stock market shocks during crises periods, safe haven currencies (including the Swiss Franc) display either insignificant or negative risk exposures, implying that these currencies are more effective hedges for global equity investors.

The strong evidence in support of the Swiss Franc as an important safe haven currency involves all latest empirical contributions. Quite interestingly, this research relies on a variety of methodological approaches, ranging from cross-quantilogram analysis (Cho and Han 2021) to time-varying factor decomposition models (Fink et al. 2022) and a regime-switching factor copula approach, implemented on a large number of assets and developed and emerging stock markets (Tachibana 2022).

Overall, although the defensive properties of the Swiss Franc are widely established, a major drawback of recent research is that the optimal asset allocation of this currency, in the context of international stock portfolio diversification, has consistently been neglected. This drawback stands in sharp contrast with research focusing on gold and other precious metals, where most contributions address the risk management implications of estimated models, in terms of optimal portfolio design and dynamic hedging ratios, underlining the importance of adding some safe haven asset to a stock-diversified portfolio in order to improve its overall risk-adjusted return performance (see, e.g., El Hedi Arouri et al. 2015; Mensi et al. 2017a, 2017b; Hussain Shazad et al. 2020).

This relevant shortcoming of the Swiss Franc literature has been explicitly recognized in some contributions, which emphasize how "*for global investors, the optimal hedging problem of various currencies for a particular international stock portfolio is also a crucial issue*" (Chan et al. 2018, p. 75) and underline the need to explore the hedging effectiveness of precious metals versus that of some key international currencies (Balcilar et al. 2020, Section 4).

Finally, and from a more general perspective, a further limitation of all contributions surveyed in this section is that the sample sizes are always rather small and never encompass the last two decades. This prevents analysis of the portfolio management implications associated with all financial turbulences that occurred over the last two decades, from the 2007/2008 Great Financial Crisis up to the recent COVID-19 pandemic.

3. Methodology

3.1. Data and Descriptive Statistics

The analysis relies on monthly data from January 1999 to July 2021, yielding a total of 271 observations. In the perspective of a global international investor, two well-known safe haven assets are considered—namely, gold and the Swiss Franc—along with four aggregate stock market indexes, covering most representative world macroeconomic areas (United States, Europe, Japan, and Emerging Markets). All series are obtained from the Thomson Reuters Datastream and refer to end-of-month data.

Gold price is expressed in US Dollars, while the Swiss Franc exchange rate is measured through the Swiss Franc Index, which refers to the nominal exchange rate of this currency against a basket of foreign currencies. Since an increase in this series points out a Swiss Franc appreciation (i.e., the Swiss Franc becoming more expensive in terms of foreign currency units), a positive rate of change of this variable denotes an increase in Swiss Franc returns.[1] All stock price indexes are provided by Morgan Stanley Capital Investment (MSCI) and are expressed in US Dollars. The US Dollar represents the reference currency for international investors; moreover, stock returns expressed in US Dollars allow a simple comparison with other asset returns studied in this paper.[2]

Table 1 contains descriptive statistics for these series. These statistics refer to the basic properties of asset returns and to standard normality, homoscedasticity, and serial correlation tests.

Table 1. Descriptive Statistics for Asset Returns. Monthly Data: 1999M2–2021M7 (270 Obs.).

	DUS	DEU	DJP	DEM	DG	DSW
Mean	0.0045	0.0016	0.0019	0.0054	0.0068	0.0018
Standard Deviation	0.0440	0.0529	0.0473	0.0630	0.0474	0.0129
Skewness	−0.699	−0.712	−0.244	−0.766	−0.128	0.267
Excess Kurtosis	1.503	1.903	0.423	2.407	0.934	7.489
Jarque-Bera	47.4 ***	63.6 ***	4.71 *	91.6 ***	10.6 ***	634.2 ***
Arch (1)	29.6 ***	22.3 ***	6.8 ***	20.9 ***	3.9 **	19.5 ***
Arch (6)	38.6 ***	30.4 ***	23.5 ***	27.3 ***	6.2	21.8 ***
Ljung-Box (1)	1.22	3.57 *	4.22 **	8.25 ***	2.90 *	0.90
Ljung-Box (12)	10.9	13.2	13.9	14.9	12.4	12.4
Ljung-Box (24)	23.4	18.3	21.3	25.1	22.3	20.1

Jarque–Bera: Jarque and Bera (1980) test for the null hypothesis of normality. ARCH: ARCH test for the null hypothesis of homoscedasticity. Ljung–Box: Ljung–Box test for the null hypothesis of absence of serial correlation. DUS: US returns; DEU: Europe returns; DJP: Japan returns; DEM: Emerging Markets returns; DG: Gold returns; DSW: Swiss Franc returns. ***: significant at a 1% level; **: significant at a 5% level; *: significant at a 10% level.

All average returns are close to zero, in line with the efficient market hypothesis. With regards to equity returns, only US returns are statistically significant at the 10% level; both safe haven assets display, instead, average returns significant at the 5% level. Standard deviations for all series display a significant degree of variability, particularly in the case of Emerging Markets stocks. All series (except Swiss Franc returns) are negatively skewed, pointing out asymmetric distributions with long tails in the leftward direction. All monthly returns, moreover, exhibit positive excess kurtosis, thus denoting fatter tails relative to the normal density. In line with the above evidence, the Jarque–Bera test consistently rejects the null of normality. Strong Arch effects are documented for all series, suggesting that a Multivariate Garch approach is suitable to estimate conditional volatilities. The Ljung–Box test, finally, documents some first-order serial correlations in most series, whereas serial correlation disappears at longer lags.

Table 2 contains unconditional correlation coefficients.

Table 2. Correlation Matrix of Asset Returns. Monthly Data: 1999M2–2021M7 (270 Obs.).

	DUS	DEU	DJP	DEM	DG	DSW
DUS	1					
DEU	0.858	1				
DJP	0.635	0.643	1			
DEM	0.764	0.815	0.646	1		
DG	0.014	0.122	0.101	0.231	1	
DSW	−0.140	−0.092	−0.111	−0.113	0.169	1

See Table 1 for explicative notes.

In line with recent research, (see e.g., Tronzano (2021)), all global stock indexes display positive and relatively high correlation coefficients. This reflects the increased capital liberalization process of the last decades, and the occurrence of relevant financial crises with their associated contagion effects. Turning to safe haven assets, we observe very low (positive) values between gold and equity returns, and very low (negative) values between the Swiss Franc and equity returns. Overall, this evidence points out the defensive properties of these assets against stock markets turbulences. Finally, the low correlation coefficient between safe haven assets confirms their usefulness as powerful risk-diversification tools.

3.2. Dynamic Conditional Correlation Estimates

The analysis of the next section requires accurate estimates of conditional variances and covariances of the assets involved.

A widely used approach in the class of time-varying hedge ratio models is the Engle (2002) Dynamic Conditional Correlation (DCC) Garch model.[3] The main advantage of this model is to allow a multivariate analysis of asset returns in a parsimonious parameters setting.

This approach relies on the following decomposition for the conditional variance-covariance matrix of asset returns:

$$H_t = D_t R_t D_t \tag{1}$$

where D_t is a $(n \times n)$ diagonal matrix of time-varying standard deviations from univariate Garch models, and R_t is a $(n \times n)$ time-varying correlation matrix of asset returns $(\rho_{ij,t})$.

The conditional variance-covariance matrix (H_t) is estimated in two steps. In the first step, univariate Garch (1,1) models are applied to mean returns equations, thus obtaining conditional variance estimates for each financial asset ($\sigma^2{}_{it}$; for i = 1, 2, . . . , n), namely:

$$\sigma^2{}_{it} = \overline{\sigma}^2{}_{it}(1 - \lambda_{1i} - \lambda_{2i}) + \lambda_{1i}\, \sigma^2{}_{i,t-1} + \lambda_{2i}\, \varepsilon^2{}_{i,t-1} \tag{2}$$

where $\overline{\sigma}^2{}_{it}$ is the unconditional variance of the asset return, λ_{1i} is the volatility persistence parameter, and λ_{2i} is the parameter capturing the influence of past errors on the conditional variance.

In the second step, the residuals vector obtained from the mean equations system (ε_t) is divided by the corresponding estimated standard deviations, thus obtaining standardized residuals (i.e., $u_{it} = \varepsilon_{it} / \sqrt{\sigma^2_{i,t}}$ for i = 1, 2, . . . , n), which are subsequently used to estimate the parameters governing the time-varying correlation matrix.

The dynamic conditional correlation matrix of asset returns may, thus, be expressed as:

$$Q_t = (1 - \delta_1 - \delta_2)\, \overline{Q} + \delta_1 Q_{t-1} + \delta_2\, (u_{t-1}\, u'_{t-1}) \tag{3}$$

where $\overline{Q} = E[u_t u'_t]$ is the $(n \times n)$ unconditional covariance matrix of standardized residuals, and δ_1 and δ_2 are parameters (capturing, respectively, the persistence in correlation dynamics and the impact of past shocks on current conditional correlations).

In order to compute optimal portfolio weights and compare the hedging properties of alternative safe haven assets, two Multivariate DCC Garch Models are estimated: the former includes gold and stock returns, and the latter includes Swiss Franc and stock returns.

According to Section 3.1, almost all asset returns exhibit significant first-order serial correlation. For this reason, all returns were pre-filtered through an AR (1) process.[4] Visual inspection of residuals from the filtered series confirms that they are white noise processes. A further relevant feature, emerging from the preliminary data inspection, is the existence of fat tails in asset returns and the rejection of the null hypothesis of normal distributions. In order to account for these features, the t-DCC specification of the Engle (2002) model, developed by Pesaran and Pesaran (2010), is implemented.[5] In the estimates of both models, conditional volatility coefficients (λ_1, λ_2) are unrestricted and assumed to be different for each financial asset (i) (see Equation (2)). Correlation parameters are left unrestricted as well, although a common correlation structure is imposed in the model (see δ_1, δ_2 parameters in Equation (3)).

The Maximum Likelihood estimator relies on 249 observations (20 observations are used to initialize the recursions), and converges after 43 iterations in the gold case and 35 iterations in the Swiss Franc case. The validity of estimated t-DCC models is assessed using the diagnostic tests suggested in Pesaran and Pesaran (2010). The null hypothesis of correct model specification is not rejected (for both models), at standard significance levels, by neither a Lagrange multiplier test for serial correlation in probability transform estimates, nor by a Kolmogorov–Smirnov statistic testing the uniformity of the distribution of probability transform estimates.[6]

Table 3 contains the results from Multivariate Garch DCC Models. The upper section of this Table 3 (A) refers to a global stock portfolio, where gold is used as a hedging asset; conversely, in the lower section of the same Table 3 (B), the Swiss Franc is used as a hedging asset.

Table 3. (**A**) Multivariate Garch (1,1)—DCC Model: Gold and Global Stock Returns Sample: 2000m11–2021m7 (249 Observations). (**B**) Multivariate Garch (1,1)—DCC Model: Swiss Franc and Global Stock Returns Sample: 2000m11–2021m7 (249 Observations).

(**A**)			
Parameter	**Estimate**	**Standard Error**	**t-Ratio [Prob]**
λ_{1DUS}	0.666 ***	0.119	5.56 [0.000]
λ_{1DEU}	0.885 ***	0.031	27.8 [0.000]
λ_{1DJP}	0.820 ***	0.105	7.75 [0.000]
λ_{1DEM}	0.710 ***	0.108	6.51 [0.000]
λ_{1DG}	0.866 ***	0.141	6.10 [0.000]
λ_{2DUS}	0.197 ***	0.053	3.67 [0.000]
λ_{2DEU}	0.078 ***	0.0191	4.08 [0.002]
λ_{2DJP}	0.113 **	0.053	2.11 [0.035]
λ_{2DEM}	0.128 ***	0.043	2.92 [0.004]
λ_{2DG}	0.083	0.054	1.53 [0.127]
δ_1	0.823 ***	0.062	13.1 [0.000]
δ_2	0.040 ***	0.012	3.16 [0.002]
df	12.34 ***	3.13	3.93 [0.000]
Maximized Log-Likelihood: 2413.2			

Table 3. *Cont.*

(B)			
Parameter	**Estimate**	**Standard Error**	**t-Ratio [Prob]**
λ_{1DUS}	0.736	0.076	9.67 [0.000]
λ_{1DEU}	0.875	0.034	25.2 [0.000]
λ_{1DJP}	0.826	0.092	8.89 [0.000]
λ_{1DEM}	0.714	0.112	6.34 [0.000]
λ_{1DSW}	0.568	0.158	3.57 [0.000]
λ_{2DUS}	0.178	0.043	4.13 [0.000]
λ_{2DEU}	0.083	0.020	4.12 [0.002]
λ_{2DJP}	0.121	0.054	2.24 [0.026]
λ_{2DEM}	0.126	0.043	2.87 [0.004]
λ_{2DSW}	0.157	0.050	3.14 [0.002]
δ_1	0.788	0.090	8.71 [0.000]
δ_2	0.061	0.014	4.16 [0.000]
df	10.95	2.502	4.37 [0.000]
Maximized Log-Likelihood: 2843.6			

***: significant at a 1% level; **: significant at a 5% level. λ_{1i}, λ_{2i}: volatility parameters (assumed different for each asset) from univariate Garch equations: see Equation (2). i = DUS, DEU, DJP, DEM, DG, DSW (see Table 1 for explicative notes about meanings of these symbols). δ_1, δ_2: correlation parameters (assumed equal for all asset returns): see Equation (3). df: degrees of freedom parameter for the multivariate t-distribution.

4. Portfolio Management, Optimal Hedging Strategies and Value-at-Risk

A basic output from estimated Multivariate DCC Garch models is the time-varying variance-covariance matrix of asset returns. This information has crucial implications for portfolio management. On this basis, risk managers may select optimal portfolio allocations based on (time-varying) asset weights and dynamic risk-minimizing hedging strategies.

This section exploits the results of Section 3 in this perspective. First, optimal assets weights, optimal hedge ratios, and hedging effectiveness are defined. Then, conditional variances are used, and covariances are extracted from DCC Garch models, to perform an optimal portfolio analysis and some Value-at-Risk (VaR) simulations.

The analysis focuses on two issues. The former is the defensive power of alternative financial instruments in bilateral portfolios, including one equity index and one safe haven asset. The latter refers to a VaR comparison between two risk-adjusted stock portfolios (hedged, respectively, through gold or the Swiss Franc). Value-at-Risks of these portfolios are compared, assuming either equal weights for all assets or an approximate measure of optimal weights derived from previous empirical estimates.

4.1. Optimal Weights, Hedge Ratios and Hedging Effectiveness

The portfolio management implications of estimated DCC Garch models can be summarized through the following financial indicators: (a) optimal portfolio weights; (b) optimal hedging ratios; (c) hedging effectiveness.

The former indicator assumes, in our case, that a representative investor holds a safe haven asset (Gold: "G"; or Swiss Franc: "SF") in order to protect their portfolio from stock price volatility. The investor's objective is to minimize portfolio risk, while obtaining the same expected return. Then, following the recent literature (see, e.g., Kroner and Ng 1998), the optimal weight of stock in a one-dollar portfolio of stock/gold, at time (t), is given by:

$$w_{SG,t} = \frac{h_{G,t} - h_{SG,t}}{h_{S,t} - 2h_{SG,t} + h_{G,t}}$$
$$w_{SG,t} = \begin{array}{c} 0 \text{ if } w_{SG,t} < 0 \\ w_{SG,t} \text{ if } 0 \leq w_{SG,t} \leq 1 \\ 1 \text{ if } w_{SG,t} > 1 \end{array} \quad (4)$$

where: $h_{G,t}$ = conditional variance of gold; $h_{S,t}$ = conditional variance of stock; $h_{SG,t}$ = conditional covariance between stock and gold.[7]

The second indicator defines the risk minimizing optimal hedge ratio. Referring, again, to the above example, this indicator is defined as:

$$\beta_{SG,t} = \frac{h_{SG,t}}{h_{G,t}} \tag{5}$$

In this case, the ratio defines how much a long position (buy) of one dollar in the equity market must be hedged by a short position (sell) in the gold market. Therefore, while a positive ($\beta_{SG,t}$) indicates that a long position (buy) in the risky asset is hedged by a short position (sell) in the safe haven asset, a negative ($\beta_{SG,t}$) means that optimal hedging implies a long position both in the risky asset (stock) and in the safe haven asset (gold).

The last indicator captures the performance of the optimal hedging strategy by comparing the variance of the hedged portfolio to that of the unhedged portfolio. With reference to the above example, the hedging effectiveness is thus defined as:

$$HE_{SG,t} = \frac{\text{Variance}_{\text{Unhedged}} - \text{Variance}_{\text{Hedged}}}{\text{Variance}_{\text{Unhedged}}} \tag{6}$$

with: $\text{Variance}_{\text{Hedged},t} = (w_{SG,t})^2\, h_{S,t} + (1 - w_{SG,t})^2\, h_{G,t} + 2\, w_{SG,t}\, (1 - w_{SG,t})\, h_{SG,t}$.

The indicator defined in Equation (6) ranges between 0 (no risk reduction) and 1 (perfect hedge). Since a higher value of this indicator implies a greater hedging effectiveness, in terms of a portfolio's variance reduction, comparing the hedging effectiveness of alternative safe haven assets is a useful exercise to evaluate their hedging power and its evolution over time.

4.2. Optimal Portfolio Management: Implications from DCC Garch Models

This section analyzes optimal equity weights, optimal hedge ratios and the hedging effectiveness of bivariate portfolios, including one global stock and one safe haven asset. This empirical evidence is discussed in two steps. First, I concentrate on the average values of these indicators; second, I discuss their time-varying patterns in the light of recent financial crises episodes.

Table 4 contains average optimal weights (W), average optimal hedge ratios (β), and hedging effectiveness indicators (HE) for each bivariate stock portfolio. These indicators are defined, respectively, in Equations (4)–(6). The suffix "SG" (or "SSF") in these indicators points out whether they refer to gold (or the Swiss Franc) as a defensive asset (see also footnote 9).

The upper section refers to stock portfolios hedged through gold, while in the lower section, the Swiss currency acts as the hedging asset.

The optimal weights of equity for most gold/stocks pairs oscillate around 50%, with a slightly lower value for Emerging Market stocks (0.394), due to their higher variability with respect to other asset returns (see Table 1). These results are closely in line with the recent literature investigating the optimal weight of gold in various bilateral stock portfolios. Mensi et al. (2017a), for instance, report optimal gold weights of 0.41 and 0.53 for bilateral portfolios related, respectively, to US and European stocks. These results closely reflect those obtained in the upper section of Table 4 for the United States and Europe, which confirm a slightly higher optimal weight of gold in the European stock portfolio (recall that, in the present paper, W_{SG} indicates the optimal weight of stock in a one-dollar stock/gold portfolio). Further close similarities with our optimal gold weights results may be found in Sikiru and Salisu (2021), where an almost identical value is reported for a Japanese stock/gold portfolio, and broadly similar values are reported for a large group of Emerging Market economies.

Table 4. Optimal Weights, Optimal Hedge Ratios, and Hedging Effectiveness; Average Values: 2000M11–2021M7 (249 Observations).

Gold and Global Stocks Portfolios			
Global Stocks	$\mathbf{W_{SG}}$	$\boldsymbol{\beta_{SG}}$	$\mathbf{HE_{SG}}$
United States	0.513	−0.015	0.492
Europe	0.462	0.129	0.476
Japan	0.481	0.190	0.428
Emerging Markets	0.394	0.261	0.490
Swiss Franc and Global Stocks Portfolios			
Global Stocks	$\mathbf{W_{SSF}}$	$\boldsymbol{\beta_{SSF}}$	$\mathbf{HE_{SSF}}$
United States	0.250	−0.301	0.808
Europe	0.205	−0.210	0.827
Japan	0.235	−0.367	0.823
Emerging Markets	0.187	−0.383	0.861

See Section 4.1, for the definitions of all symbols appearing in this table.

Focusing on the lower section of Table 4, the optimal weights of equity for Swiss Franc/stocks portfolios are, instead, notably lower. Average values range from 0.25 (US stocks) to 0.187 for Emerging Market stocks. Overall, this implies a much higher proportion of risky assets hedged through the Swiss Franc, suggesting that the Swiss currency has better properties than the yellow metal in reducing the downside risk of equity investments.

As discussed in Section 2, the optimal weight of the Swiss Franc in global stock portfolios has never been explored in the literature. Accordingly, there is no benchmark comparison for our results assigning a very large weight to the Swiss currency in all global stocks portfolios. In a more general perspective, however, this empirical evidence is consistent with Lee (2017), where Markov-Switching VAR models are applied to six currencies in order to capture their time-varying relationships with one global stock market index (MSCI All Country World Index). As documented in Lee (2017), only the Swiss Franc and the Japanese Yen qualify as safe haven currencies, displaying insignificant co-movements with this global stock market index under both "normal" and under "crises" periods. Since this global index measures the stock performance of a large number of countries (23 developed and 23 emerging markets), Lee (2017) results are closely in line with the large weight assigned to the Swiss Franc in global stock portfolios examined in the present paper.

Turning to average optimal hedge ratios (Table 4, second column), a relevant difference is apparent when comparing the values recorded for alternative safe haven assets.

Focusing on the gold case (β_{SG}), all values are positive, with the US stocks as the only exception. This means that long positions in European, Japanese, or Emerging Markets stocks should be hedged through short positions in the gold market. In the Emerging Markets case, for instance, where β_{SG} displays the largest positive value (0.261), a $1 long position in the equity market should be hedged with a 26.1 cents short position in the gold market. On the whole, optimal hedge ratios obtained in this case point out that, with the exception of US stocks, hedging strategies based on gold are, on average, relatively more expensive, particularly in the case of Japanese and Emerging Markets stocks, where β_{SG} reaches high positive values.

The evidence for Swiss Franc hedged stock portfolios is notably different. Optimal hedge ratios (β_{SSF}) are now always negative, ranging from −0.210 (European stocks) to −0.383 (Emerging Markets stocks). This means that, for all global stocks, a long position in equity should be hedged with a long position in the Swiss currency. On the whole, therefore, optimal hedging strategies implemented through the Swiss Franc are notably less expensive than those implemented through gold. This evidence is in line with previous results and indicates that the Swiss Franc has better hedging properties than gold with reference to equity portfolios analyzed in this paper.

The performance of optimal hedging strategies can be measured in terms of Hedging Effectiveness indicators. These indicators appear in the third column of Table 4, respectively for gold (HE_{SG}) and Swiss Franc (HE_{SSF}) portfolios.

As illustrated in Equation (6), this performance indicator ranges between zero (no risk reduction) and one (perfect hedge). A higher HE index indicates, therefore, a greater hedging effectiveness of the associated investment strategy in terms of portfolio's variance reduction.

The Hedging Effectiveness indicators appearing in Table 4 confirm the better hedging properties of the Swiss Franc. As shown in the upper section, all gold/stocks portfolios display values around 0.4–0.5. On the other hand, global stocks portfolios hedged through the Swiss Franc display values consistently higher than 0.8, reaching a maximum value of 0.86 in the case of Emerging Markets stocks. These results imply that the inclusion of gold in global stock portfolios ensures, on average, a variance reduction of around 40–50%, whereas the same stocks portfolios hedged through the Swiss currency yield a much higher variance reduction, always exceeding 80%.

Regarding gold, this empirical evidence is broadly in line with the existing literature, although slightly more conservative. For instance, in the case of Japan, Yousaf et al. (2021) report an average value of Hedging Effectiveness of 0.599 during the pre-COVID period. Additionally, El Hedi Arouri et al. (2015) report values around 0.40 (i.e., very similar to ours) for various multivariate volatility models applied to a portfolio of gold and Chinese stocks (not considered in the present paper). A more original feature of this analysis is, however, related to Swiss Franc results where, according to our estimates, the proportion of variance reduction in global stocks portfolios is extremely high. No previous contribution, to the best of my knowledge, had documented this notably high hedging performance of the Swiss currency during the last decades.

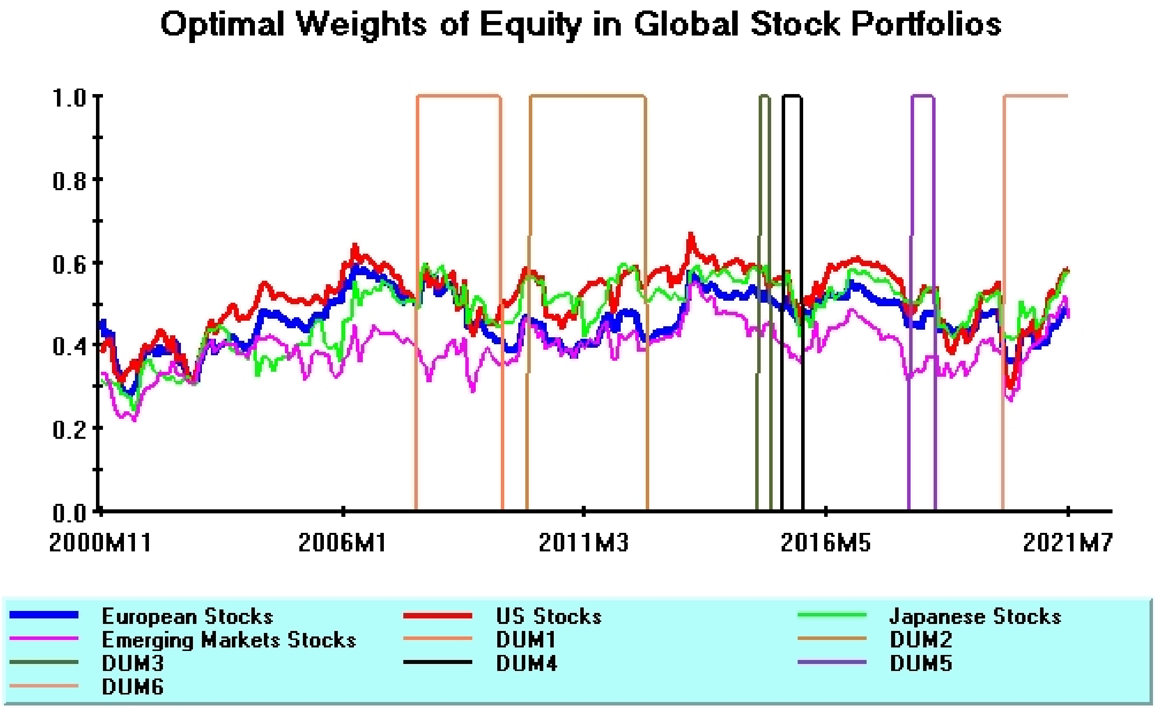
The dynamic patterns of these indicators are now the focus. More specifically, since the sample includes various financial crises, how these indicators evolve during these turbulent periods is analyzed.

Figures 1–3 summarize these results. Figure 1 shows the dynamic patterns of optimal weights for equity in all global stocks portfolios assuming, respectively, gold (upper section of Figure 1) or the Swiss Franc (lower section of Figure 1) as safe haven assets. These time-varying patterns are computed through Equation (4). Figure 2 shows the dynamic patterns of optimal hedge ratios for the same risk-adjusted portfolios (gold: upper section; Swiss Franc: lower section). The time-varying patterns of these risk-minimizing hedge ratios are computed through Equation (5). Figure 3 compares hedging effectiveness indicators related to our alternative safe haven assets (gold: upper section; Swiss Franc: lower section). The time-varying patterns of these performance indicators are computed through Equation (6).

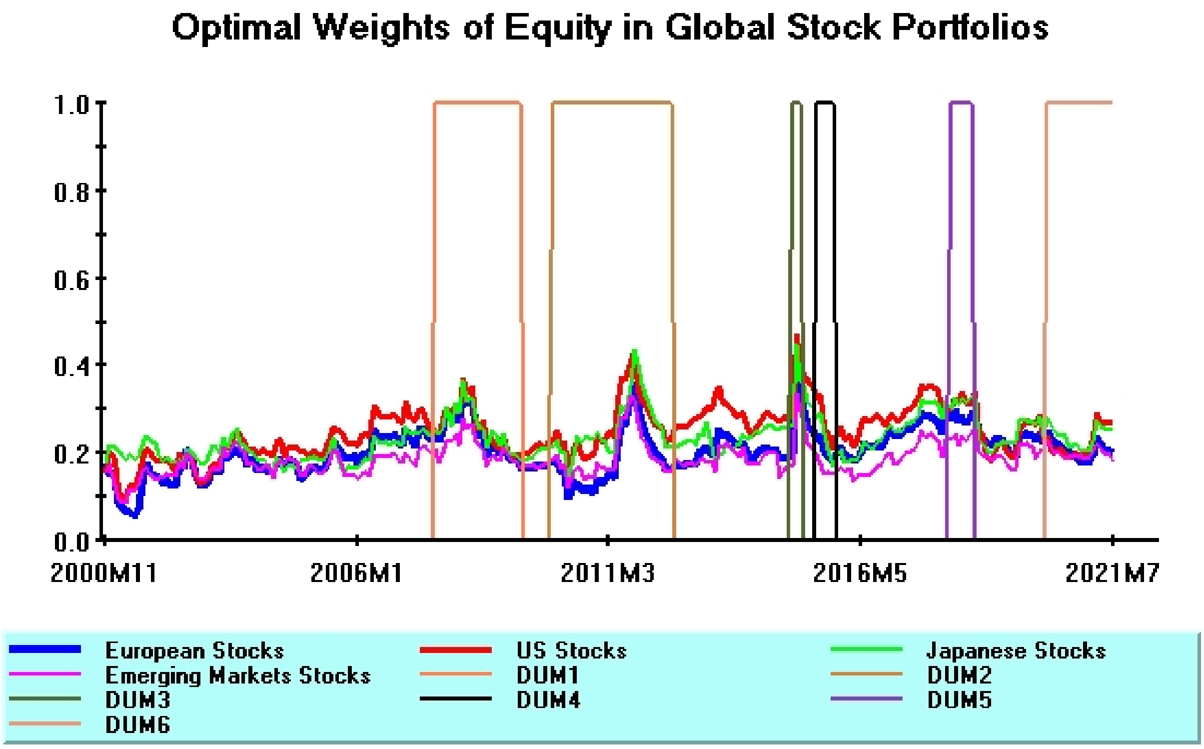
Financial crises are indicated by vertical bars in all figures (Dum 1, . . . , Dum 6) and refer, in chronological order, to the following episodes:

(1) Great Financial Crisis (Dum1);
(2) Eurozone Debt Crisis (Dum 2);
(3) Russian Crisis (Dum 3);
(4) Chinese Stock Market Crisis (Dum 4);
(5) Turkish Crisis (Dum 5);
(6) COVID-19 Crisis (Dum 6).

Regarding the first five episodes, the reader is referred to Tronzano (2021) for a discussion about basic features of these episodes and the months characterizing these crises periods. Regarding the last crisis, based on information from the "European Centre for Disease Prevention and Control" (https://www.ecdc.europe.eu, (accessed on 7 October 2021), the crisis period includes all months from March 2020 until the end of the sample. This choice reflects the ongoing evolution of the pandemic situation and its prolonged negative effects on financial markets.

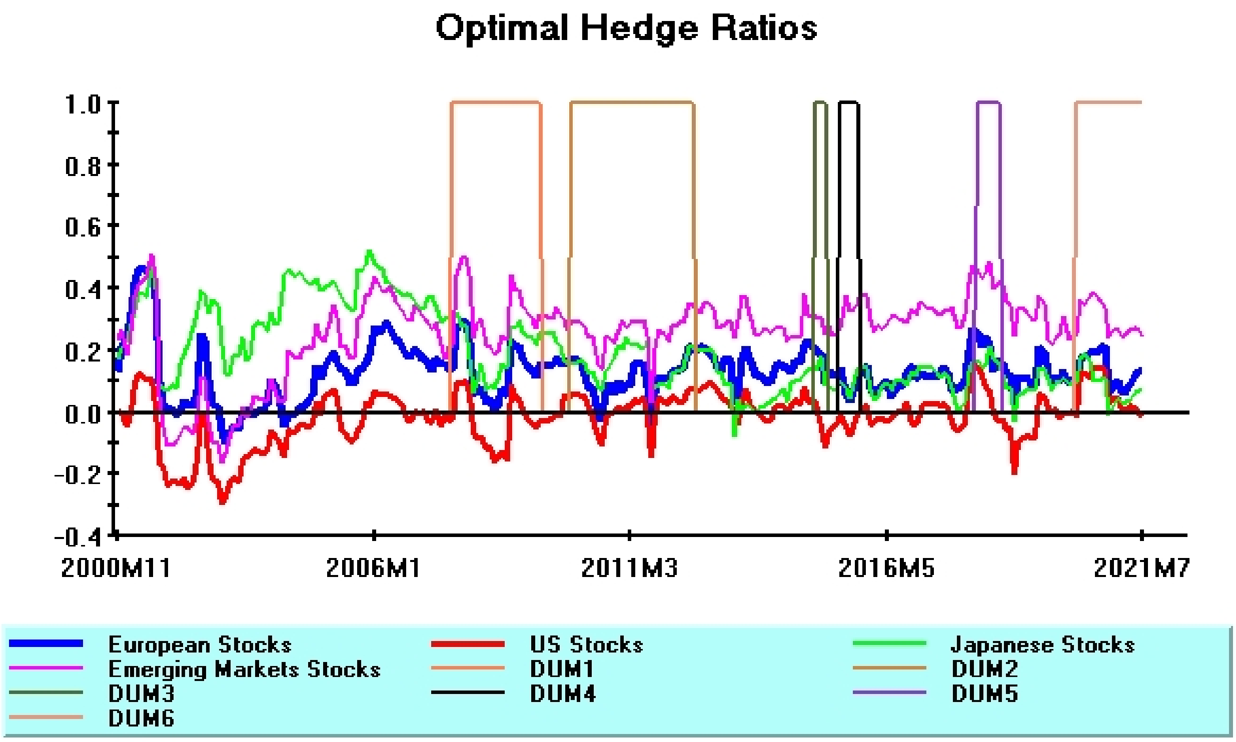


(**a**)

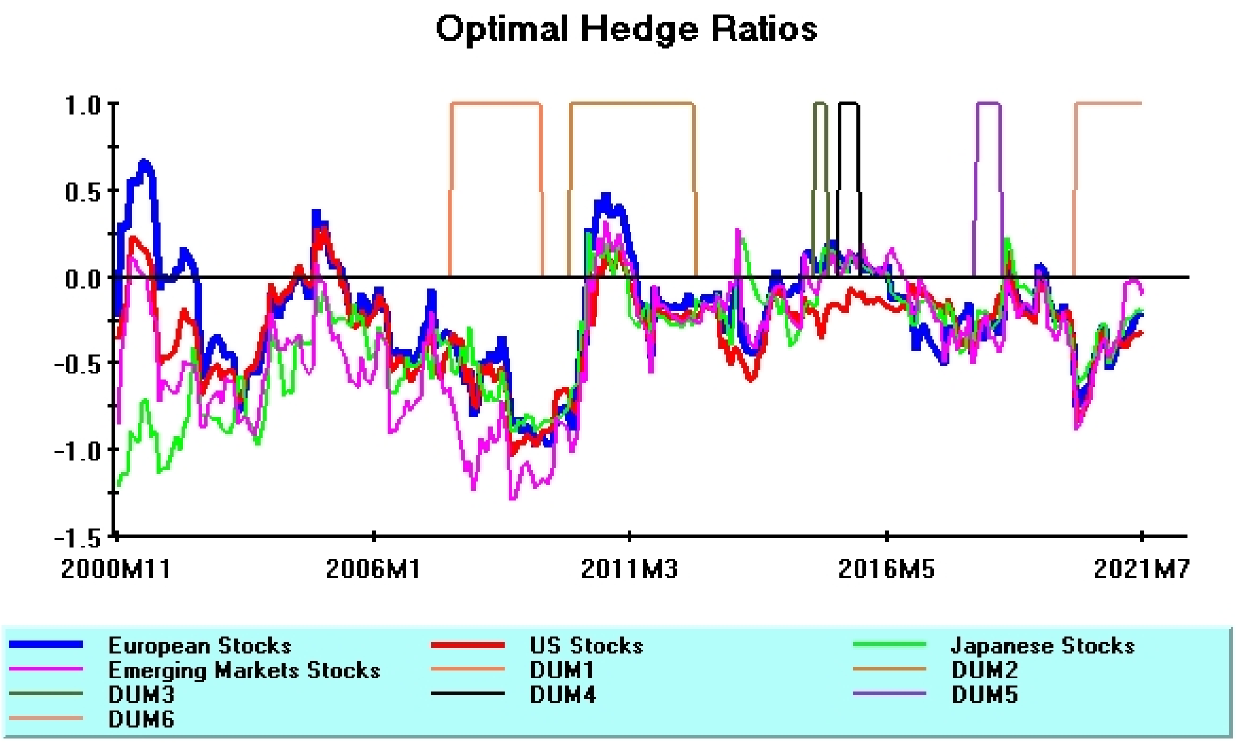


(**b**)

Figure 1. (**a**) Gold as a safe haven asset; (**b**) Swiss Franc as safe haven asset.

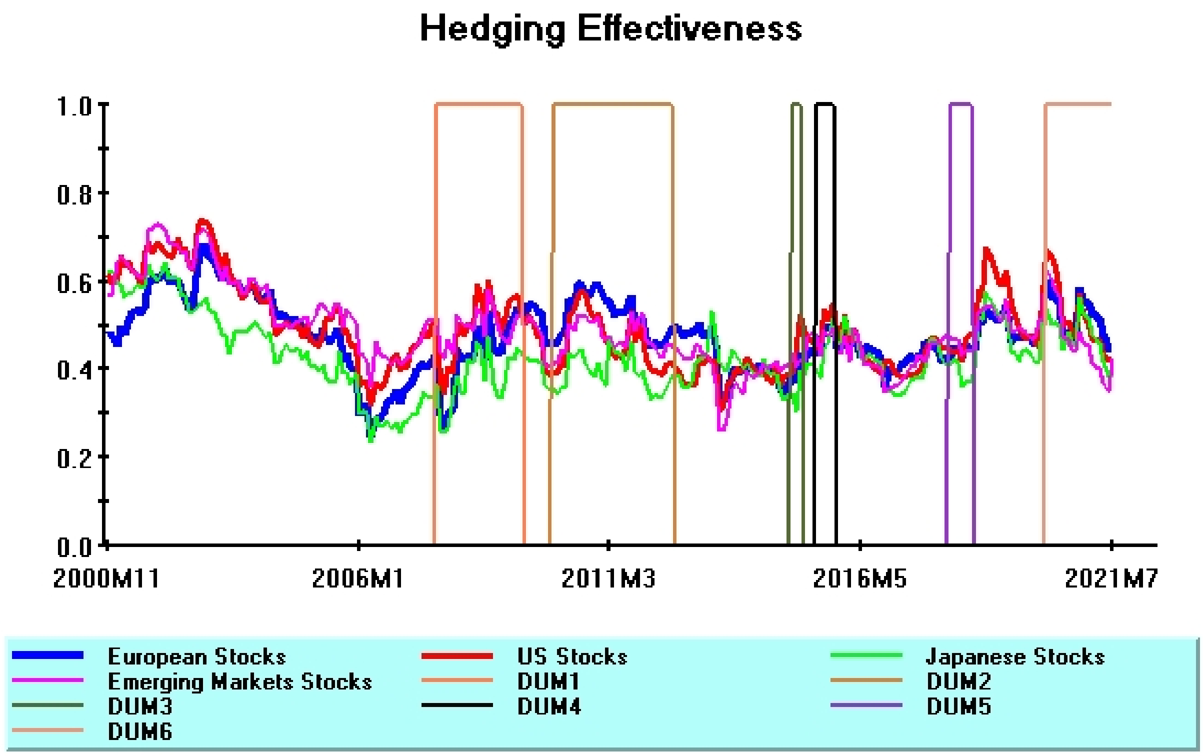


(**a**)

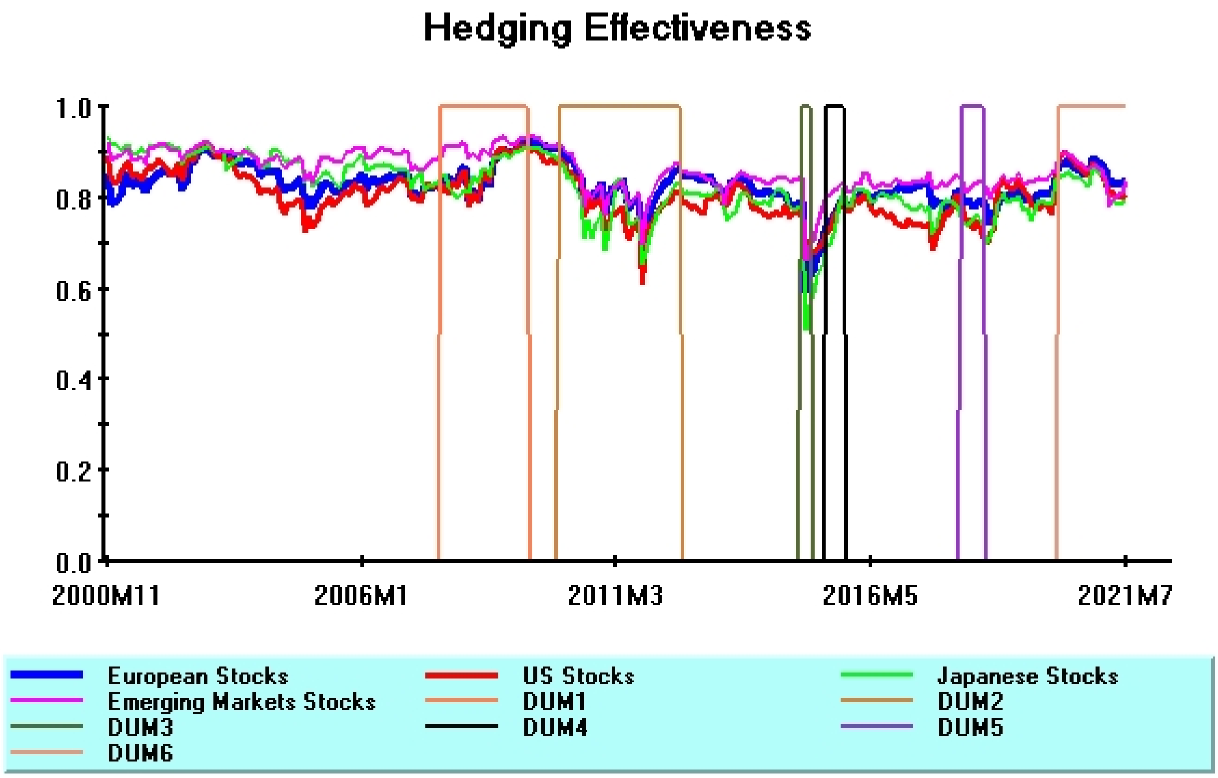


(**b**)

Figure 2. (**a**) Gold as a safe haven asset; (**b**) Swiss Franc as safe haven asset.



(**a**)



(**b**)

Figure 3. (**a**) Gold as a safe haven asset; (**b**) Swiss Franc as safe haven asset.

Consider, first, optimal equity weights. Intuitively, during financial crises, one expects a decrease in these weights due to adverse effects on stock market returns. Figure 1 confirms this intuition, although these effects are not uniformly distributed along all crises episodes. During the 2007/2008 Great Financial Crisis, a clear downward trend is documented for equity weights involving both gold and Swiss Franc portfolios. During the Eurozone Debt Crisis, we observe, instead, a more erratic pattern in both cases. The subsequent short-lived crises periods, namely the Russian Crisis and the Chinese Stock Market Crisis, are again associated with strong downward trends in optimal equity weights. Towards the end of the sample, the Turkish Crisis does not give rise to any appreciable effect; an abrupt fall is, instead, documented in the gold case during the initial part of the COVID-19 period, whereas a smoother downward trend is present in the Swiss Franc case.

Consider, now, the time-varying patterns of optimal hedge ratios. It is worthwhile remembering that, when (β) (hedge ratios coefficient) is positive, a downward shift in this parameter means that a long position in equity is covered through a decreasing short position in the safe haven asset; additionally, when (β) is negative, a downward shift in this parameter means that a long position in equity is covered through an increasing long position in the safe haven asset. In both cases, downward (β) shifts capture a portfolio re-adjustment from equities towards safe haven assets. Economic intuition suggests, therefore, that significant downward (β) shifts should be expected during financial crises. This intuition is largely consistent with the evidence appearing in Figure 2 since, for both gold and Swiss Franc portfolios, large downward shifts in optimal hedge ratios occur during most crises episodes. Huge downward shifts are observed during the Great Financial Crisis and the Eurozone Debt Crisis (albeit with a more erratic pattern in the gold case). During the two subsequent crises, a significant fall in (β) is documented, in the gold case, for most stock portfolios, whereas Swiss Franc hedged portfolios are unaffected. During the last part of the sample, finally, the expected pattern of hedge ratios is fully confirmed regards the Turkish Crisis, while during the initial part of the COVID-19 period sharp downturns are observed for all Swiss Franc portfolios.

Consider, finally, the dynamic patterns of hedging effectiveness indicators. An interesting feature emerging from Figure 3 is that neither gold nor the Swiss Franc were able to provide increased protection against portfolio variances during all financial crises episodes. A moderate increase in hedging effectiveness is observed, for both safe haven assets, during the 2007/2008 Great Financial Crisis. During the Eurozone Debt Crisis, conversely, one observes a downward trend in these indicators, with significant declines in the case of Swiss Franc/Japanese stocks and Swiss Franc/US stocks portfolios. The Russian crisis displays mixed short-run evidence. Appreciable increases in all hedging effectiveness indicators are instead observed during the 2016 Chinese Stock Market Crisis and the early stage of the COVID-19 Pandemic Crisis.

To sum up, the present section performs an analysis of portfolio management implications related to previously estimated DCC Garch models.

The main result is that, from the perspective of a risk-minimizing representative investor, the Swiss Franc offered significantly better hedging properties than gold for typical global stocks portfolios built over the last two decades. Focusing on average values, Swiss Franc hedged portfolios denote an almost perfect hedge, ensuring a reduction in variance by over 80%, with respect to all unhedged portfolios. Optimal equity weights, moreover, are notably lower in the case of Swiss Franc portfolios, while the corresponding hedging strategies turn out to be significantly less expensive than those implemented through gold. With regards to dynamic patterns of financial management indicators, diffused reductions in optimal equity weights are observed during most financial crises episodes. In line of this evidence, optimal hedge ratios display large downward swings during these financial turmoils. Finally, with regards to hedging effectiveness indicators, neither gold nor the Swiss Franc were able to ensure a higher portfolio protection during all financial crises episodes, although significant increases are observed during the 2007/2008

Great Financial Crisis, the 2016 Chinese Stock Market Crisis, and the early stage of the COVID-19 Pandemic Crisis.

4.3. Value-at-Risk of Hedged Global Stock Portfolios: Gold vs. Swiss Franc

Previous results show that, during the last two decades, the Swiss Franc displayed better defensive properties than gold. This evidence, however, refers to univariate stock portfolios.

This section extends the analysis inside a multivariate asset framework. The risk minimizing properties of gold and the Swiss Franc are thus re-examined focusing on multivariate stock portfolios simultaneously including all equity indexes (i.e., European, US, Japanese, and Emerging Markets stock indexes).

A standard approach based upon Value-at-Risk (VaR) indicators is followed. More specifically, previously estimated Multivariate Garch DCC models are relied on, and alternative VaR indicators are simulated under different hypotheses for portfolio weights.

All portfolios include five assets: one safe haven asset (gold or Swiss Franc) and the four stock indexes described in Section 3.1.

VaR indicators are simulated at a 1% confidence level, under two scenarios:

(a) A "Benchmark" scenario (equal asset weights);
(b) An "Optimal" scenario (optimal asset weights).

In the former (a), all assets have identical weights (0.20 for each asset). In the latter (b), by relying on average optimal weights computed in Section 3.2 inside a bivariate context, some simplifying assumptions are made to transpose them inside a multivariate framework.[8] As explained in footnote 10, the following "optimal weights" are used with regards to the (b) scenario:

- Gold-Hedged Portfolio: 0.54 (Gold); 0.115 (Each of the four Global Stocks);
- Swiss Franc-Hedged Portfolio: 0.78 (Swiss Franc); 0.055 (Each of the four Global Stocks).

These weights reflect, in a multivariate framework, optimal asset allocations obtained in the previous section, i.e., a "Gold-hedged" portfolio with an approximate 50%/50% distribution between gold and equities, and a more unbalanced "Swiss Franc-hedged" portfolio with a higher component of the safe haven asset (see Figure 1).

The first two plots in this figure refer, respectively, to a gold portfolio (former upper plot) and to a Swiss Franc portfolio (lower latter plot). These plots compare Value-at-Risk dynamics in the (a) scenario (blue lines: equal weights) and in the (b) scenario (red lines: optimal weights). The last plot (third plot, see Figure 4, continued) contains, instead, a direct comparison between VaR patterns of gold and Swiss Franc portfolios under optimal weights ((b) scenario).

Focusing on the former two plots, it is apparent that optimal asset weights induce favorable risk-minimizing effects on both hedged portfolios, since we observe downward shifts in both VaR indicators.

There is, however, a relevant difference between gold and Swiss Franc portfolios. In the gold case, this downward shift is, on average, very small. In the Swiss Franc case, conversely, optimal asset weights have a much larger impact in terms of portfolio risk reduction, since one observes a large downward shift in the VaR indicator over the whole sample. Results from VaR simulations are summarized in Figure 4.

Consider, for instance, the Great Financial Crisis period, when both VaR indicators under the "benchmark" (a) scenario reach their absolute maximum levels (respectively, 0.199 for gold, and 0.187 for the Swiss Franc in November 2008). Focusing on November 2008, the corresponding VaR indicators with optimal weights are respectively equal to 0.162 (gold) and to 0.046 (Swiss Franc). Therefore, while in the gold case the maximum loss decreases from about 20 to 16%, the maximum loss reduction for the Swiss Franc-hedged portfolio is much larger, i.e., it goes from about 19 to 4.6% in November 2008.

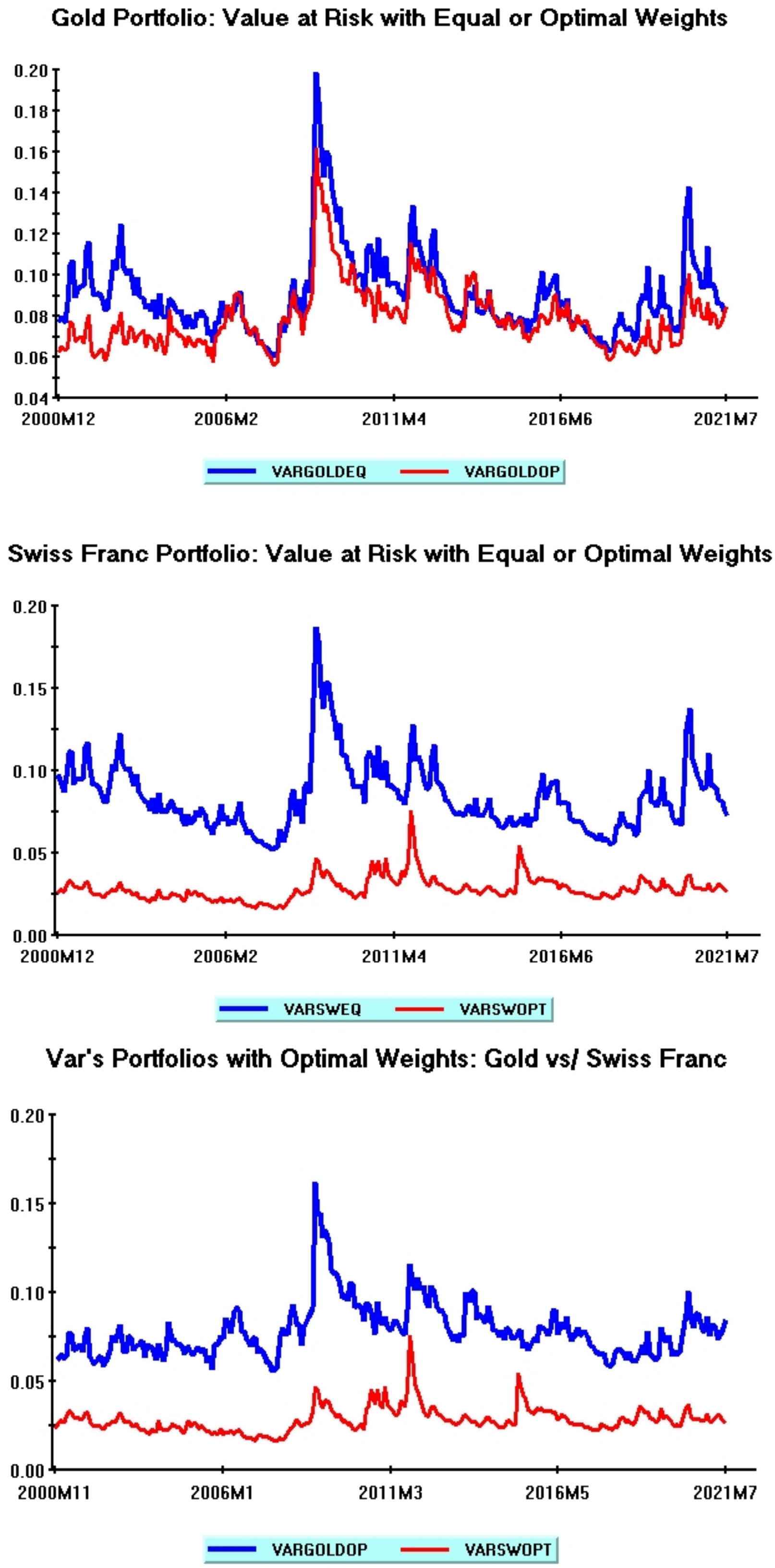


Figure 4. Value at Risk Simulations.

A further interesting example of large differences in potential maximum losses occurs during the recent COVID-19 period, when both hedged portfolios under the (a) scenario reach new relative peak values around 14% (respectively, 0.143 (gold) and 0.138 (Swiss Franc) in March 2020). VaR indicators using "optimal" weights reduce the maximum potential loss of only about four percentage points in the gold case (i.e., from 0.143 to 0.10), whereas the maximum potential loss reduction amounts to over ten percentage points in the Swiss Franc case (i.e., from 0.138 to 0.037).

These large differences in the defensive performance of safe haven assets during extreme events (not only during the Great Financial Crisis and the COVID-19 periods but during all financial turmoil episodes) are well captured in the first two plots appearing in Figure 4. The upper plot (gold) consistently exhibits small differences between blue ((a) scenario) and red ((b) scenario) lines, whereas large differences are documented in the lower plot (Swiss Franc).

The last plot in Figure 4 compares VaR indicators under optimal weights, confirming the notably higher hedging properties of the Swiss currency. A large positive difference between the blue line (VaR under the gold "optimal" portfolio) and the red line (VaR under the Swiss Franc "optimal" portfolio) is indeed documented during almost the whole sample.[9]

To sum up, this section assesses the robustness of portfolio management implications achieved in Section 4.2, concerning the better hedging properties of the Swiss Franc with respect to gold in global stock portfolios and the risk-minimizing benefits of an asset allocation strategy, giving relatively more weight to this safe haven asset. Differently from the previous section, which relies on bivariate optimal asset weights and hedge ratios, the present section extends the analysis in a multivariate asset framework.

VaR simulations, relying on estimated Multivariate DCC Garch models, are implemented while comparing two different scenarios: (a) a "benchmark" scenario with equal asset weights; (b) an "optimal" scenario in which asset weights approximately reflect optimal weights.

The empirical evidence is closely in line with previous findings. Assuming "optimal" asset weights, there is a large downward shift in the VaR indicator, relative to the Swiss Franc-hedged portfolio, which remains notably lower during the whole sample, than the corresponding risk indicator relative to the Gold. The better Swiss Franc performance as a safe haven asset is, thus, confirmed inside a multivariate asset framework.

5. Gold and Swiss Franc Properties during Extreme Negative Stock Market Conditions

Section 4 has documented, under various perspectives, that the Swiss Franc has better defensive properties than gold in the global stock portfolio of a representative international investor.

One important issue not addressed in this section, however, is the performance of gold and the Swiss Franc during periods of high economic and financial distress and when stock market returns exhibit extremely large downward swings.

These periods have been quite pervasive during the last decades, particularly during the 2007/2008 Great Financial Crisis and the early stages of the COVID-19 pandemic crisis. For instance, in October 2008 all equity returns experienced absolute maximum monthly decreases, amounting, respectively, to −23.9% (Europe); −18.9% (US); −16% (Japan); −32.1% (Emerging Markets). Similar, although relatively less intense, equity return drops were observed during the initial months of the COVID-19 crisis: −15.9% (Europe); −13.7% (US); −8.4% (Japan); −16.9% (Emerging Markets).

This section analyzes the properties of gold and the Swiss Franc under extreme negative return conditions. Although there is a large amount of literature exploring the role of safe haven assets, existing contributions focusing on the effects of extreme events are rare and usually consider only the role of gold, other precious metals, or other financial instruments in protecting stock market portfolios during highly bearish states. Moreover, to the best of my knowledge, no applied contribution performs a systematic comparison between gold and Swiss Franc properties during the last decades, which were characterized by frequent financial turmoil episodes.[10]

This section therefore contributes, in various directions, to the existing literature.

The analysis relies on a standard regression approach with quantile dummies summarized by the following equation[11]:

$$\rho_{ij,t} = \gamma_0 + \gamma_1 D(r_{stock} q_5) + \gamma_2 D(r_{stock} q_1) + \varepsilon_{ij,t} \quad (7)$$

where $\rho_{ij,t}$ is the time-varying conditional correlation between each defensive asset return (i = Gold, Swiss Franc) and each global stock return (j = US, European, Japanese, and Emerging Markets stocks); $D(r_{stock} q_5)$ and $D(r_{stock} q_1)$ are dummy variables capturing extreme negative movements in the underlying stock return, respectively, at the 5% and 1% quantiles. Both dummy variables take values of one at these negative extreme movements and values of zero otherwise.

According to this approach, the defensive asset is a diversifier in the stock portfolio if γ_0 is positive (lower than one) and statistically significant. On the other hand, the defensive asset is a weak hedge if γ_0 is not significant, or it is a strong hedge if γ_0 is negative and statistically significant. The defensive asset, moreover, is a weak safe haven if γ_1 and γ_2 are not significantly different from zero, while it is a strong safe haven if γ_1 and γ_2 are negative and statistically significant.

The mean values of estimated conditional correlations (γ_0 coefficients), therefore, provide inferences about the hedging properties of defensive assets, while the reactions of conditional correlations during extreme events (γ_1 and γ_2 coefficients) provide inferences about the safe haven properties of these assets.

Table 5 summarizes the results. The upper (lower) section of this table refers to conditional correlations between gold (Swiss Franc) and various global stock indexes. All estimated equations use the Newey–West (1987) estimator of the covariance matrix and are, therefore, robust to serial correlation and heteroscedasticity in the error terms.

Table 5. Hedge and Safe Haven Properties of Gold and Swiss Franc Under Extreme Negative Stock Market Conditions. Monthly Data: 2000M11–2021M7 (249 Observations).

Gold				
Parameters	**US Stocks**	**European Stocks**	**Japanese Stocks**	**Emerging Markets Stocks**
γ_0	−0.010 (−0.86)	0.124 *** (9.26)	0.182 *** (7.75)	0.226 *** (10.84)
γ_1	−0.022 (−0.89)	−0.030 (−1.08)	−0.08 ** (2.84)	−0.041 (−1.45)
γ_2	0.021 (0.40)	0.018 (0.63)	0.111 *** (5.43)	−0.006 (−0.08)
Swiss Franc				
Parameters	**US Stocks**	**European Stocks**	**Japanese Stocks**	**Emerging Markets Stocks**
γ_0	−0.148 *** (−7.28)	−0.089 *** (−3.53)	−0.163 *** (−7.28)	−0.146 *** (−5.80)
γ_1	−0.054 (−0.98)	−0.096 ** (−1.97)	0.009 (0.16)	−0.078 (−1.46)
γ_2	−0.130 ** (−2.06)	−0.128 * (−1.92)	−0.187 *** (−2.73)	−0.122 ** (−1.96)

Estimated Equation: $\rho_{i,j,t} = \gamma_0 + \gamma_1 D(r_{stock} q_5) + \gamma_2 D(r_{stock} q_1) + \varepsilon_{ijt}$; where $\rho_{i,j}$ are conditional correlations between defensive assets (i = Gold, Swiss Franc) and stock returns (j = US, European, Japanese, and Emerging Market stocks). $D(r_{stock} q_5)$ ($D(r_{stock} q_1)$) are dummy variables, taking values of 1 during periods of extreme negative market conditions at the 5% (1%) quantiles, and values of 0 elsewhere. Newey–West (1987) heteroscedasticity and autocorrelation consistent estimates. t-statistics in parentheses below parameters estimates. ***: significant at a 1% level; **: significant at a 5% level; *: significant at a 10% level.

Overall, these results display a significant difference between gold and Swiss Franc defensive properties in global stock portfolios and are, therefore, closely in line with previous empirical evidence.

Consider, first, the hedging properties of these assets. In the gold case, the γ_0 parameter is not significantly different from zero for US stocks, and it is positively significant at the 1% level in the remaining cases. The yellow metal, therefore, represents a weak hedge for US stocks, whereas it does not offer any hedge for all other global stock indexes; the positive and significant values for γ_0 point out that gold is a diversifier for European, Japanese, and Emerging Markets stocks. These results stand in sharp contrast to the corresponding results for the Swiss Franc. As shown in the lower section of Table 5, γ_0 is consistently negative and statistically significant at the 1% level. The Swiss currency, therefore, represents a strong hedge for all equity indexes.

The better defensive properties of the Swiss Franc are confirmed when focusing on the effects of extreme negative stock returns. Considering extreme negative returns at the 5% quantiles, both gold and the Swiss Franc appear as weak safe haven assets since, in most cases, γ_1 coefficients are not significantly different from zero.[12] However, considering extreme negative returns at the 1% quantiles, all γ_2 parameters are negative and statistically significant in the Swiss Franc case, whereas most γ_2 parameters are not significant in the gold case. Taken as a whole, this evidence shows that only the Swiss currency is a strong safe haven, focusing on the most extreme negative stock returns that occurred during the last decades.

The better safe haven properties of the Swiss Franc, with respect to gold, are broadly in line with results appearing in the recent literature. Balcilar et al. (2020), for instance, document that the Swiss currency displays either insignificant or negative risk exposures during market stress periods to negative market shocks, whereas traditional safe havens, such as precious metals, exhibit positive risk exposures to global stock market shocks during high volatility periods. Focusing on US stock returns, moreover, parameters estimates reported in Table 5 reveal that the safe haven properties of the Swiss currency are stronger than those documented in the recent literature (see Cho and Han (2021), Section 4.2).

To sum up, this section fills one relevant gap in the literature by analyzing the hedge and safe haven properties of gold and the Swiss Franc under highly negative market turmoil.

The main result is that only the Swiss Franc acts as a strong safe haven, focusing on the absolute worse stock market downturns. This evidence is fully consistent with the empirical findings discussed in Section 4, both with regards to the values of bivariate hedging effectiveness indicators and with regards to the lower Value-at-Risk associated with a Swiss Franc hedged global stock portfolio.

6. Concluding Remarks

Since Markovitz (1952) seminal contribution, optimal portfolio allocation represents a core issue in the finance literature, both in a theoretical and in an empirical perspective. Drawing on this contribution, the risk/return relationship has been analyzed inside the classical Capital Asset Pricing Model developed by Sharpe (1964) and Lintner (1965), while many authors added further important refinements in this area (see e.g., Black 1972; Merton 1973). Focusing on equity markets, one important topic related to asset allocation choices is that of portfolio diversification in order to mitigate the idiosyncratic risk typically associated with equity investments (see, e.g., Goetzmann and Kumar 2001).

The benefits from portfolio diversification, however, have significantly lowered over the last decades, due to increased risk spillovers across international equity markets induced by frequent financial turmoil. Since the 2008–2009 Global Financial Crisis, recurrent crises episodes have sharply increased cross-market linkages, pointing out the existence of contagion effects on international equity markets (Forbes and Rigobon 2002).

In this new scenario, "flight-to-quality" strategies have attracted increasing attention from investors and portfolio managers; moreover, the hedge and safe haven properties of many defensive assets have been extensively investigated.

This paper contributes to the empirical research on safe haven assets analyzing the defensive properties of gold and the Swiss Franc for various aggregate stock market indexes. Since these indexes cover major world macroeconomic areas, the paper's perspective reflects that of a global international investor.

The main contribution to the literature is twofold. First, a thorough comparison between gold and Swiss Franc hedge and safe haven properties is provided for a representative portfolio of global equity markets. As discussed in Section 2, although gold's properties during the latest financial crises have widely been studied, optimal hedging strategies and the hedging effectiveness of most relevant safe haven currencies have never been addressed in recent research. Second, the sample size of this paper is much larger than that employed in existing contributions. This allows for accurately tracing out the dynamic patterns of optimal portfolio weights, optimal hedge ratios, and hedging effectiveness indicators during all financial crises episodes of the last two decades, including the effects of the recent COVID-19 pandemic period.

The empirical findings may be summarized as follows.

Average optimal weights of equities in global portfolios are in a 0.4–0.5 range, using gold as a defensive asset, whereas they are notably lower in the Swiss Franc case. These results imply significantly higher weights of the Swiss currency in all stocks portfolios. Average optimal hedge ratios are (almost) always positive in gold-hedged portfolios and consistently negative in Swiss Franc-hedged portfolios. This implies that optimal hedging strategies implemented through the yellow metal are relatively more expensive, since long positions in equities need to be covered, on average, with short positions in gold. Average hedging effectiveness indicators point out a clear advantage of the Swiss Franc as a defensive asset, since the variance reduction ensured by this currency (80–85%) is notably higher than that recorded for all gold-hedged portfolios.

The dynamic patterns of these financial indicators provide further interesting insights. In line with economic intuition, optimal weights for equities in global portfolios display decreasing patterns during most financial crises. These downward trends are particularly strong during the 2007/2008 Global Financial Crisis, both for gold and for Swiss-Franc portfolios. Optimal hedge ratios exhibit huge downward swings during most crises' episodes. Sharp downturns are recorded during the 2007/2008 Global Financial Crisis (for both safe haven assets) and during the early stages of the COVID-19 crisis (in the Swiss Franc case). The dynamic patterns of hedging effectiveness indicators, finally, suggest that neither gold, nor the Swiss Franc were able to offer increased protection during all financial turmoil episodes, although the Swiss currency always preserved its superiority as a defensive asset.

The above findings refer to single stock portfolios hedged through different safe haven assets. The robustness of these results inside a multivariate asset framework is, therefore, assessed through some Value-at-Risk (VaR) simulations. More specifically, two benchmark scenarios, assuming either equal portfolio weights or "optimal" weights proxied through the results of Multivariate Garch DCC models, are compared.

These VaR simulations provide strong support to previous results. Under the "optimal" weights scenario, the Value-at-Risk reduction, obtained through the Swiss Franc-hedged portfolio, is notably higher than that achieved through the gold-hedged portfolio. The better defensive properties of the Swiss currency are thus confirmed inside a multivariate asset framework, simultaneously, including all equity indexes.

Finally, focusing on gold and Swiss Franc properties during extreme negative stock market conditions, this paper detects further significant differences between these defensive assets. A standard regression approach with quantile dummies documents that focusing on extreme negative stock returns at the 1% quantile, only the Swiss Franc can be regarded as a strong safe haven asset.

To sum up, this paper documents that, during the last two decades, the Swiss Franc has been notably superior to gold as a defensive asset for stock portfolios based on major global equity indexes. This result relies on standard hedging effectiveness indicators derived through the Engle (2002) Dynamic Conditional Correlation model, and their time-varying patterns during most financial crises episodes. These empirical findings are robust to an extension of the analysis inside a multivariate asset framework and find further support under extreme negative stock market conditions.

There is one, yet quite important, policy implication to be drawn from the present study. Since, during the last two decades, the Swiss Franc has consistently ensured a greater hedging effectiveness than gold inside various risk-adjusted international stock portfolios, this empirical regularity should be properly accounted for in the design of future asset allocation strategies. The empirical findings of this paper are therefore of interest for investors and portfolio managers aiming to improve the risk-adjusted performance of global aggregate stock portfolios. Although it is obvious that past financial asset prices cannot provide exact information about their future dynamics, the strong safe haven properties of the Swiss Franc (as well as those of the Japanese Yen) are likely to persist, backed by their countries' relevant and constant creditor positions (Lee 2017).

This paper can be profitably extended along various research directions.

The robustness of the empirical findings can be further assessed, using more sophisticated approaches to compute conditional correlations, allowing for asymmetric responses in conditional variance and conditional correlations to negative returns (Cappiello et al. 2006), or to extract a short and a long run component for dynamic correlations through a DCC Midas model (Colacito et al. 2009). An econometric analysis of potential determinants of hedged returns (macroeconomic variables, risk factors, and uncertainty indicators) may provide further interesting information in a dynamic asset allocation context. In a wider perspective, another fruitful research line is the extension of the present investigation to the defensive properties of other safe haven assets. Potential candidates are represented by other key international currencies (Yen, US Dollar) and other financial assets related to commodity, energy, bond, and cryptocurrency markets.

Funding: This research received no external funding.

Acknowledgments: The author is grateful to three anonymous referees for their insightful comments and suggestions on a previous version of this paper.

Conflicts of Interest: The author declares no conflict of interest.

Notes

1. As regards safe haven assets, the relevant references and Thomson Reuters codes are the following: Gold: Gold Bullion LBM $/t oz, Thomson Reuters code: "GOLDBLN"; Swiss Franc: Swiss Franc Index, Thomson Reuters code: "SWXTW..NF".
2. As regards stock price indexes, the relevant references and Thomson Reuters codes are the following: United States: MSCI United States of America, Thomson Reuters code: "MSUSAML"; Europe: MSCI Europe Index, Thomson Reuters code: "MSEROP$"; Japan: MSCI Japan Index, Thomson Reuters code: "MSJPAN$"; Emerging Markets: MSCI Emerging Markets U$, Thomson Reuters code: "MSEMKF$".
3. Other important models include: the Constant Conditional Correlation (CCC) Garch model (Bollerslev (1990)), the BEKK-Garch model (Engle and Kroner (1995)), and Dynamic Copula Methods. See Geng and Wang (2021) for a compact discussion of these approaches. The present paper employs the standard version of the DCC model developed in Engle (2002) seminal paper. Note however that, according to recent research, this standard version leads to diversification benefits and hedging effectiveness results outperforming some variants of this approach (Hamma et al. (2021).
4. The only exception is represented by the Swiss Franc. In this case, given the very low value of the Ljung-Box test at the first lag, the demeaned series has been used in the empirical investigation.
5. Note that, under this alternative distributional assumption, Engle (2002) two-step original procedure is no longer applicable. The Maximum Likelihood estimator relies now on a more efficient approach, involving the simultaneous estimation of model's parameters and an additional degrees-of-freedom parameter relative to the multivariate t distribution (see Pesaran and Pesaran (2010), Section 4 for more technical details). The econometric software used in the present paper is Microfit 5.5 (see Pesaran and Pesaran (2009)).

6 See Pesaran and Pesaran (2010), Section 5, for a technical discussion on conditional evaluation procedures based on probability integral transforms. Under the null hypothesis of correct model specification, probability transforms estimates are serially uncorrelated and uniformly distributed in the interval (0, 1).

7 If we refer to the alternative safe haven asset, i.e., the Swiss Franc ("SF"), the symbol "SF" replaces "G" in all equations reported in the main text.

8 Based upon Section 4.2 estimated optimal weights (see Table 4, first columns), the average optimal weight for the total equity component (W_{SG}) in a multivariate gold-hedged portfolio may be approximated as: (0.513 + 0.462 + 0.481 + 0.394)/4 ≅ 0.46. Therefore, computing the ratio: 0.46/4 = 0.115 yields the weight for each single asset stock in this case. The optimal weight for gold may be approximated as the complement to 1 of 0.46, i.e., (1 − 0.46) = 0.54. An identical procedure is implemented for the multivariate Swiss Franc-hedged portfolio. The average optimal weight for the total equity component (W_{SSF}) is now given by: (0.250 + 0.205 + 0.235 + 0.187)/4 ≅ 0.22. Therefore, computing the ratio: 0.22/4 = 0.055 yields the weight for each single asset stock in this case. The optimal weight for the Swiss Franc may be approximated as the complement to 1 of 0.22, i.e., (1 − 0.22) = 0.78.

9 We observe only two minor exceptions, when a significant narrowing occurs between these VaR indicators: the former during the latest period of the Eurozone Debt Crisis; the latter during the 2015 Chinese Stock Market Crisis.

10 Yousaf et al. (2021) analyze the safe haven and hedging properties of gold from 2015 to 2020. Their main result is that gold provides strong hedging properties against most equity markets, whereas its safe haven properties are limited to a smaller group of countries. The main limitation of this paper, as recognized by the authors, is that the sample includes only Asian countries. Low et al. (2016) analyze seven stock indexes of industrial and emerging market countries, and document that gold and other precious metals have better defensive properties than diamonds during market crisis periods. Although providing a more comprehensive approach, this paper refers to the 2003–2013 period, and therefore does not address financial crises occurred during the second half of the last decade. Hussain Shazad et al. (2020) compare gold and Bitcoin properties for various G7 stock index returns during the last decade, documenting gold's indisputable role as a safe haven and hedging asset. This paper provides technically accurate and up to date evidence, but does not perform a comparison between gold and other traditional safe haven assets. An interesting earlier work in this area is Ratner and Chiu (2013), which focuses on various US stock sectors and documents the strong risk reducing benefits provided by credit default swaps (CDS). This paper, however, does not consider any safe haven asset.

11 See Ratner and Chiu (2013), Yousaf et al. (2021) for examples of this approach to analyze extreme movements in stock market returns. An alternative approach, originally proposed in Baur and Lucey (2010) and Baur and McDermott (2010), employs a time-varying parameter (b_t) computed from a rolling regression to extract co-movements between defensive asset (i) returns and stock asset (j) returns. Thus, while in the present paper dynamic conditional correlations obtained from Engle (2002) model ($\rho_{ij,t}$) appear on the left-hand side of Equation (7), in this alternative approach a time varying parameter (b_t) appears as dependent variable in the regression equation with quantile dummies (see, e.g., Low et al. (2016), Hussain Shazad et al. (2020)).

12 Two exceptions, supporting "strong" safe haven properties, are observed for gold as regards Japanese stocks, and for the Swiss Franc as regards European stocks. In both cases, γ_1 parameters are negatively significant at the 5% level.

References

Abid, Ilyes, Abderrazak Dhaoui, Stephane Goutte, and Khaled Guesmi. 2020. Hedging and diversification across commodity assets. *Applied Economics* 52: 2472–92. [CrossRef]

Akhtaruzzaman, Md, Sabri Boubaker, Brian Lucey, and Ahmet Sensoy. 2021. Is gold a hedge or a safe haven asset in the COVID-19 Crisis? *Economic Modelling* 102: 105588. [CrossRef]

Balcilar, Mehmet, Riza Demirer, Rangan Gupta, and Mark E. Wohar. 2020. The effect of global and regional stock market shocks on safe haven assets. *Structural Change and Economic Dynamics* 54: 297–308. [CrossRef]

Baur, Dirk G., and Thomas K. McDermott. 2010. Is gold a safe haven? International evidence. *Journal of Banking and Finance* 34: 1886–98. [CrossRef]

Baur, Dirk G., and Brian M. Lucey. 2010. Is gold a hedge or a safe haven? An analysis of stocks, bonds and gold. *The Financial Review* 45: 217–29. [CrossRef]

Beckmann, Joscha, Theo Berger, Robert Czudaj, and Thi-Hong-Van Hoang. 2019. Tail dependence between gold and sectorial stocks in China: Perspectives for portfolio diversification. *Empirical Economics* 56: 1117–44. [CrossRef]

Black, Fisher. 1972. Capital market equilibrium with restricted borrowing. *Journal of Business* 45: 444–55. [CrossRef]

Bollerslev, Tim. 1990. Modelling the coherence in short-run nominal exchange rates: A multivariate generalized ARCH model. *Review of Economics and Statistics* 72: 498–505. [CrossRef]

Campbell, John Y., Karine Serfaty-de Medeiros, and Luis M. Viceira. 2010. Global currency hedging. *Journal of Finance* 65: 87–121. [CrossRef]

Cappiello, Lorenzo, Robert F. Engle, and Kevin Sheppard. 2006. Asymmetric dynamics in the correlation of global equity and bond returns. *Journal of Financial Econometrics* 4: 537–72. [CrossRef]

Chan, Kalok, Jian Yang, and Yinggang Zhou. 2018. Conditional co-skewness and safe haven currencies: A regime-switching approach. *Journal of Empirical Finance* 48: 58–80. [CrossRef]

Chkili, Walid. 2016. Dynamic correlations and hedging effectiveness between gold and stock markets: Evidence from BRICs countries. *Research in International Business and Finance* 38: 22–34. [CrossRef]

Cho, Dooyeon, and Heejoon Han. 2021. The tail behavior of safe haven currencies: A cross-quantilogram analysis. *Journal of International Financial Markets, Institutions and Money* 70: 101257. [CrossRef]

Colacito, Riccardo, Robert F. Engle, and Eric Ghysels. 2009. A component model for dynamic correlations. *Journal of Econometrics* 164: 45–59. [CrossRef]

Danthine, Jean-Pierre, and Samuel Danthine. 2017. On the rewards to international investing: A safe haven currency perspective. *Swiss Journal of Economics and Statistics* 154: 14. [CrossRef] [PubMed]

Dimitriou, Dimitrios, and Theodore Simos. 2014. Contagion effects on stock and FX markets: A DCC analysis among USA and EMU. *Studies in Economics and Finance* 31: 246–54. [CrossRef]

Dong, Xiyong, Changhong Li, and Seong-Ming Yoon. 2021. How can investors build a better portfolio in small open economies? Evidence from Asia's four little dragons. *North American Journal of Economics and Finance* 58: 101500. [CrossRef]

Dua, Pami, and Divya Tuteja. 2016. Financial crises and dynamic linkages across international stock and currency markets. *Economic Modelling* 59: 249–61. [CrossRef]

El Hedi Arouri, Mohamed, Amine Lahiani, and Duc Khuong Nguyen. 2015. World gold prices and stock returns in China: Insights for hedging and diversification strategies. *Economic Modelling* 44: 273–82. [CrossRef]

Engle, Robert F. 2002. Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroscedasticity models. *Journal of Business & Economic Statistics* 20: 339–50.

Engle, Robert F., and Kenneth F. Kroner. 1995. Multivariate simultaneous generalized ARCH. *Econometric Theory* 11: 122–50. [CrossRef]

Fink, Fabian, Lucas Frei, and Oliver Gloede. 2022. Global risk sentiment and the Swiss Franc: A time-varying daily factor decomposition model. *Journal of International Money and Finance* 122: 102539. [CrossRef]

Forbes, Kristine, and Roberto Rigobon. 2002. No contagion, only interdependence: Measuring stock market comovements. *Journal of Finance* 57: 2223–61. [CrossRef]

Geng, Qianjie, and Yudong Wang. 2021. Futures hedging in CSI 300 markets: A comparison between minimum-variance and maximum utility frameworks. *Computational Economics* 57: 719–42. [CrossRef]

Goetzmann, William K., and Alok Kumar. 2001. *Equity Portfolio Diversification*. NBER Working Paper n. 8686. Cambridge, MA, USA: National Bureau of Economic Research.

Hamma, Wajdi, Ahmed Ghorbel, and Anis Jarboui. 2021. Hedging Islamic and conventional stock markets with other financial assets: Comparison between competing DCC models and hedging effectiveness. *Journal of Asset Management* 22: 179–99. [CrossRef]

Hood, Matthew, and Farook Malik. 2013. Is gold the best hedge and a safe haven under changing stock market volatility? *Review of Financial Economics* 22: 47–52. [CrossRef]

Hussain Shazad, Syed Jawad, Elie Bouri, David Roubaud, and Ladislav Kristoufek. 2020. Safe haven, hedge and diversification for G7 stock markets: Gold versus bitcoin. *Economic Modelling* 87: 212–24. [CrossRef]

Jarque, Carlos M., and Anil K. Bera. 1980. Efficient tests for normality, homoscedasticity and serial independence of regression residuals. *Economics Letters* 6: 255–59. [CrossRef]

Ji, Qiang, Dayong Zhang, and Yuqian Zhao. 2020. Searching for safe haven assets during the COVID-19 pandemic. *International Review of Financial Analysis* 71: 101526.

Kroner, Kenneth F., and Victor K. Ng. 1998. Modeling asymmetric comovements of asset returns. *Review of Financial Studies* 11: 817–44. [CrossRef]

Kugler, Peter, and Beatrice Weder. 2004. International portfolio holdings and Swiss Franc asset returns. *Swiss Journal of Economics and Statistics* 140: 301–25.

Lee, Kang-Soek. 2017. Safe haven currency: An empirical identification. *Review of International Economics* 25: 924–47. [CrossRef]

Lintner, John. 1965. The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics* 47: 13–37. [CrossRef]

Low, Rand K., Yiran Yao, and Robert Faff. 2016. Diamond vs. precious metals: What shines brightest in your investment portfolio? *International Review of Financial Analysis* 43: 1–14. [CrossRef]

Markovitz, Harry. 1952. Portfolio Selection. *Journal of Finance* 7: 77–91.

Mensi, Walid, Khamis Hamed Al-Yahyaee, and Sang Hoon Kang. 2017a. Time-varying volatility spillovers between stock and precious metal markets with portfolio implications. *Resources Policy* 53: 88–102. [CrossRef]

Mensi, Walid, Shawkat Hammoudeh, and Sang Hoon Kang. 2017b. Risk spillovers and portfolio management between developed and BRICS stock markets. *North American Journal of Economics and Finance* 41: 133–55. [CrossRef]

Merton, Robert C. 1973. An intertemporal capital asset pricing model. *Econometrica* 41: 867–87. [CrossRef]

Nitoi, Mihai, and Maria M. Pochea. 2019. What drives European Union stock market co-movements? *Journal of International Money and Finance* 97: 57–69. [CrossRef]

Pesaran, Bahran, and Hashem Pesaran. 2009. *Time Series Econometrics Using Microfit 5.0: A User's Manual*. Oxford: Oxford University Press.

Pesaran, Bahran, and Hashem Pesaran. 2010. Conditional volatility and correlations of weekly returns and the VaR analysis of 2008 stock market crash. *Economic Modelling* 27: 1398–416. [CrossRef]

Ranaldo, Angelo, and Paul Söderlind. 2010. Safe haven currencies. *Review of Finance* 14: 385–407. [CrossRef]

Ratner, Mitchell, and Jason Chiu. 2013. Hedging stock sector risk with credit default swaps. *International Review of Financial Analysis* 30: 18–25. [CrossRef]

Salisu, Afees A., Xuan Vinh Vo, and Brian Lucey. 2021. Gold and US sectoral stocks during COVID-19 pandemic. *Research in International Business and Finance* 57: 101424. [CrossRef]

Sharpe, William F. 1964. Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance* 19: 425–42.

Sikiru, Abdulsalam, and Afees Salisu. 2021. Hedging with financial innovations in the Asia-Pacific markets during the COVID-19pandemic. The role of precious metals. *Quantitative Finance and Economics* 5: 352–72. [CrossRef]

Syllignakis, Manolis N., and Georgios P. Kouretas. 2011. Dynamic correlation analysis of financial contagion: Evidence from the Central and Eastern European Markets. *International Review of Economics and Finance* 20: 717–32. [CrossRef]

Tachibana, Minoru. 2022. Safe haven assets for international stock markets: A regime-switching factor copula approach. *Research in International Business and Finance* 60: 101591. [CrossRef]

Tarchella, Salma, and Abderrazak Dhaoui. 2021. Chinese jigsaw: Solving the equity market response to the Covid-19 crisis: Do alternative asset provide effective hedging performance? *Research in International Business and Finance* 58: 101499. [CrossRef]

Tronzano, Marco. 2021. Financial crises, macroeconomic variables, and long-run risk: An econometric analysis of stock returns correlations (2000 to 2019). *Journal of Risk and Financial Management* 14: 127. [CrossRef]

Wang, Peijin, Hongwei Zhang, Cai Yang, and Yaoqi Guo. 2021. Time and frequency dynamics of connectedness and hedging performance in global stock markets: Bitcoin versus conventional hedges. *Research in International Business and Finance* 58: 101479. [CrossRef]

Yousaf, Imran, Elie Bouri, Ali Shoaib, and Nehme Azoury. 2021. Gold against Asian stock markets during the COVID-19 outbreak. *Journal of Risk and Financial Management* 14: 186. [CrossRef]