The effect of global and regional stock market shocks on safe haven assets

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Highlights

- We examines fundamental linkages between stock markets and safe haven assets.
- We develop a two-factor, regime-based volatility spillover model
- The risk exposures of safe havens with respect to global and regional stock market shocks display significant time variation
- •Precious metals exhibit positive risk exposures regional and global stock market shocks during high volatility periods

Abstract

This paper examines the fundamental linkages between stock markets and safe haven assets by developing a two-factor, regime-based volatility spillover model with global and regional stock market shocks as risk factors. The risk exposures of safe havens with respect to global and regional stock market shocks are found to display significant time variation and regime-specific features, with the exception of VIX for which consistent negative risk exposures are observed with respect to both global and regional stock market shocks. While traditional safe havens like precious metals exhibit positive risk exposures to both regional and global stock market shocks during high volatility periods, Swiss Franc, Japanese Yen and U.S. Treasuries are found to display either insignificant or negative risk exposures during market stress periods to equity market shocks, implying these assets would serve as more effective hedges (or safe havens) for equity investors. Our findings highlight the importance of dynamic models in assessing the linkages between safe haven assets and stock returns as static models would introduce large biases in diversification measures and optimal hedge ratios.

Keywords: Safe haven assets; Multivariate regime-switching; Equity market shocks

JEL classification: C32; G11; G15

1. Introduction

The global financial crisis and the prolonged uncertainty in the Eurozone have exposed financial markets to significant volatility on a global scale. Structural changes in global risk appetite, largely driven by financial market uncertainty in developed nations, coupled with increased global economic integration, dragged numerous emerging stock markets down even though those markets had no significant exposure to the credit market issues that plagued Western markets. For example, although the U.S. market that was the source of the credit market crisis suffered about a 35% loss in the S&P 500 index in 2008, shifts in global risk sentiment hit emerging markets particularly hard, wiping out almost half of total stock market capitalizations during the same period in developing nations including S. Arabia, Kuwait, Qatar, Turkey and Egypt in addition to other emerging markets in Latin America and Asia.

Given the significant risk exposure of emerging markets with respect to global financial market risks (as experienced during the 2007/2008 crisis) and the lack of locally available risk management tools to hedge financial market risks, a natural research question is the role of global safe haven assets as a risk management tool for stock market investors, particularly in emerging markets. Considering the increase in cross-border capital flows and greater integration in economic activity across the developed and emerging market economies, one can argue that any structural change in economic dynamics in one region will have spillover effects in other parts of the world, suggesting possible synchronization in regime transitions globally. Clearly, this is not only a matter of importance for corporations and domestic investors in emerging markets regarding the management of currency and stock market risk exposures locally, but also for central banks and policy makers in order to understand risk exposures of local markets with respect to global market risks and design market mechanisms and tools that can benefit investors and corporations.

Following the global financial crisis, the literature on safe haven assets has witnessed a surge in the number of studies that examine the performance of various potential safe havens for stock and bond investors. Most studies, however, have particularly focused on gold as the traditionally accepted safe haven. A number of papers including Capie et al. (2005), Baur and Lucey (2010), Baur and McDermott (2010), Hood and Malik (2013), Reboredo (2013), Gurgun and Unalmis (2014) and Bredin et al. (2015) have examined whether gold can serve as a safe haven for stock and/or bond investors in developed stock markets, while recent studies by Ciner et al. (2013) and Agyei-Ampomah et al. (2014) have expanded the set of potential safe havens to other assets including oil, currencies and industrial metals. These studies have generally produced evidence in favor of gold as a safe haven and /or hedge for financial investors, while exceptions are documented in some cases [e.g. Hood and Malik (2013) in favor of VIX; Agyei-Ampomah et al. (2014) in favor of industrial metals].[1] Focusing on gold, recently, Boako et al. (2019) document a significant co-jump of gold and stock market returns, rejecting the safe-haven attribute of gold. At the same time, studies including Ranaldo and Soderling (2010) and Grisse and Nitschka (2015) have focused on the so-called safe haven currencies that can be used to hedge portfolio values against global risks. These studies generally document safe haven characteristics of the Swiss Franc and Japanese Yen against other currencies, in response to increased volatility in financial markets.

Most of the studies in the safe haven literature, however, do not distinguish between financial market shocks that can be due to developed markets (as in the case of the credit crunch of 2007/2008 or Eurozone debt crisis) or regional market dynamics. From an economic point of view, assuming that international markets are not necessarily perfectly integrated, distinguishing between (partial) global and regional stock market shocks allows one to assess the safe haven potential of these assets for investors in different domestic markets (or regions). To that end, it can be argued that the current literature on safe havens provides an incomplete assessment of the fundamental linkages between financial market shocks and safe haven asset returns. Furthermore, most studies in this strand of the literature utilize static models that ignore the time variation in risk exposures and instead, model structural breaks using (i) dummy variables to represent extreme market conditions (e.g. Baur and Lucey, 2010; Baur and McDermott, 2010; Hood and Malik, 2013; Gurgun and Unalmis, 2014; and Agyei-Ampomah et al., 2014); (ii) quantile regressions (e.g. Ciner et al., 2013); or (iii) copulas to assess extreme market dependences (e.g. Reboredo, 2013).

This study examines the fundamental linkages between stock markets and various safe haven assets from a novel angle by developing a two-factor volatility spillover model with developed and regional stock market shocks as risk factors. Unlike most studies in the safe haven literature that focus on gold as the traditionally accepted safe haven (e.g. Baur and Lucey, 2010; Baur and McDermott, 2010; Hood and Malik, 2013; Agyei-Ampomah et al., 2014), we examine various financial and real assets including precious metals, US Treasury securities as well as VIX and currency futures and examine the risk exposures of these assets with respect to developed and regional stock market shocks during normal and stressed market periods. From an economic point of view, the two-factor model allows us to assess the potential of these assets as hedges or safe havens with respect to local and global risks in stock portfolios. From an econometric point of view, unlike the existing literature that has largely utilized a static specification which uses dummy variables to represent market stress periods, we adopt a regime-switching framework and examine the structural breaks and time-variation in the linkages between safe havens and stock market shocks by formally differentiating between market states that can be characterized by calm and stressed market periods. By doing so, this study contributes to the strands of the literature on safe havens and financial integration.

Our empirical analysis suggests that the risk exposures of safe haven assets with respect to global and regional stock market shocks display significant time variation and regime-specific features. All safe haven assets are generally found to carry low risk exposures, well below unity, with respect to stock market shocks, implying the relative segmentation of these assets from equity markets. Traditional safe havens like precious metals are found to exhibit positive risk exposures to both regional and global stock market shocks during market stress periods, underscoring the increased demand for these assets during crisis periods. We argue that the positive risk exposures observed for precious metals diminish the potential benefits of these assets as hedges or safe havens. On the other hand, we find that Swiss Francs, Japanese Yen and U.S. Treasuries display either insignificant or negative risk exposures during market stress periods, implying that these assets would serve as better hedges or safe havens for equity investors. Interestingly, VIX futures are found to exhibit consistently negative risk exposures with respect to both global and regional market shocks across both market regimes, suggesting that these securities could serve as more effective hedges against stock market shocks.

The analysis of variance ratios indicates that the large percentage of the conditional variance of the excess returns on safe haven assets is due to idiosyncratic shocks, further supporting the relative segmentation of these assets from stock markets in general. While shocks related to emerging and Latin American markets are found to be partially significant in the conditional volatility of precious metal returns, Euro area shocks are found to account for about 17% of the conditional volatility of excess returns in Swiss Francs. Similarly, developed market shocks are found to account for about 10% of the conditional volatility for the Yen and U.S. Treasuries. Overall, our findings underscore the importance of structural breaks and time-variation in the linkages between safe haven assets and stock returns and imply that static models would introduce large biases in diversification measures as well as optimal hedge ratios.

The remainder of the paper is organized as follows. Section 2 presents the methodological details regarding the two-factor model. Section 3 reports the empirical findings on risk exposures and the analysis of variance rations. Section 4 concludes the paper.

2. Methodology

2.1. Model specification

We develop a two-factor model to examine the fundamental linkages between safe haven assets and stock markets. Unlike other empirical studies in the safe haven literature, the two-factor specification allows us to distinguish between shocks due to developed markets (e.g. the credit crunch of 2007/2008) and regional shocks that can be specific to a certain region. From an economic point of view, distinguishing between (partial) global and regional stock market shocks allows us to assess the safe haven potential of various assets for individual markets (or regions). From an econometric perspective, as mentioned earlier, the two-factor model offers a clear advantage as, unlike the existing literature that has largely utilized a static specification which uses dummy variables to represent market stress periods, it utilizes a regime-switching framework and examines the structural breaks and time-variation in the linkages between safe havens and stock market shocks by formally differentiating between market states that can be characterized by calm and stressed market periods.

We begin by describing developed market shocks as an obvious risk factor driving financial market dynamics globally. Considering the evidence of a significant U.S. monetary policy effect on emerging economies (e.g. Anaya et al., 2017) and the suggestion by Miranda-Agrippino and Rey (2015) and Rey (2018) of a global financial cycle in capital flows, driven in part by U.S. monetary policy and risk aversion in global markets, one can argue that developed market shocks would serve as a major factor driving regional and local stock market shocks. For this purpose, we specify developed market shocks by decomposing excess returns for developed markets ($R_{d,t}$) into expected and unexpected components as

$$R_{d,t} = \mu_{d,S_{d,t}} + \phi^d_{d,S_{d,t}} R_{d,t-1} + \varepsilon_{d,t} \tag{1}$$

where $S_{d,t} \in \{1, 2\}$ is the latent regime variable following a two-state, first order Markov process $\mu_{d,S_{d,t}}$ is regime dependent intercept. In this specification, developed market (idiosyncratic) shock is represented by the term $\varepsilon_{d,t}$, with

$$\varepsilon_{d,t} \sim iid\left(0, \sigma^2_{S_{d,t}}\right)$$

In the next step, the excess return ($R_{m,t}$) on a regional market m is formulated as a function of the systematic component based on the regional market's sensitivity to developed market shocks ($\beta^d_{m,S_{m,t}}$) and the equity market shock ($\varepsilon_{m,t}$) specific to the region given by

$$R_{m,t} = \mu_{m,S_{m,t}} + \phi^{d}_{m,S_{m,t}} R_{d,t-1} + \phi^{m}_{m,S_{m,t}} R_{m,t-1} + \xi_{m,t} \quad (2)$$

In this specification, $\mu_{m,S_{m,t}}$ is a regime dependent intercept and $\phi^{d}_{m,S_{m,t}}$ is the regime specific return spillover from the developed market to regional market. The unexpected component is specified as $\xi_{m,t} = \beta^{d}_{m,S_{m,t}} \varepsilon_{d,t} + \varepsilon_{m,t}$, where $\beta^{w}_{m,S_{m,t}}$ is the regime-specific risk exposure of market *m* with respect to developed market shocks and $\varepsilon_{d,t}$is the developed market shock described in Eq. (1). Thus unexpected component of the market excess return is partly driven by the developed market shock, $\varepsilon_{d,t}$, and the idiosyncratic shock, $\varepsilon_{m,t}$.This specification provides a flexible framework in that it allows for partial segmentation of regional stock markets from their advanced counterparts via the idiosyncratic error term, $\varepsilon_{m,t}$. Again, following the regime-based specification, the latent regime variable for the regional market takes values 1 or 2, i.e. $S_{m,t} \in \{1, 2\}$.

Next, following a number of works in the safe haven literature (e.g. Baur and McDermott, 2010; Baur and Lucey, 2010; Hood and Malik, 2013) suggesting that financial market shocks drive the demand for safe haven assets, particularly during periods of market stress, we next formulate a dynamic, two-factor model of excess returns for safe haven assets ($R_{sh,t}$) as a function of their exposure to developed and regional market shocks as well as an idiosyncratic component as follows

$$R_{sh,t} = \mu_{sh,S_{sh,t}} + \phi^{d}_{sh,S_{sh,t}} R_{d,t-1} + \phi^{m}_{sh,S_{sh,t}} R_{m,t-1} + \phi^{sh}_{sh,S_{sh,t}} R_{sh,t-1} + \xi_{sh,t} \quad (3)$$

where $\mu_{sh,S_{sh,t}}$ is the regime dependent intercept, and $\phi^{d}_{sh,S_{sh,t}}$ and $\phi^{d}_{sh,S_{sh,t}}$ is the regime specific return spillover from the developed market and regional market to safe heave asset, respectively. The unexpected component of the safe heave asset is driven by the developed market shock $\varepsilon_{d,t}$, , the regional market shock $\varepsilon_{m,t}$, and the idiosyncratic shock $\varepsilon_{sh,t}$, i.e. $\xi_{sh,t} = \beta^{m}_{sh,S_{sh,t}} \varepsilon_{m,t} + \beta^{d}_{sh,S_{sh,t}} \varepsilon_{d,t} + \varepsilon_{sh,t}$. Here, $\beta^{m}_{sh,S_{sh,t}}$ and $\beta^{d}_{sh,S_{sh,t}}$ measure the risk exposure of safe haven asset returns with respect to regional and developed market shocks during various market states. From an economic point of view, the two-factor model distinguishes between (partial) global and regional market integration of safe haven assets and allows us to assess their safe haven benefits with respect to local and global risk exposures of equity portfolios. A similar specification has also been adopted in Baele (2005), Baele and Inghelbrecht (2009, 2010) and Balcilar et al. (2015) to distinguish between risk exposures due to local and global risk factors. In our application, the two-factor model allows us to separately assess the effect of shocks emanating from advanced markets and shocks that are driven by regional risk factors.

The two-factor model provides several significant advantages from an econometric point of view as well. First, compared to the existing studies in the safe haven literature, the two-factor model provides a more comprehensive framework to model the fundamental linkages between safe haven assets and stock markets. Second, the regime-switching model allows us to examine the dynamic interactions across these markets by formally differentiating between market states that can be characterized by calm and stressed market periods. It must be noted that the existing literature has largely utilized a static specification where model parameters are assumed to be constant over time and instead, possible structural breaks are modeled using dummy variables representing 10, 5, and 1 percentile of stock market return distributions. In contrast, our econometric model addresses nonlinearity in an explicit and formal way by employing a Markov-Switching model which accounts for market regimes where the relationship between safe haven asset returns and the stock market shocks takes different forms.

A feature of the specification in Eqs. (1)–(3) is the broad treatment of the regimes in the global, regional, and safe haven asset markets. The latent regime variables $S_{d,\,t}$, $S_{m,\,t}$, and $S_{sh,\,t}$ are specific to each market and not jointly estimated, so that neither the independence restrictions are needed nor the cross-regime correlations are estimated, allowing the regimes for developed, regional, and safe haven assets to be synchronized, partially synchronized or completely synchronized depending on the estimated state variables. The specification is finally completed by defining the transition probabilities of the Markov chains as $p_{ij}^{l} = P\left(S_{l,t+1} = i | S_{l,t} = j\right)$ where p_{ij}^{l} for market $l = d, m, sh$ is the probability of being in regime *i* at time *t*+1 given that the market was in regime *j* at time *t*. Finally, the transition probabilities satisfy $\sum_{i=1}^{2} p_{ij}^{l} = 1$

2.2. Variance ratios

In order to provide further insight into the dynamic linkages between stock market shocks and safe havens, we also examine how much of the conditional variance of the unexplained component of safe haven returns is due to regional and developed market shocks. For this purpose, following Eqs. (1)–(3), we decompose the unexplained component of safe haven excess returns into three components: (i) a component due to developed market shocks; (ii) a component due to regional market shocks and (iii) the idiosyncratic component as

$$\xi_{sh,t} = \beta_{sh,S_{sh,t}}^{m} \varepsilon_{m,t} + \beta_{sh,S_{sh,t}}^{d} \varepsilon_{d,t} + \varepsilon_{sh,t} \tag{4}$$

where ξ denotes the unexpected component of excess returns. Similarly, unexpected components for regional and developed market excess returns are specified as

$$\xi_{m,t} = \beta_{m,S_{m,t}}^{d} \varepsilon_{d,t} + \varepsilon_{m,t} \tag{5}$$

$$\xi_{d,t} = \varepsilon_{d,t} \tag{6}$$

A novelty of the MS spillover model utilized in this study is that it allows for the computation of the time-varying conditional moments using the predictive probabilities, i.e. the probability of each asset being in regime *i* (i=1,2) at time *t* given the data through $t-1$. In the first step, we compute the conditional means for each asset's excess returns. The conditional means represent the expected component of the excess returns for each market. We next compute the time-varying conditional variances for the unexplained component of excess returns using the predictive probabilities, the estimated risk exposure values and regime specific variance terms. Finally, the variance ratios are calculated as the percentage of the total conditional variance for each safe haven asset that is explained by regional, developed market components as well as the idiosyncratic component.[2]

In order to calculate the conditional means and variances based on Eqs. (4)–(6) we first estimate predictive probabilities, $p_{i,t|t-1}^{l} = P\left(S_{l,t} = i | \psi_{t-1}\right)$, i.e. the probability of asset *l* being in regime i at time t given the information set available through time $t-1$, ψ_{t-1}. Let the vector of predictive probabilities as $p^l_{t|t-1} = \left[p^l{}_{i,t|t-1}\right]$, $i = 1, 2$, and the matrix of transition probabilities of sector/market l as $\mathrm{P}^l = \left[p^l_{ij}\right]$, $i, j = 1,2,3$. The predictive probabilities can then be calculated ad $p^l_{t|t-1} = \mathbf{P}^l p^l_{t-1|t-1}$, where $p^l_{t-1|t-1}$ is the vector of probabilities of asset l at time $t-1$ given data through $t-1$, that is, $p^l_{t-1|t-1} = \left[p^l_{i,t-1|t-1}\right] = \left[P\left(S_{l,t-1} = i|\psi_{t-1}\right]\right.$. These are also known as filtered probabilities and can be calculated using

$$p^l_{i,t|t} = \frac{p^l_{i,t|t-1} f_{(i)}\left(R_{l,t}|\psi_t,\theta\right)}{\sum_{i=1}^{3} p^l_{i,t|t-1} f_{(i)}\left(R_{l,t}|\psi_t,\theta\right)} \tag{7}$$

where $f_{(i)}(R_{i,\,t}|\psi_t,\,\theta)$ is the likelihood function of $R_{l,\,t}$ of asset l being in regime i and θ is the parameter vector.

The sequential estimation approach we adopt from Bekaert and Harvey (1997), Bekaert et al. (2005) and Balcilar et al. (2015) requires estimating Eq. (1) in the first step, Eq. (2) in the second step and Eq. (3) in the third step, estimating the idiosyncratic shock $\varepsilon_{d,\,t}$, $\varepsilon_{m,\,t}$, and $\varepsilon_{sh,\,t}$, respectively, in each. Thus, we need estimates of conditional means (expected component of each market's excess return) in each step. The conditional means are computed as the weighted average of the conditional means in each regime with weights equal to the predictive probability of the respective regimes. The deviation of the actual return from the conditional mean gives an estimate of the shocks. Let the expected component (conditional mean) is given by $\mu_{l,\,t}$, $l = d, m, sh$, then defining β^l_i as the risk exposure parameters in Eqs. (1)–((3) of asset l in regime i and x^l_t as the vector of independent variables, the conditional means are obtained as

$$\mu_{l,t} = E\left[|R_{l,t}|\psi_{t-1}\right] = \textstyle\sum_{i=1}^{2} p^l_{i,t|t-1}\left[\beta'{}_i x^l_t\right], \qquad l = d, m, sh \tag{8}$$

Then, the developed market, regional and safe asset idiosyncratic shocks are obtained as $\varepsilon_{l,t} = R_{l,t} - \mu_{l,t}$. Similarly, the conditional variances of $\varepsilon_{i,\,t}$ are given by

$$\sigma^2_{l,t} = E\left[\varepsilon^2_{l,t}\middle|\psi_{t-1}\right] = \textstyle\sum_{i=1}^{2} p^l_{i,t|t-1}\sigma^2_{l,i}, \qquad l = d, m, sh \tag{9}$$

Using the estimates of the conditional variances in Eq. (9) we next obtain the variances of the unexpected component of excess returns defined in Eqs. (4)–(6). Bekaert et al. (2009) show that a two-factor, time-varying coefficient spillover model with global and regional market shocks is sufficiently rich to eliminate most of the idiosyncratic shock correlations even when the equations are estimated independently. Using the predictive probabilities, we can estimate conditional variances using the following equations:

$$h_{d,t} = E\left[\xi^2_{d,t}\middle|\psi_{t-1}\right] = \textstyle\sum_{i=1}^{2} p^d_{i,t|t-1}\sigma^2_{d,i} \tag{13}$$

$$h_{m,t} = E\left[\xi_{m,t}^2 \middle| \psi_{t-1}\right] = \sum_{i=1}^{2} p_{i,t|t-1}^{m} \left[\left(\beta_{m,i}^{d}\right)^2 \sigma_{d,t}^2 + \sigma_{m,i}^2\right] \quad (14)$$

$$h_{sh,t} = E\left[\xi_{sh,t}^2 \middle| \psi_{t-1}\right] = \sum_{i=1}^{2} p_{i,t|t-1}^{sh} \left[\left(\beta_{sh,i}^{d}\right)^2 \sigma_{d,t}^2 + \left(\beta_{sh,i}^{m}\right)^2 \sigma_{m,t}^2 + \sigma_{sh,i}^2\right] \quad (15)$$

Given the conditional variance estimates obtained from Eqs. (13)–(14), the variance ratios can be calculated as the percentage of the conditional variances of the unexpected safe haven asset returns explained by the conditional variances of the regional and the developed market unexpected returns

$$VR_{sh,t}^{d} = \frac{\sum_{i=1}^{2} p_{i,t|t-1}^{sh} \left(\beta_{sh,i}^{d}\right)^2 \sigma_{sh,t}^2}{h_{sh,t}} \times 100 \quad (16)$$

$$VR_{sh,t}^{m} = \frac{\sum_{i=1}^{2} p_{i,t|t-1}^{sh} \left(\beta_{sh,i}^{m}\right)^2 \sigma_{m,t}^2}{h_{sh,t}} \times 100 \quad (17)$$

$$VR_{sh,t}^{sh} = \frac{\sum_{i=1}^{2} p_{i,t|t-1}^{sh} \sigma_{sh,i}^2}{h_{sh,t}} \times 100 \quad (18)$$

where $VR_{sh,t}^{d}$, $VR_{sh,t}^{m}$, and $VR_{sh,t}^{sh}$ are the percentage of conditional variances explained by the developed market, regional and asset specific idiosyncratic shocks, respectively.

3. Empirical results

3.1. Data

We use weekly data for a number of potential safe haven assets and MSCI stock market indices for developed and regional markets obtained from Datastream. The weekly data corresponds to the closing price on Wednesday of each week. Following the safe haven literature, we consider eight alternative safe haven assets including Gold, Silver, Brent crude oil, Japanese Yen, Swiss Francs, Treasury Bonds, Treasury Notes, and VIX. Developed markets are represented by the MSCI Developed Markets Index while regional markets for emerging stock markets, Euro area, Europe & Middle East, Latin America, and North America are represented by the corresponding MSCI indexes, respectively. The foreign currency rates are defined as the US dollar per unit of the currency, implying an increase corresponds to appreciation in the currency. In addition to broad regional indexes, we also examine a number of emerging stock markets individually including Brazil, Chile, Greece, Hungary, India, Indonesia, Korea, Kuwait, Malaysia, Mexico, Poland, Qatar, Russia, Saudi Arabia, South Africa, Taiwan, Thailand, Turkey and UAE (Unites Arab Emirates). Excess returns are computed using the 3-Month Treasury bill rate (USTB3).

Table 1 presents the descriptive statistics for weekly log returns along with the sample period and the number of observations for each return series. The end point for all return series is Nov 12, 2014 while the starting points are governed by data availability. We observe positive mean returns in all return series with the exception of Japanese Yen and VIX, while Swiss Francs, among the safe haven assets, have the highest mean return. The high return for Swiss Francs is coupled with the highest return volatility of 11.1% for this currency, while the US Treasury securities experience the lowest volatility in returns. Unlike other safe haven assets, weekly returns for Swiss Francs exhibit positive skewness and significantly large kurtosis, implying greater likelihood of experiencing positive returns as well as the presence of extreme movements.

Table 1
Descriptive statistics.

	n	Mean	S.D.	Min	Max	Skewness	Kurtosis	JB	Q(1)	Q(4)	ARCH(1)	ARCH(4)	Sample period
BRENT	1353	0.13	4.59	-38.45	21.94	-0.70	5.75	1982.44***	4.61**	15.44***	65.75***	93.36***	12/07/1988-11/12/2014
GOLD	1880	0.09	2.69	-13.11	20.21	0.29	5.96	2814.62***	0.17	6.24	33.69***	206.55***	11/01/1978-11/12/2014
SILVER	2184	0.09	4.42	-29.54	21.81	-0.30	4.41	1807.40***	3.57*	14.18***	57.15***	156.66***	01/10/1973-11/12/2014
SWISS FRANC	2184	0.17	11.11	-229.52	230.81	4.06	414.91	15700825.25***	0.01	86.91***	0.01	86.22***	01/10/1973-11/12/2014
TBOND	1942	0.02	1.60	-19.60	8.34	-0.89	13.59	15241.50***	0.97	4.67	0.84	7.14	08/24/1977-11/12/2014
TNOTE	1697	0.03	1.02	-11.94	6.51	-0.78	13.57	13224.25***	1.70	6.47	0.48	3.99	05/05/1982-11/12/2014
VIX	554	-0.05	7.98	-26.86	34.19	0.34	1.27	48.55***	15.73***	17.09***	14.39***	23.03***	03/31/2004-11/12/2014
JAPANESE YEN	2184	-0.01	1.51	-16.84	9.31	-0.25	8.83	7139.11***	6.51**	19.77***	3.71*	11.92**	01/10/1973-11/12/2014
DEVELOPED	2184	0.13	2.12	-21.68	12.46	-0.83	7.50	5387.51***	0.28	23.23***	41.90***	94.88***	01/10/1973-11/12/2014
EMERGING	1401	0.16	2.98	-26.06	16.76	-0.99	6.29	2550.83***	4.19**	34.93***	21.43***	250.57***	01/06/1988-11/12/2014
EURO AREA	1401	0.10	2.66	-13.97	14.89	-0.63	3.58	846.44***	11.10***	23.29***	132.03***	172.83***	01/06/1988-11/12/2014
EUROPE & MEAST	1401	0.08	3.78	-32.56	17.46	-0.90	6.38	2576.22***	0.64	21.64***	37.49***	229.44***	01/06/1988-11/12/2014
LAT. AMERICA	1401	0.24	4.08	-40.33	13.70	-1.35	9.03	5205.75***	1.00	12.70**	9.06***	52.08***	01/06/1988-11/12/2014
NORTH AMERICA	2184	0.13	2.25	-16.97	14.93	-0.48	7.72	5522.64***	2.49	3.52	38.95***	63.19***	01/10/1973-11/12/2014
BRAZIL	1225	1.08	5.80	-32.50	31.20	0.12	4.48	1034.19***	6.09**	113.75***	131.00***	168.69***	05/22/1991-11/12/2014
CHILE	1453	0.29	2.42	-17.44	9.70	-0.22	3.73	860.24***	22.78***	52.68***	28.67***	48.71***	01/07/1987-11/12/2014
EGYPT	1036	0.22	3.74	-24.50	16.02	-0.53	3.71	645.93***	3.44*	13.63***	8.75***	51.84***	01/04/1995-11/12/2014
GREECE	1362	0.08	4.29	-16.17	18.83	-0.02	1.50	128.39***	3.94**	22.93***	30.01***	73.85***	10/05/1988-11/12/2014
HUNGARY	1245	0.23	3.84	-20.05	30.10	-0.09	6.08	1925.48***	1.08	18.67***	85.92***	139.00***	01/02/1991-11/12/2014
INDIA	866	0.11	3.85	-25.78	22.95	-0.35	5.49	1114.60***	1.28	8.97*	93.88***	110.35***	04/08/1998-11/12/2014
INDONESIA	1649	0.24	3.86	-31.45	74.28	3.91	87.70	533962.22***	2.19	30.76***	110.69***	114.41***	04/06/1983-11/12/2014
KOREA	2080	0.16	3.47	-17.46	19.83	-0.16	3.90	1329.79***	1.35	20.17***	167.37***	253.52***	01/01/1975-11/12/2014
KUWAIT	1037	0.12	2.08	-17.27	7.57	-1.22	8.25	3212.51***	16.17***	44.23***	68.41***	176.12***	12/28/1994-11/12/2014
MALAYSIA	1819	0.12	3.33	-32.63	27.97	-0.65	12.45	11909.60***	5.06**	22.36***	206.06***	229.18***	01/02/1980-11/12/2014
MEXICO	1401	0.44	3.76	-19.44	33.65	0.38	6.56	2556.14***	2.95*	27.39***	52.44***	139.97***	01/06/1988-11/12/2014
POLAND	1230	0.32	4.53	-34.11	25.53	-0.14	7.68	3044.38***	15.80***	26.79***	68.01***	232.16***	04/17/1991-11/12/2014
QATAR	848	0.28	3.41	-27.73	14.29	-1.16	11.23	4671.40***	0.02	13.39***	31.67***	58.93***	08/12/1998-11/12/2014
RUSSIA	1036	0.19	6.95	-49.00	40.22	-0.34	6.15	1661.09***	0.04	26.31***	44.13***	165.76***	01/04/1995-11/12/2014
SAUDI ARABIA	880	0.16	3.33	-27.32	13.92	-1.60	10.29	4281.76***	6.48**	12.88**	42.18***	101.28***	12/31/1997-11/12/2014
SOUTH AFRICA	1140	0.22	2.75	-15.68	12.59	-0.47	2.86	433.03***	4.23**	9.24*	3.97**	39.50***	01/06/1993-11/12/2014
TAIWAN	2184	0.17	4.06	-24.12	24.05	-0.31	3.70	1285.96***	16.63***	43.14***	127.47***	368.28***	01/10/1973-11/12/2014
THAILAND	2063	0.13	3.50	-19.15	17.82	-0.20	3.89	1320.34***	17.23***	49.30***	113.60***	192.43***	04/30/1975-11/12/2014
TURKEY	1401	0.67	6.33	-32.84	32.33	0.05	2.94	508.76***	2.29	12.72**	35.26***	83.93***	01/06/1988-11/12/2014
UAE	567	0.22	3.49	-23.90	13.95	-1.18	8.26	1757.92***	4.19**	16.94***	10.63***	30.25***	12/31/2003-11/12/2014
USTB3	2184	0.10	0.07	0.00	0.33	0.52	0.37	112.85***	2173.04***	8600.76***	2112.65***	2110.56***	01/10/1973-11/12/2014

Note: This table reports the descriptive statistics for weekly log returns in percent. Safe haven assets assets (in shaded rows) include BRENT (Brent crude oil), YEN (FINEX Japanese Yen index), GOLD (gold), SILVER (Silver), SWISS FRANC (CME Swiss Franc rate in US Dollars), TBOND (30 Year US Treasury Bond), TNOTE, (10 Year Treasury Note), and VIX (CBOE Volatility Index). Regional markets include broad market indices EMERGING (MSCI Emerging Markets), EURO AREA (MSCI Euro Area), Europe & MEAST (MSCI Europe and Middle East), LAT. AMERICA (MSCI Latin America), and N. AMERICA (MSCI North America), while individual market indices include BRAZIL, CHILE, GREECE, HUNGARY, INDIA, INDONESIA, KOREA, KUWAIT, MALAYSIA, MEXICO, POLAND, QUATAR, RUSSIA, SAUSI ARABIA, SOUTH AFRICA, TAIWAN, TURKEY, UEA (Unites Arab Emirates), and TURKEY. The DEVELOPED index is the MSCI Developed Markets Index, while USTB3 is the US 3-Month Treasury Bill rate. In addition to the mean, standard deviation (S.D.), minimum (min), maximum (max), skewness, and kurtosis statistics, the table reports the Jarque-Berra normality test (JB), the Ljung-Box first [Q(1)] and the fourth [Q(4] autocorrelation tests, and the first [ARCH(1)] and the fourth [ARCH(4)] order Lagrange multiplier (LM) tests for the autoregressive conditional heteroskedasticity (ARCH). ***,** and * represent significance at the 1%, 5%, and 10% levels, respectively. The sample periods vary across series and are given in the last column. *n* is the number of observations.

Table 2 provides the unconditional correlation estimates among the safe haven assets and stock market indices. Although safe haven asses generally exhibit low correlations with stock markets, we observe mostly negative correlations between stock markets and currencies, U.S. Treasury securities and VIX futures. The preliminary analysis thus suggests that currencies and U.S. Treasury securities generally stand out from the rest of safe haven assets both in terms of their higher moments and their correlations with stock market returns. Next, we briefly explain the estimation procedure and present the formal analysis of the risk exposures of these assets with respect to stock market shocks.

Table 2
Correlations of safe haven and stock market returns.

	BRENT	GOLD	SILVER	SWISS FRANC	TBOND	TNOTE	VIX	YEN	DEVEL.
BRENT	1.000								
GOLD	0.268	1.000							
SILVER	0.263	0.754	1.000						
SWISS_FRANC	0.084	0.335	0.035	1.000					
TBOND	-0.118	0.071	0.005	0.139	1.000				
TNOTE	-0.094	0.069	0.001	0.135	0.954	1.000			
VIX	-0.154	-0.094	-0.180	-0.013	0.263	0.232	1.000		
YEN	0.004	0.157	0.095	0.048	0.086	0.101	0.170	1.000	
DEVELOPED	0.126	0.130	0.187	0.012	0.019	-0.023	-0.468	0.160	1.000
EMERGING	0.125	0.174	0.280	0.007	-0.132	-0.131	-0.477	-0.032	0.695
EURO AREA	0.085	0.008	0.138	-0.206	-0.184	-0.190	-0.585	-0.123	0.706
EUROPE & MEAST	0.154	0.171	0.275	0.155	-0.120	-0.109	-0.450	0.001	0.578
LAT. AMERICA	0.152	0.173	0.258	-0.014	-0.102	-0.094	-0.486	-0.052	0.493
NORTH AMERICA	0.125	0.045	0.112	0.024	-0.009	-0.020	-0.650	-0.064	0.570
BRAZIL	0.060	0.097	0.149	-0.026	-0.070	-0.067	-0.448	-0.033	0.335
CHILE	0.062	0.027	0.099	-0.083	-0.083	-0.075	-0.397	-0.131	0.309
EGYPT	0.160	0.090	0.132	0.064	-0.076	-0.080	-0.189	-0.067	0.309
GREECE	0.038	0.048	0.116	-0.026	-0.135	-0.134	-0.376	-0.070	0.433
HUNGARY	0.135	0.063	0.174	-0.084	-0.145	-0.171	-0.375	-0.029	0.447
INDIA	0.146	0.126	0.197	0.048	-0.085	-0.077	-0.254	-0.124	0.450
INDONESIA	0.078	0.088	0.133	-0.021	-0.051	-0.048	-0.314	-0.029	0.281
KOREA	0.009	0.028	0.083	-0.015	-0.056	-0.079	-0.386	0.019	0.384
KUWAIT	0.027	-0.036	-0.002	-0.014	-0.051	-0.073	-0.117	-0.054	0.181
MALAYSIA	0.006	0.041	0.104	-0.075	-0.043	-0.063	-0.327	-0.019	0.388
MEXICO	0.083	0.077	0.146	-0.075	-0.023	-0.032	-0.476	-0.038	0.405
POLAND	0.075	0.062	0.124	-0.045	-0.112	-0.111	-0.398	-0.022	0.363
QATAR	0.152	0.059	0.114	0.085	-0.054	-0.053	-0.195	-0.044	0.339
RUSSIA	0.170	0.115	0.199	0.001	-0.141	-0.146	-0.356	-0.043	0.426
SAUDI ARABIA	0.161	-0.007	0.044	0.004	-0.133	-0.129	-0.183	-0.102	0.296
SOUTH AFRICA	0.190	0.296	0.313	-0.001	-0.183	-0.194	-0.406	-0.029	0.537
TAIWAN	-0.060	-0.011	0.040	-0.019	-0.060	-0.075	-0.353	-0.046	0.308
THAILAND	-0.002	0.036	0.094	-0.066	-0.039	-0.045	-0.309	-0.010	0.366
TURKEY	0.061	0.029	0.072	-0.029	-0.045	-0.043	-0.377	-0.020	0.256
UAE	0.208	-0.001	0.077	0.034	-0.113	-0.108	-0.137	-0.135	0.335

Note: The table reports the Pearson correlation estimates across various safe haven assets and stock markets.

3.2. Estimation results

The MS models described in Eqs. (1)–(3) are estimated following the three-step estimation procedure of Bekaert and Harvey (1997) and Ng (2000).[3] In the first step, developed market shocks are obtained by estimating Eq. (1). Next, developed market shocks are related to regional market excess returns as shown in Eq. (2) and regional market shocks are obtained accordingly.[4] In the third step, developed and regional market shocks are related to excess returns on safe haven assets as shown in Eq. (3). In order to provide support for the regime-based specification, we test the MS specification against the linear alternative using the likelihood ratio (LR) tests with the upper bound for the p-values obtained according to Davies (1987). We also supplement the LR tests with AIC. In order to check the robustness of model selection, we use the bootstrap testing approach of Di Sanzo (2009) which tests for linearity in Markov-Switching models.[5]

Given that the number of regimes is known, we estimate the parameters of the MS models using the maximum likelihood estimation procedure. The error terms in Eq. (3) are assumed to follow t-distribution in order to account for fat tails. The conditional moments of the MS models are then estimated using the predictive probabilities that are obtained from the transition probabilities and the filtered probabilities of the Hamilton filter (see Balcılar et al., 2015 for details). The estimates are obtained by maximizing the log-likelihood subject to the constraint that the probabilities lie between 0 and 1 and sum to unity. Finally, the likelihood is evaluated using the filtering procedure of Hamilton (1990), followed by the smoothing algorithm of Kim (1994).

Table 3
Risk exposures of safe haven assets to developed market shocks.

	Brent		Gold		Silver		Swiss Franc	
	$\beta^d_{sh,1}$	$\beta^d_{sh,2}$	$\beta^d_{sh,1}$	$\beta^d_{sh,2}$	$\beta^d_{sh,1}$	$\beta^d_{sh,2}$	$\beta^d_{sh,1}$	$\beta^d_{sh,2}$
EMERGING	0.4150***	0.0769	-0.0330	0.0926**	0.0908**	0.5298***	0.1918***	-0.0358
EURO AREA	0.3424***	0.2586*	-0.0226	0.2750***	0.0758*	0.6735***	0.1924***	0.0264
EUROPE & MEAST	0.4364***	0.1595	-0.0171	0.1964***	0.0807*	0.5519***	0.2049***	-0.0652
LAT. AMERICA	0.4013***	0.1643	-0.0230	0.2203***	0.1332***	0.5700***	0.2035***	-0.0169
N. AMERICA	0.4060***	0.1769*	0.0364	0.4129***	0.0828*	0.8073***	-0.0548	0.0722***
BRAZIL	0.4906***	0.2813***	-0.0213	0.1863***	0.1048***	0.6898***	0.2197***	-0.0936***
CHILE	0.3717***	0.1585	-0.0233	0.0948**	0.1082***	0.6844***	-0.1063***	0.1342***
EGYPT	0.6011***	0.2890***	0.0580*	0.2463***	0.0911*	0.6531***	-0.0698*	0.0294
GREECE	0.3851***	0.1618	-0.0247	0.1741***	0.0547	0.6817***	0.1924***	-0.1246**
HUNGARY	0.4547***	0.2470***	-0.0102	0.2054***	0.1042*	0.6685***	-0.1145***	0.1386***
INDIA	0.5567***	0.2928***	0.0643*	0.1872**	0.1362**	0.6687***	0.1977***	-0.0525
INDONESIA	0.4096***	0.1614	0.0063	0.1372***	0.0701	0.5786***	-0.0472	0.1547***
KOREA	0.3347	0.2932	0.0325	0.4300***	0.0914**	0.8765***	-0.0414	0.1844***
KUWAIT	0.5792***	0.2902***	-0.0283	0.2280***	0.0908*	0.6545***	0.0102	0.0034
MALAYSIA	0.3722	0.1762	0.0234	0.4022***	0.0754*	0.8141***	-0.0705	0.1905***
MEXICO	0.3749***	0.1500	-0.0030	0.1390***	0.0694	0.6852***	-0.2182***	0.2308***
POLAND	0.5154***	0.2755***	-0.0376	0.2015***	0.0658	0.6645***	0.2079***	-0.0868**
QATAR	0.6187***	0.2467***	0.0565	0.2436**	0.1224**	0.7015***	-0.4619***	0.0548**
RUSSIA	0.6218***	0.2840***	0.0453*	0.2400***	0.1102**	0.6795***	0.0279**	-0.0045
SAUDI ARABIA	0.5898***	0.2830***	0.0777**	0.2319**	0.1028*	0.6783***	0.2006***	-0.1058***
SOUTH AFRICA	0.6177***	0.2825***	-0.0148	0.1997***	0.1179**	0.6709***	0.2107***	-0.0776**
TAIWAN	0.3821***	0.1935	0.0323	0.4462***	0.0932**	0.7597***	-0.0699	0.1314***
THAILAND	0.4066***	0.1633	0.0260	0.3983***	0.0621	0.7989***	-0.0595*	0.1868***
TURKEY	0.3771***	0.1101	-0.0068	0.1585***	0.0909*	0.6706***	-0.0492*	0.1703***
UAE	0.5900***	0.5041***	0.2496***	0.2556**	-0.9102***	0.7384***	0.1924**	-0.0117

	Japanese Yen		US T-Bond		US T-Note		VIX	
	$\beta^d_{sh,1}$	$\beta^d_{sh,2}$	$\beta^d_{sh,1}$	$\beta^d_{sh,2}$	$\beta^d_{sh,1}$	$\beta^d_{sh,2}$	$\beta^d_{sh,1}$	$\beta^d_{sh,2}$
EMERGING	0.2890***	-0.1569***	-0.1140***	0.2722***	0.2391***	-0.0951***	-0.6869***	-2.1441***
EURO AREA	0.2675***	-0.0762***	0.2068***	-0.1381***	-0.0807***	0.1761***	-0.7870***	-1.9398***
EUROPE & MEAST	0.3197***	-0.0992***	0.2876***	-0.1582***	-0.1136***	0.1862***	0.1207***	-1.5627***
LAT. AMERICA	0.2918***	-0.0235	0.2597***	-0.1704***	-0.1214***	0.0761***	-0.6323***	-2.0204***
N. AMERICA	-0.0099	0.4347***	0.1960***	-0.0426*	-0.1041***	0.1005***	-1.1414***	-1.2153***
BRAZIL	-0.0885***	0.2381***	0.0713	-0.1758***	-0.1204***	0.0350	-0.7437***	-1.9851***
CHILE	0.3601***	-0.0450**	0.2309***	-0.1369***	-0.1167***	0.0769***	-0.4674**	-1.9885***
EGYPT	-0.0148	-0.0139	-0.0197	-0.1667***	-0.1127***	0.0217	-0.6654***	-2.1040***
GREECE	0.3335***	-0.0870***	0.2223***	-0.1112***	-0.1022***	0.0476**	-0.5642***	-1.9223***
HUNGARY	0.0330	0.0111	0.2437***	-0.1675***	-0.1252	0.0850	-0.7559***	-1.9523***
INDIA	0.2169***	-0.1170***	-0.2275***	0.0197	-0.1252***	0.0029	-0.6228***	-2.0947***
INDONESIA	0.3447***	-0.0800***	-0.1733***	0.2257***	-0.1151***	0.0861***	-0.6537***	-1.9119***
KOREA	-0.0555**	0.3742***	-0.0289	0.1123*	-0.0746**	0.0632**	-0.6447***	-1.9092***
KUWAIT	-0.0711***	0.1663***	0.0471	-0.2130***	-0.0885***	-0.0290	-0.6440***	-1.9753***
MALAYSIA	0.3785***	-0.0830***	-0.0585***	0.0256	-0.0419***	0.0320***	-0.6544***	-1.9740***
MEXICO	0.3150***	-0.1429***	0.2690***	-0.1633***	-0.1071***	0.0999***	-0.8526***	-2.1653***
POLAND	-0.0355***	0.3301***	0.2088***	-0.1698***	-0.1211***	0.0778	-0.6507***	-1.9742***
QATAR	-0.2603***	0.0976***	-0.1654***	-0.0166	-0.1296***	-0.0104	-0.6326***	-1.9905***
RUSSIA	-0.0287	-0.0051	-0.1222***	-0.0026	-0.1144***	0.0263	-0.5985***	-1.8746***
SAUDI ARABIA	-0.1714***	0.1016***	-0.1632***	0.0025	-0.1080***	-0.0049	-0.6928***	-1.9523***
SOUTH AFRICA	0.0844***	-0.0593*	0.0379	-0.1754***	-0.0912***	-0.0042	-0.6058***	-2.0617***
TAIWAN	-0.0403**	0.3966***	-0.0705**	0.0480	-0.0716***	0.1389***	-0.6242***	-2.0981***
THAILAND	-0.0725***	0.3826***	-0.0554***	-0.0019	-0.0875***	0.0950***	-0.6553***	-2.0068***
TURKEY	0.3379***	-0.0842***	0.2671***	-0.1669***	-0.1139***	0.0772***	4.8793***	-1.5707***
UAE	0.3391***	-0.1839***	-0.2129***	0.0030	-0.1190***	-0.0123	-0.6658***	-2.0460***

Note: The table reports the regime-specific estimates for the risk exposures ($\beta^d_{sh,S_{sh,t}}$) of various safe haven assets to developed market shocks obtained from the MS spillover model described in Eqs. (1)–(3). Only risk exposure estimates are reported to preserve space. In each case, we specify the conditional mean as a function of the p lags of the safe haven asset return, regional market return, and the developed market return. The lag order p is specified using the AIC. The error distribution is assumed to be the student t distribution, i.e., $\varepsilon_{i,t} \sim t(v_{t,S_{sh},t})$, where $v_{t,S_{sh},t}$ is the degree of freedom. The parameters are estimated using maximum likelihood (ML) estimation. ***, ** and * represent significance at the 1%, 5%, and 10% levels, respectively.

3.2.1. Time-varying risk exposures of safe haven assets

Table 3 presents the estimates for the regime-specific risk exposures ($\beta^{d}_{sh,S_{sh,t}}$) of safe haven assets with respect to developed market shocks, obtained from the MS model described in Eqs. (1)–(3). Due to space considerations, we only report the risk exposure estimates in the table. We generally observe significant and non-zero risk exposure estimates during both market regimes for most safe havens, indicating a non-linear relationship between safe haven asset return dynamics and advanced stock market shocks, thus providing support for the regime-based specification adopted in our empirical analysis. Comparing the risk exposure estimates for regimes 1 and 2, we see significantly different risk exposure patterns across the two regimes with the exception of VIX which is found to exhibit negative risk exposures with respect to developed market shocks during both market states. Similarly, Japanese Yen and US Treasuries are also observed to generally exhibit negative risk exposures to developed market shocks, however, the pattern is largely regime specific and not as consistent as in the case of VIX futures. Therefore, we argue that VIX futures could serve as a strong and unconditional hedge against developed market shocks for investors in equity markets, while the safe haven benefits for the Yen and US Treasuries should be assessed conditional on the state of the market.

In the case of the other safe havens, we generally observe mixed results across the two market states, both in terms of the statistical significance and the sign of the estimated risk exposures. Therefore, in order to better interpret the risk exposures in regimes 1 and 2, we present in Fig. 1 the smoothed probability plot for each market of being in Regime 2.[6] The smoothed probabilities generally suggest that regime 2 corresponds to periods that are characterized by market stress (or market crashes). We see that regime 2 probabilities generally take values close to 1 during the 2007/2008 global financial crisis period, more so in the case of Brent, Gold, Silver, Japanese Yen, Treasury securities and VIX, suggesting that regime 2 is the market stress regime and regime 1 is the normal (or calm) regime.

Having characterized the market regimes, the examination of risk exposures across the two regimes reveals several interesting results. First, we observe that risk exposures with respect to developed market shocks across all safe haven assets are low, well below unity, suggesting low integration of these assets with stock markets. Both precious metals, gold and silver, as the traditionally accepted safe havens, are found to exhibit positive risk exposures with respect to developed market shocks during the second regime, underscoring the increased demand for these assets during periods of market stress. However, unlike silver, the insignificant risk exposures observed for gold in regime 1 suggests the potential of this asset as a diversifier for equity portfolios during normal times. On the other hand, Swiss francs Japanese Yen and Treasury Bonds exhibit negative risk exposures with respect to developed market shocks in the second regime, suggesting that these assets could serve as safe havens for equity investors during periods of market stress.

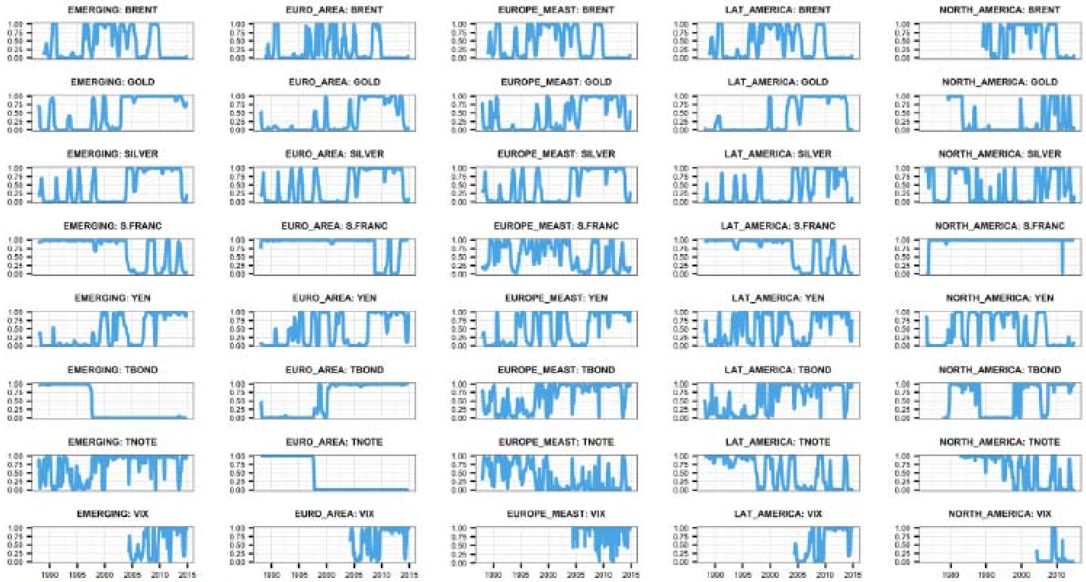

Fig. 1. Smoothed Probability of being in Regime 2.
Note: Figure plots the smoothed probability of being in Regime 2 for various safe haven assets. Areas with probability estimates higher than 0.5 indicate that these periods can be characterized by Regime 2. Due to space considerations, we only report the plots for regional market indices; the plots for individual stock markets are available upon request.

It must be noted that the estimates reported in Table 3 provide mean risk exposures across market regimes and do not provide insight to the time-variation in risk exposures. For this reason, we provide in Fig. 2 the time-varying intensities of developed market shocks to various safe haven assets. These time-varying shock spillover intensities are computed as probability-weighted risk exposures of each safe haven asset with respect to developed market shocks, i.e. $p_{1t}\beta^{d}_{sh,1} + (1 - p_{1t})\,\beta^{d}_{sh,2}$, based on the risk exposure estimates from Eq. (3) and the filtered probability estimates (p_{1t}). Once again, due to space considerations, we only report the plots for regional market indices; the plots for individual stock markets are available upon request. Fig. 2 suggests that most safe haven assets exhibit low risk exposures with respect to developed market shocks, well below unity, although these exposures have generally increased during the global financial crisis period, particularly in the case of Brent, Gold, Silver and Swiss Francs. On the other hand, Japanese Yen, U.S. Treasury securities and partially Swiss Francs exhibit mostly negative risk exposures during the financial crisis period, suggesting that these assets could serve as safe havens during that period. Once again, VIX futures stand out with consistently negative risk exposures to developed market shocks, further supporting the hedge and safe haven potential of these securities for equity investors.

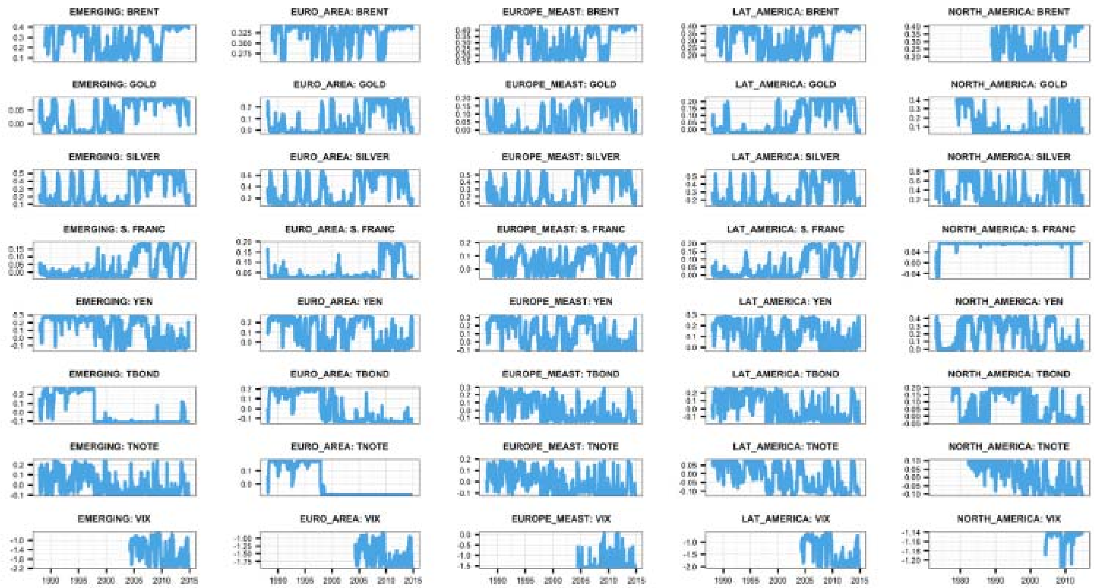

Fig. 2. Developed Market Shock Transmission Intensities over Time.

Note: The figure plots the time-varying intensities of developed market shocks to various safe haven assets. Time-varying shock spillover intensities are computed as probability-weighted shock spillover intensities from developed market shocks to safe haven assets, i.e. $p_{1t}\beta^{d}_{sh,1} + (1 - p_{1t})\beta^{d}_{sh,2}$, based on the spillover intensity estimates from Eq. (3) with the filtered probability estimates (p_{1t}). Due to space considerations, we only report the plots for regional market indices; the plots for individual stock markets are available upon request.

Examining the risk exposures with respect to regional market shocks, the regime-specific risk exposures ($\beta^{m}_{sh,S_{sh,t}}$) reported in Table 4 are found to be insignificant for most markets, suggesting that developed market shocks largely control for regional market shocks in the model. Interestingly, however, significant and negative risk exposures are observed for Swiss Francs, Japanese Yen, Treasury Bonds and VIX, implying that these securities could be used to partially hedge regional market risks along with risk exposures with respect to developed markets. Gold, on the other hand, can serve as a safe haven against local market shocks in the cash and oil rich Gulf Cooperation council nations of Kuwait, Saudi Arabia and UAE, implied by negative and significant risk exposures with respect to regional shocks associated with these countries. Similarly, Swiss Francs, Japanese Yen, Treasury securities and VIX could be utilized to hedge local market risks in emerging stock markets in general, implied by mostly negative risk exposures of these assets with respect to country-specific shocks. These observations are further supported by the time-varying regional shock spillover intensities reported in Fig. 3. We observe in Fig. 3 mostly negative risk exposures with respect to regional stock market shocks, particularly for currencies, Treasury securities and VIX during the global financial crisis period.

Table 4
Risk Exposures of Safe Haven Assets to Regional Shocks.

	Brent		Gold		Silver		Swiss Franc	
	$\beta^{m}_{sh,1}$	$\beta^{m}_{sh,2}$	$\beta^{m}_{sh,1}$	$\beta^{m}_{sh,2}$	$\beta^{m}_{sh,1}$	$\beta^{m}_{sh,2}$	$\beta^{m}_{sh,1}$	$\beta^{m}_{sh,2}$
EMERGING	0.1279**	0.2004	-0.0265	0.3879***	0.0408	0.6252***	0.1305***	-0.0747***
EURO AREA	0.1288**	-0.1100	-0.1604***	0.0403	-0.1197**	0.1556	0.1635***	-0.3954***
EUROPE & MEAST	0.1700***	0.1404*	-0.0096	0.2499***	0.0097	0.4186***	0.1073***	0.0677***
LAT. AMERICA	0.0569	0.2608***	0.0018	0.3500***	0.0404	0.4540***	0.0977***	-0.0431***
N. AMERICA	0.3663***	0.0248	-0.0851***	0.0903	0.0299	0.0149	-0.5732***	-0.1195***
BRAZIL	-0.0022	-0.0117	-0.0120	0.0974***	-0.0105	0.3314	0.0402***	-0.0310***
CHILE	0.0541	0.0597	0.0087	0.0090	0.0149	0.0232	-0.0881***	-0.0692***
EGYPT	0.1173**	0.1230**	0.0233	0.0224	0.0055	0.0503	0.1885**	-0.0026
GREECE	0.0090	-0.2021***	0.0106	-0.0295	-0.0130	-0.0435	0.0189	-0.0826***
HUNGARY	0.1300***	0.0662	-0.0156	-0.0665	0.0312	0.1411**	-0.1132***	0.0164
INDIA	0.1009*	0.0083	0.0377	0.0484	0.0284	0.0636	-0.0374	0.0025
INDONESIA	0.0202	-0.0620	0.0094	0.0617	-0.0014	0.1811***	-0.0034	-0.0213
KOREA	0.0771	-0.2612	0.0131	-0.0617	-0.0084	-0.0462	-0.0335**	-0.0111
KUWAIT	-0.0790	0.0122	-0.0053	-0.1372***	0.0612	-0.0215	-0.0261	0.0598
MALAYSIA	-0.0285	0.0193	0.0011	0.0279	0.0251	0.0465	-0.0185	-0.0989***
MEXICO	0.0430	0.0872	0.0186	0.0383	-0.0078	0.2932***	-0.0955***	-0.0235
POLAND	0.0157	0.0400	-0.0004	0.0215	0.0057	-0.0175	0.0098	-0.0491**
QATAR	0.0562	0.1733**	0.0339	-0.0231	0.0791	-0.0384	0.1284	0.0215
RUSSIA	0.1274***	0.0563**	0.0005	0.1101***	-0.0044	0.1624***	-0.0014	0.0011
SAUDI ARABIA	0.0369	0.2403**	0.0207	-0.1771***	0.0494	-0.0261	-0.0034	-0.0094
SOUTH AFRICA	0.1418*	0.2370***	0.0779***	0.3852***	0.0924**	0.7122***	0.0394	-0.0386
TAIWAN	0.0137	-0.2652***	-0.0208*	-0.0581	-0.0638***	-0.0791	0.0347***	-0.0337***
THAILAND	-0.0063	-0.0846	0.0073	0.0005	0.0042	0.1280*	-0.0108	-0.0743***
TURKEY	0.0273	0.0201	0.0009	-0.0014	0.0025	-0.0555	-0.0196**	0.0096
UAE	-0.0273	0.3331***	-0.0086	-0.1612*	-0.5792***	-0.0779	0.0059	-0.0119

	Japanese Yen		US T-Bond		US T-Note		VIX	
	$\beta^{m}_{sh,1}$	$\beta^{m}_{sh,2}$	$\beta^{m}_{sh,1}$	$\beta^{m}_{sh,2}$	$\beta^{m}_{sh,1}$	$\beta^{m}_{sh,2}$	$\beta^{m}_{sh,1}$	$\beta^{m}_{sh,2}$
EMERGING	-0.0433*	0.0133	-0.0944***	0.0491**	0.0663**	-0.0741***	-1.0366***	-0.1599
EURO AREA	-0.3147***	-0.1282***	0.1155***	-0.2240***	-0.1371***	0.0615***	-1.2157***	-1.6259***
EUROPE & MEAST	-0.0234	-0.0006	0.0427*	-0.0758***	-0.0526***	0.0321**	0.9152***	-0.4537***
LAT. AMERICA	-0.0123	-0.0498***	0.0355*	-0.0598***	-0.0341***	-0.0064	-0.5581***	-0.7351***
N. AMERICA	-0.0630***	-0.2937***	0.2624***	-0.1591***	-0.0304	0.0119	-3.2057***	-0.8375**
BRAZIL	-0.0627***	0.0066	0.0038	-0.0594**	-0.0248***	0.0025	-0.0532	-0.6780***
CHILE	-0.0330	-0.1229***	0.0499***	-0.0687***	-0.0603***	0.0113	-0.8673**	-0.4314*
EGYPT	-0.0139	-0.0451	-0.0107	-0.0269	-0.0040	-0.0368*	0.0157	-0.0024
GREECE	-0.0292**	-0.0174	-0.0092***	-0.0430***	-0.0198***	-0.0268***	-0.3337**	-0.2267**
HUNGARY	-0.0402***	0.0285	-0.0185	-0.0563***	-0.0477	-0.0120	-0.4179***	-0.4359***
INDIA	-0.0159	-0.0440**	-0.0047	-0.0028	-0.0008	-0.0030	0.1105	-0.2199
INDONESIA	-0.0171*	-0.0028	0.0009	0.0180	0.0023	0.0045	0.1495	-0.1451
KOREA	-0.0459***	-0.0028	-0.0405***	-0.0085	-0.0185**	-0.0080	-0.2500	-0.1949
KUWAIT	-0.0619**	-0.0101	-0.0776***	-0.0107	-0.0311**	-0.0028	0.0635	-0.2056
MALAYSIA	-0.0259*	-0.1088***	-0.0063	-0.0597*	-0.0041	-0.0328**	-0.5695	-0.1171
MEXICO	-0.0426***	-0.0059	0.0134	0.0007	-0.0113	0.0180	-0.8119***	-1.0589***
POLAND	-0.0300***	0.0409*	0.0019	-0.0803***	-0.0434***	0.0040	-0.1953	-0.5657***
QATAR	0.0068	0.0032	-0.0282*	0.0094	0.0029	-0.0001	0.0351	0.1878
RUSSIA	-0.0203**	-0.0085	-0.0244***	-0.0458	-0.0133**	-0.0150	-0.1245	-0.0983
SAUDI ARABIA	-0.0271	-0.0340*	-0.0451***	-0.0452	-0.0243***	-0.0711**	0.0363	-0.0076
SOUTH AFRICA	-0.0046	-0.0804*	-0.0838***	-0.0683**	-0.0473***	-0.0591**	-0.1206	-0.7499***
TAIWAN	-0.0245**	-0.0183*	-0.0368***	-0.0059	-0.0250***	-0.0142	-0.2331	0.0941
THAILAND	-0.0323*	-0.0130	0.0002	0.0363	-0.0117	-0.0076	0.0646	-0.2480
TURKEY	-0.0144**	-0.0091	0.0208**	-0.0100	-0.0026	0.0022	-0.0123	-0.3108***
UAE	0.0300	-0.0473**	-0.0055	-0.1069**	-0.0027	-0.0649**	0.0100	0.2218

Note: The table reports the estimates for the regime-specific risk exposures ($\beta^{m}_{sh,S_{sh,t}}$) of various safe haven assets to regional shocks obtained from the MS spillover model described in Eqs (1)–(3). Only risk exposure estimates are reported to preserve space. In each case, we specify the conditional mean as a function of the p lags of the safe haven asset return, regional market return, and the developed market return. The lag order p is specified using the AIC. The error distribution is assumed to be the student t distribution, i.e., $\varepsilon_{i,t} \sim t(\nu_{t,S_{sh},t})$, where $\nu_{t,S_{sh},t}$ is the degree of freedom. The parameters are estimated using maximum likelihood (ML) estimation. ***, ** and * represent significance at the 1%, 5%, and 10% levels, respectively.

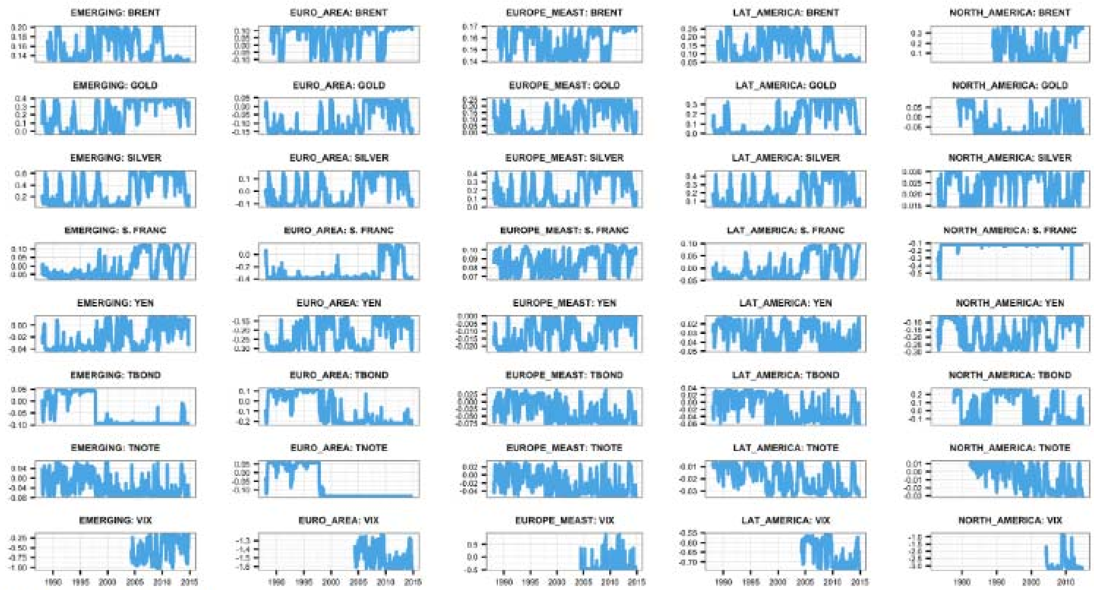

Fig. 3. Regional Shock Spillover Intensities over Time.
Note: The figure plots the time-varying intensities of regional shocks to various safe haven assets. Time-varying shock spillover intensities are computed as probability-weighted shock spillover intensities from regional shocks to safe haven assets, i.e. $p_{1t}\beta^{m}_{sh,1} + (1 - p_{1t})\beta^{m}_{sh,2}$, based on the spillover intensity estimates from Eq. (3) with the filtered probability estimates (p_{1t}). Due to space considerations, we only report the plots for regional market indices; the plots for individual stock markets are available upon request.

Overall, the dynamic analysis of the risk exposures of safe haven assets suggest mixed findings regarding the hedge and safe haven potential of these assets against global and regional market shocks, while VIX stands out from the rest with significantly negative risk exposures to financial market shocks in general. This finding is also consistent with Hood and Malik (2013) who show that VIX is a superior hedging tool and safe haven than gold. Given the heterogeneity in the response of safe haven assets to global and regional market shocks, policy makers should focus on the development of locally available risk management instruments that will allow domestic investors to mitigate the effect of these shocks depending on how each shock relates to safe haven assets for a given stock market.

3.2.2. Variance ratio analysis

In order to gain further insight into the fundamental linkages between safe havens and stock market shocks, we report in Table 5 the means for the variance ratios computed as the percentage of the conditional variance of the unexplained component of safe haven excess returns explained by regional and developed market shocks as well as the idiosyncratic component. We observe in general that the large percentage of the conditional variance of the unexplained component of safe haven returns is due to idiosyncratic shocks, implying the relative segmentation of these assets from stock markets in general. This is particularly more evident for Brent, gold and silver with more than 90% of the excess return variance is explained by idiosyncratic shocks. Interestingly, shocks related to emerging and Latin American markets are found to be partially significant in the conditional volatility of precious metal returns, accounting for 3 to 9 percent of conditional volatility in these assets. Similarly, Euro area shocks are found to account for about 17% of the conditional volatility of excess returns in Swiss Francs.

Table 5
Variance ratios.

	Brent			Gold			Silver			Swiss Franc		
	Developed	Regional	Idiosyncratic	Developed	Regional	Idiosyncratic	Developed	Regional	Idiosyncratic	Developed	Regional	Idiosyncratic
EMERGING	2.97%	0.59%	96.44%	0.54%	7.25%	92.22%	3.44%	4.56%	92.00%	2.41%	1.73%	95.86%
EURO AREA	2.41%	0.26%	97.33%	2.29%	2.18%	95.53%	5.34%	0.58%	94.08%	1.61%	16.95%	81.45%
EUROPE & MEAST	3.17%	1.55%	95.28%	1.49%	5.69%	92.82%	3.61%	5.07%	91.32%	3.85%	3.72%	92.43%
LAT. AMERICA	2.90%	1.27%	95.83%	1.82%	9.20%	88.98%	2.73%	3.33%	93.94%	2.44%	1.86%	95.70%
N. AMERICA	2.75%	1.11%	96.14%	2.27%	0.54%	97.19%	5.01%	0.02%	94.97%	0.88%	2.19%	96.93%
BRAZIL	4.63%	0.01%	95.36%	1.68%	1.76%	96.56%	5.41%	4.15%	90.44%	5.04%	1.57%	93.40%
CHILE	2.56%	0.08%	97.36%	0.69%	0.01%	99.30%	4.88%	0.02%	95.10%	2.74%	1.27%	95.99%
EGYPT	6.00%	0.77%	93.23%	1.23%	0.11%	98.67%	6.37%	0.08%	93.56%	0.31%	1.72%	97.97%
GREECE	2.68%	0.66%	96.66%	1.43%	0.18%	98.39%	5.83%	0.11%	94.06%	5.23%	1.82%	92.95%
HUNGARY	3.79%	0.81%	95.40%	1.89%	0.57%	97.54%	5.21%	0.69%	94.10%	3.06%	3.42%	93.52%
INDIA	5.59%	0.12%	94.30%	0.99%	0.11%	98.89%	6.86%	0.07%	93.07%	4.10%	0.12%	95.77%
INDONESIA	2.95%	0.04%	97.01%	0.91%	0.20%	98.90%	4.17%	0.42%	95.41%	1.93%	0.03%	98.04%
KOREA	2.40%	1.02%	96.58%	2.29%	0.14%	97.57%	5.92%	0.04%	94.04%	2.78%	0.27%	96.95%
KUWAIT	5.69%	0.06%	94.25%	2.80%	0.78%	96.42%	6.06%	0.11%	93.84%	0.02%	0.18%	99.80%
MALAYSIA	2.56%	0.02%	97.42%	1.99%	0.01%	98.00%	6.58%	0.06%	93.36%	3.44%	1.41%	95.15%
MEXICO	2.67%	0.17%	97.16%	0.78%	0.23%	98.99%	5.66%	2.22%	92.12%	8.99%	1.61%	89.40%
POLAND	5.05%	0.09%	94.86%	2.07%	0.06%	97.87%	4.92%	0.02%	95.06%	4.30%	1.03%	94.67%
QATAR	6.46%	0.52%	93.02%	1.14%	0.14%	98.72%	7.40%	0.28%	92.32%	3.21%	0.33%	96.46%
RUSSIA	6.06%	1.36%	92.58%	1.67%	1.52%	96.81%	5.52%	1.55%	92.93%	0.14%	0.00%	99.86%
SAUDI ARABIA	5.96%	1.13%	92.91%	1.04%	0.74%	98.22%	6.73%	0.11%	93.15%	5.51%	0.02%	94.47%
SOUTH AFRICA	6.08%	1.27%	92.64%	2.20%	10.29%	87.51%	5.01%	6.57%	88.42%	4.37%	0.38%	95.25%
TAIWAN	2.70%	1.25%	96.05%	1.49%	0.24%	98.27%	4.38%	0.66%	94.96%	2.40%	0.75%	96.85%
THAILAND	2.87%	0.13%	97.00%	1.93%	0.01%	98.06%	5.47%	0.30%	94.23%	3.14%	1.05%	95.80%
TURKEY	2.59%	0.11%	97.30%	1.09%	0.00%	98.91%	4.74%	0.19%	95.07%	2.25%	0.39%	97.36%
UAE	8.86%	1.63%	89.51%	3.60%	0.59%	95.81%	13.05%	1.24%	85.71%	5.35%	0.03%	94.63%
	Japanese Yen			**US T-Bond**			**US T-Note**			**VIX**		
	Developed	Regional	Idiosyncratic	Developed	Regional	Idiosyncratic	Developed	Regional	Idiosyncratic	Developed	Regional	Idiosyncratic
EMERGING	12.92%	0.30%	86.78%	6.79%	1.77%	91.45%	11.18%	2.83%	85.98%	17.55%	4.15%	78.31%
EURO AREA	8.17%	8.74%	83.08%	7.15%	6.40%	86.45%	7.17%	6.86%	85.97%	18.47%	11.88%	69.65%
EUROPE & MEAST	10.56%	0.16%	89.28%	10.84%	2.75%	86.41%	11.85%	3.47%	84.67%	17.40%	4.71%	77.89%
LAT. AMERICA	8.00%	0.77%	91.23%	10.85%	1.67%	87.48%	6.35%	0.86%	92.79%	15.81%	7.24%	76.94%
N. AMERICA	14.28%	3.94%	81.78%	3.64%	5.23%	91.14%	5.82%	0.21%	93.97%	10.20%	32.27%	57.52%
BRAZIL	5.72%	2.34%	91.94%	4.10%	1.52%	94.38%	5.41%	1.01%	93.58%	19.32%	5.50%	75.18%
CHILE	9.84%	2.33%	87.83%	8.04%	1.04%	90.91%	5.91%	1.09%	92.99%	18.37%	3.02%	78.61%
EGYPT	0.05%	0.19%	99.76%	3.13%	0.18%	96.69%	5.83%	0.44%	93.72%	18.29%	0.00%	81.70%
GREECE	11.81%	0.47%	87.72%	5.52%	1.20%	93.29%	4.61%	1.11%	94.27%	15.83%	1.98%	82.19%
HUNGARY	0.20%	0.81%	98.99%	9.93%	1.46%	88.61%	7.67%	2.32%	90.01%	16.62%	3.92%	79.46%
INDIA	6.89%	0.30%	92.80%	8.84%	0.00%	91.15%	7.19%	0.00%	92.81%	17.71%	0.18%	82.10%
INDONESIA	14.28%	0.04%	85.68%	8.97%	0.04%	91.00%	5.67%	0.01%	94.32%	16.73%	0.20%	83.07%
KOREA	14.69%	0.53%	84.77%	0.71%	0.60%	98.69%	2.63%	0.30%	97.07%	16.57%	0.61%	82.82%
KUWAIT	2.51%	0.53%	96.96%	8.30%	0.59%	91.11%	4.08%	0.41%	95.51%	16.92%	0.14%	82.94%
MALAYSIA	16.62%	1.47%	81.91%	0.62%	0.15%	99.23%	0.77%	0.28%	98.95%	18.41%	0.70%	80.90%
MEXICO	13.77%	0.67%	85.56%	10.60%	0.05%	89.35%	6.53%	0.32%	93.15%	18.02%	10.08%	71.90%
POLAND	4.27%	1.00%	94.72%	8.67%	2.90%	88.43%	7.04%	2.24%	90.72%	16.19%	2.85%	80.96%
QATAR	9.12%	0.01%	90.87%	5.77%	0.25%	93.98%	7.30%	0.01%	92.69%	18.78%	0.27%	80.95%
RUSSIA	0.16%	0.49%	99.36%	3.86%	1.20%	94.93%	6.08%	0.81%	93.11%	17.53%	0.37%	82.11%
SAUDI ARABIA	6.29%	0.68%	93.03%	5.94%	0.93%	93.13%	6.12%	1.79%	92.09%	17.44%	0.02%	82.54%
SOUTH AFRICA	1.28%	0.62%	98.10%	3.28%	2.22%	94.50%	3.57%	1.98%	94.45%	18.58%	2.43%	78.99%
TAIWAN	14.25%	0.46%	85.29%	0.82%	0.69%	98.48%	5.15%	0.82%	94.03%	17.89%	0.49%	81.62%
THAILAND	15.52%	0.35%	84.13%	0.45%	0.12%	99.43%	4.44%	0.14%	95.42%	16.50%	0.51%	82.99%
TURKEY	10.00%	0.23%	89.77%	10.67%	0.48%	88.85%	5.98%	0.03%	94.00%	18.89%	2.50%	78.61%
UAE	15.26%	1.13%	83.61%	8.70%	0.63%	90.67%	7.00%	0.88%	92.12%	17.42%	0.41%	82.17%

Note: This table reports the mean of the variance ratios computed as the percentage of the conditional variance of the unexplained component of excess return for each safe haven asset explained by regional and developed market shocks as well as the idiosyncratic component. The means for the variance ratios are computed over the full sample period for each market given in Table 1.

On the other hand, we observe that developed market shocks account for a relatively significant percentage of the conditional volatility of excess returns for Japanese Yen and Treasury securities, while shocks related to the Euro area and North America account for 11.88% and 32.27% of total volatility in VIX excess returns, respectively. Overall, the analysis of variance ratios underscore the relative segmentation of the safe haven assets from stock markets in general, implied by the large percentage of conditional volatility explained by individual asset-specific shocks.

4. Conclusion

This paper extends the literature on safe haven assets by examining the fundamental linkages between safe havens and stock market shocks from a novel perspective that distinguishes between global and regional risk exposures and various market regimes. Utilizing a two-factor, regime-based volatility spillover model, we examine the risk exposures of a number of potential safe havens including precious metals, US Treasury securities, VIX and currencies with respect to developed and regional stock market shocks during calm and stressed market periods. We further supplement our tests with the analysis of variance ratios and examine the percentage of the conditional variance of the unexplained component of safe haven excess returns explained by regional and developed market shocks as well as the idiosyncratic component.

The risk exposures of safe haven assets with respect to global and regional stock market shocks are found to display significant time variation and regime-specific features. Although all safe haven assets are found to carry low risk exposures, well below unity, with respect to stock market shocks, traditional safe havens like precious metals are found to exhibit positive risk exposures to both regional and global stock market shocks during market stress periods, underscoring the increased demand for these assets during crisis periods. On the other hand, safe haven currencies including Swiss Francs, Japanese Yen and U.S. Treasuries are found to display either insignificant or negative risk exposures during market stress periods, implying that these assets would serve as better hedges or safe havens for equity investors. Interestingly, VIX futures are found to exhibit consistently negative risk exposures with respect to both risk factors, suggesting that these securities could potentially serve as strong hedges against both global and regional market shocks.

Low risk exposures of safe haven asset returns to stock market shocks are further supported by the finding that the large percentage of the conditional variance of the unexplained component of safe haven excess returns is due to idiosyncratic shocks, further supporting the relative segmentation of these assets from stock markets in general. Our findings underscore the importance of structural breaks and time-variation in the linkages between safe haven assets and stock returns and imply that static models would introduce large biases in diversification measures as well as optimal hedge ratios. For future research, it would be interesting to implement the two-factor model in a predictive setting within a portfolio context and examine the effectiveness of the safe haven assets considered in our study against stock market shocks across a wide range of developed and emerging stock markets. It would also be interesting to explore the role of local and global uncertainties as a driver of global and regional market shocks.

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