Is the RMB a Safe-haven Currency?

Evidence from Conditional Coskewness and Cokurtosis

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ABSTRACT: We examine whether RMB is a safe haven currency in terms of its hedging effectiveness of financial stress for global or Asian equity investors. RMB co-skewness (covariance between RMB premium and equity volatility) is mostly negative, implying that RMB is not a good hedge in the volatile market. Moreover, positive RMB co-kurtosis (covariance between RMB premium and equity skewness) implies that RMB is unable to hedge against stock market crash. Neither RMB co-skewness nor co-kurtosis is priced, suggesting equity investors with skewness and kurtosis preferences would not use RMB to hedge against financial stress. Therefore, RMB is not a safe haven currency yet.

Keywords: currency hedging, conditional co-skewness, conditional co-kurtosis, idiosyncratic skewness, international asset pricing

JEL classification: G11, G12, G15

1. Introduction

Following the inclusion of the Renminbi (RMB), the Chinese currency, into SDR basket on October 1st, 2016, some market participants argue the Renminbi is already a safe haven, others dismiss this notion and assert that the Renminbi is not sufficiently liquid, not easily convertible, and will not become a safe haven currency until Chinese economic and broader institutional reforms are implemented. In the academic literature, Fatum et al. (2017) do not find evidence to suggest that the Renminbi is currently a safe haven currency or that the Renminbi is progressing towards safe haven currency status.

To gain understanding of the situation, it is natural to revisit the literature on safe haven currencies. Habib and Stracca (2012) argue that safe haven currencies are those that investors flock whenever there is a crisis, or merely an outbreak of uncertainty, and give hedging benefits in times of volatile financial market or financial distress. According to conventional wisdom, US dollar (USD), Swiss franc (CHF) and Japanese Yen (JPY) are safe haven currencies.[1] Fatum and Yamamoto (2016) provide a ranking of safe haven currencies, showing that JPY is the safest, followed by the CHF and USD. Chan et al. (2018) provide direct evidence that these three safe-haven currencies possess desirable hedging benefits in times of volatile financial market.

There are two perspectives in evaluating the hedging benefits of the currencies. The first is based on the correlation (or covariance) between equity and currency markets (e.g., Dumas and Solnik, 1995; De Santis and Gerard, 1998). From this perspective, investors use foreign currencies to minimize the risk of a diversified portfolio and will long those currencies that are more negatively correlated with international equity portfolio returns to minimize the overall portfolio's

[1] Conventional wisdom argues that "When foreign exchange investors felt panicky, they head to, or back to, old faithfuls: the Swiss franc, the US dollar and the Japanese yen." See "Dollar Stands Out as Safe Haven Currency", *Wall Street Journal*, December 9th, 2011.

volatility. Campbell et al. (2010) show that US dollar, the Euro, and the Swiss franc move against the international equity market. Thus, these currencies should be attractive to risk-minimizing global equity investors despite their low average returns. A limitation of this approach is that the hedging benefits of the currency might not be fully captured by its correlation (or covariance) with the equity portfolio returns, as risk is not adequately measured when investors display mean-variance preferences or equivalently when returns follow a multivariate normal distribution.

To overcome this shortcoming, the second perspective in evaluating the hedging benefits of the currency is to assume non-normal return distribution and introduce both skewness and kurtosis preference for investors. A number of theoretical papers demonstrate that investors will seek higher (positive) skewness and lower (negative) kurtosis (Rubinstein, 1973; Kraus and Litzenberger, 1976). The skewness and kurtosis preference may be based on "prudence" [2] (e.g., Kimball, 1990) and "temperance" (e.g., Denuit and Eeckhoudt, 2010), respectively. In the portfolio context, an investor will examine an asset's contribution to the skewness and kurtosis of a broadly diversified portfolio, referred to as "co-skewness" and "co-kurtosis" with the portfolio. The recent literature has provided supportive empirical evidence that co-skewness and co-kurtosis on stock, bond and option markets are significant on the determination of expected returns (e.g., Harvey and Siddque, 2000; Dittmar, 2002; Vanden, 2006; Guidolin and Timmermann, 2008; Yang et al., 2010). In evaluating the hedging benefits of the currency, one can therefore measure its co-skewness and

[2] Prudence suggests precautionary saving motive, the propensity to prepare and forearm oneself in face of uncertainty. It is in contrast to "risk aversion," which is how much one dislikes uncertainty and would turn away from uncertainty if possible.

co-kurtosis with the equity market. [3] In contrast, crash risk captured by currency (idiosyncratic) skewness (Brunnermeier et al., 2008; Burnside et al., 2010), and global foreign exchange volatility factor (Menkhoff et al., 2012) do not study hedging properties of currencies from a broadly diversified portfolio point of view. Although currency covariance with global equity volatility in Lustig et al. (2011) is conceptually similar to currency coskewness, we propose time-varying currency co-skewness and cokurtsis, which are essentially risk factors.

In this paper, we extend Campbell et al. (2010) and Chan et al. (2018) by exploring higher moment (beyond the second moment) risk management implications of both onshore and offshore RMB for global or Asian equity investors and comparing it to the Japanese yen. In the literature, Cenedese (2015) uses Markov Switching modelling to show that during periods of volatile world equity markets, currency portfolios provide different hedging benefits than in bull markets. From the multivariate Markov switching models, we characterize the conditional distribution of currency risk premiums on a moment-by-moment basis, including co-skewness and co-kurtosis. Onshore RMB (CNY) has positive co-skewnenss with equity market in some period while the offshore RMB (CNH) has negative co-skewness. The patterns imply that CNY can only hedge against stock market volatility to some extent while CNH can't. In contrast, JPY has positive co-skewness in all period and is a better hedge in the volatile market, as it appreciates when the equity volatility increases. Moreover, both onshore and offshore RMB co-kurtosises with the equity market are positive and thus can't hedge against stock market crash. In contrast, JPY co-kurtosis is negative, suggesting even higher hedging effectiveness during extreme stock market downturns.

[3] Similar to Yang, Zhou and Wang (2010), in the case of two different assets such as stocks and currencies, the cross-market co-skewness and co-kurtosis can be interpreted in a somewhat different context from the conventional one, where an individual asset is part of the stock market portfolio. Intuitively, currency co-skewness (co-kurtosis) with the stock market is the relation between currency premium and stock volatility (skewness). A higher and positive currency co-skewness means that when stock volatility goes up, currency risk premium also goes up. Similarly, a lower and negative currency kurtosis means that when stock market returns are skewed to the left, implying a (higher) possibility of market crash, currency risk premium tends to be higher instead.

Furthermore, we run predictive regressions and find that RMB co-skewness with stock markets is not priced in the RMB return while JPY counterpart is priced, which suggests that prudent equity investors use JPY rather than RMB to hedge against global or Asian stock market volatility. After controlling for currency beta (Lustig et al., 2014；Verdelhan, 2018)，volatility factors (Lustig et al., 2011; Menkhoff et al. , 2012), and crash risk (Brunnermeier et al., 2008; Burnside et al., 2010), conditional co-skewness of RMB with the equity market do not command statistically and economically significant ex ante risk premiums, with the expected negative sign for the price of RMB co-skewness. Moreover, both JPY and RMB co-kurtosises are not priced in the sense that conditional co-kurtosises of RMB and JPY with the equity market do not command statistically and economically significant ex ante risk premiums, with the expected positive sign for the price of currency co-kurtosis. By implication, temperate investors use neither RMB nor JPY to hedge against global or Asian stock market crisis. Therefore, RMB is not a safe haven currency yet, while JPY exhibits some degree of safe-haven property.

The rest of the paper is organized as follows. Section 2 describes data. Section 3 discusses the regime-switching models and derives their conditional moments. Section 4 presents the empirical results for developed market currencies. Section 5 shows the results for emerging market currencies. Finally, Section 6 makes concluding remarks.

2. Data Description

The stock data are monthly from the Morgan Stanley Capital International (MSCI) US-dollar-denominated world, Asian, emerging market and Asian emerging market total return indices. The MSCI world stock portfolio is a market-value weighted index which represents approximately 60% of the total equity market capitalization of each of 22 developed country markets. Using US dollar-denominated world stock returns corresponds to assessing the risk premium faced by a US dollar-based investor who is totally unhedged against exchange rate risk. The premium compounds the risk premium on the portfolio of underlying assets with an exchange rate risk premium.

We consider both onshore and offshore RMB as well as the Japanese Yen. The monthly exchange rate of CNY/USD and JPY/USD as well as 3-month Treasury bill rates of the US and Japan are from the International Financial Statistics (IFS) database published by the International Monetary Fund. CNY 3-month Treasury bill rate data is from WIND. In contrast, CNH/USD and CNH 3-month deposit rate is from Bloomberg since there is no active offshore RMB Treasury market. The sample periods begin in the months when currencies started to float, or the data is best available and all end in December 2018. In particular, the CNY and CNH start their samples from July 2005, since CNY started to float, and August 2010, when CNH is available. For comparison, JPY sample starts from July 2005.

The stock returns are the log differences of MSCI stock return indices and the stock premiums are their excess returns over and above US short term interest rate, a proxy for the US and world risk free rate. The currency premiums are the log excess returns to a US investor of borrowing in US dollars to hold foreign currencies, which equals interest rate differentials (foreign interest rate - US interest rate) minus the rates of foreign currency depreciation.[4] All measures are annualized.

As shown in Table 1, the average world and Asian stock premiums are 2.2% and 1.5% respectively. They also display similar volatility of more than 50%. By comparison, emerging market and Asian merging market have relatively higher stock premiums of 2.3% and 3.9% respectively. They also have relatively higher volatility of more than 70%. All stock markets

[4] Under covered interest parity, interest rate differential is equal to forward discount and the currency premium is the log return on buying a foreign currency in the forward market and then selling it in the spot market after one month.

exhibit negative skewnesses and positive excess kurtosises, suggesting left long and fat tails with financial crisis.

[Insert Table 1 here]

Table 1 also shows summary statistics of currency risk premiums. The RMB premiums are 1.6% for CNH and 2.5% for the CNY while the JPY premium is -1.5%. The striking difference can probably be attributed to the different hedging properties. The volatility of currency premiums varies from 9.9% for CNY, 14.6% for CNH to 32.3% for JPY. Most notably, the skewnesses of CNY and CNH are both significantly negative while the JPY counterpart is not significantly different from zero. Moreover, the kurtosises of CNY and CNH are very significant and highly positive while the JPY counterpart is close to zero. The left long and fat tails of RMB are much more pronounced than the JPY counterparts, an indication of a less desirable hedging property for the RMB.

3. Empirical Methodology

The empirical methodology used in this study follows a three-pass procedure. First, we estimate a bivariate regime-switching model for stock and currency premiums. such regime-switching-model-based estimates are typically determined with considerably more accuracy than estimates of the higher moments obtained directly from realized returns (Guidolin and Timmermann, 2008). Second, we derive the conditional moments and co-moments of stock and currency premiums using the bivariate regime-switching model. Finally, we examine the pricing behavior of estimated co-skewness and co-kurtosis series by conducting predictive regressions of the expected currency premium on the expected currency co-skewness, and co-kurtosis, controlling for the expected beta, idiosyncratic volatility and skewness and correcting for the error-in-variables problem.

3.1. Regime-Switching Models

From an econometric perspective, regime-switching models belong to a general class of mixture distributions and can generate time-varying moments through use of some simple distributions, such as the normal distributions in each regime. Following much of the literature (e.g., Gray, 1996; Ang and Bekaert, 2002; Connolly et al., 2005; Guidolin and Timmermann, 2008), we focus on the two-state regime-switching model, which has an intuitively appealing interpretation: a bear state has higher volatility due to economic recession and/or market crashes, while a bull state has less volatile returns.

Moreover, we specify the conditional means equation as Chan et al. (2018) do.

$$\begin{pmatrix} r_t^s \\ r_t^c \end{pmatrix} = \begin{pmatrix} \mu_i^s \\ \mu_i^c \end{pmatrix} + \begin{pmatrix} \lambda_i^s & 0 \\ 0 & \lambda_i^c \end{pmatrix} \begin{pmatrix} RF_{t-1} \\ RD_{t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{it}^s \\ \varepsilon_{it}^c \end{pmatrix} \tag{1}$$

where μ_i^s and μ_i^c are the constant means of stock and currency premiums given regime i, RF_{t-1} is the first lagged risk free rate and RD_{t-1} is the first lagged interest differential (foreign country interest rate minus US interest rate). λ_i^s and λ_i^c are the regression coefficients given regime i. The risk free rate is closely attuned to discount rates and has significant predictive power for future stock returns. The predictive power of nominal risk free rates has a long tradition in finance, and Ang et al. (2006) recently show that the short rate has more predictive power than any term spread in forecasting GDP out-of-sample. Meanwhile, it is well known that interest differentials predict positive currency premiums from carry trade. Lustig and Verdelhan (2007) and Campbell et al. (2010) both use interest differentials as the sole conditioning variable to study currency premiums. It would be interesting to see whether interest differentials can predict currency premiums differently in different regimes. In general, the conditional means might not just linearly depend on the first lag of the instrument and there are other instruments. Thus, the specification adopted here represents a tradeoff between flexibility and parsimony.

For the conditional variance-covariance matrices, we assume that $\boldsymbol{\varepsilon_{it}}$ follows an i.i.d bivariate normal distribution. Then the conditional distribution of $\boldsymbol{r_t}$ is a mixture of two i.i.d bivariate normal distributions as follows:

$$\boldsymbol{r_t}|\boldsymbol{F_{t-1}} \sim \begin{cases} IIN\ (\boldsymbol{\mu_{it}}, \boldsymbol{H_{1t}}), & w.p.\ \ p_{1t}, \\ IIN\ (\boldsymbol{\mu_{2t}}, \boldsymbol{H_{2t}}), & w.p.\ \ p_{2t}. \end{cases} \tag{2}$$

Since mixtures of the normal distribution can approximate a very broad set of density families, this assumption is not very restrictive. Moreover, the variances and correlation are assumed to be constant with each regime, and conditional heteroskedasticity can be generated by switches between regimes. The parsimonious specification for the conditional variance-covariance matrices is as follows:

$$\boldsymbol{H_{it}} = \boldsymbol{D_{it}}\boldsymbol{R_{it}}\boldsymbol{D_{it}}, \boldsymbol{D_{it}} = \begin{bmatrix} \sqrt{h_i^s} & 0 \\ 0 & \sqrt{h_i^c} \end{bmatrix}, \boldsymbol{R_{it}} = \begin{bmatrix} 1 & 0 \\ \rho_i & 1 \end{bmatrix}, i \in \{1,2\} \tag{3}$$

where h_i^s and h_i^c are the constant conditional volatilities of stock and currency premiums given regime *i*. ρ_i is the constant conditional stock-currency correlation given regime *i*. Nevertheless, we also address below the possibility that the estimated correlations between stock and currency premiums may vary across two regimes.

Furthermore, we specify the transition probabilities to be a function of the lagged interest rate differentials RD_{t-1}, which is a good balance in defining regimes of both currency and equity markets. The recent literature, such as Lustig et al. (2011) and Menkhoff et al (2012), uses interest rate differential or, equivalently, the forward discount to sort currencies into portfolios and then construct the risk factor based on the comparison between the portfolios of high versus low quintiles.

$$p_{ii,t} = p(S_t = i|S_{t-1} = i, \mathbf{F}_{t-1}) = \Phi(a_i + b_i RD_{t-1}), i \in \{1,2\} \quad (4)$$

where a_i and b_i are unknown parameters and Φ is the cumulative normal distribution function, which ensures that $0 < p_{ii,t} < 1$. This specification makes transition probabilities monotonic in the instrument, thus facilitating the interpretations of the parameters.

With the above specification, we obtain quasi-maximum likelihood estimates (QMLEs) for model parameters and use the standardized LR test proposed by Hansen (1992) to test the existence of regimes[5]. Meanwhile, diagnostic tests will be conducted on the standardized residuals from the regime-switching model and the corresponding single-regime model.

In the Appendix, we derive the conditional moments in general, and (i) the conditional covariance between stock and currency excess returns, (ii) conditional variance and standard deviation of equity and currency excess returns, (iii) conditional currency beta with respect to global stock return, (iv) conditional (standardized) currency co-skewness (i.e., conditional covariance between currency excess returns and stock volatility), and (iv) conditional (standardized) currency co-kurtosis (*i.e.*, conditional covariance between currency excess returns and stock skewness) in particular. Note that these conditional moments are time-varying driven by the joint distribution of currency and equity returns, particularly model parameter estimates and conditional state probabilities are derived recursively from transition probabilities.

3.2. Currency Co-skewness and Co-kurtosis Pricing Effects

An important question is whether currency co-skewness and co-kurtosis with the world stock market are priced in currency premiums beyond conventional beta factor. Guided by the

[5] Note that the likelihood ratio (LR) test does not have the standard X^2 distribution for Markov-switching models due to unidentified nuisance parameters. The standardized LR test proposed by Hansen (1992) is able to circumvent this problem and provides an upper bound of the p-value for general cases.

stochastic discount factor framework, we approximate the pricing kernel through a fourth-order Taylor-expansion and adopt the following predictive regressions:

$$\bar{r}^{c}_{t,t+m} = \lambda_0 + \lambda_1 \widehat{\beta}_t + \lambda_2 \widetilde{cos}^{c}_{t} + \lambda_3 \widetilde{cot}^{c}_{k} + \varepsilon^{c}_{t} \tag{5}$$

where $\overline{r}^{c}_{t,t+m}$ is the expected average currency excess return over the future m-month horizon $[\mathrm{t}, \mathrm{t}+\mathrm{m}]$. The expected beta, $\hat{\beta}_t$, controls for traditional CAPM pricing effect. The second factor is the expected standardized currency co-skewness. Instead of including $\widehat{cos}^{c}_{t}$ directly, we separate the additional effect of volatility from the effect of beta and use the orthogonal residual $\widetilde{cos}^{c}_{t}$. If investors display the skewness preference with a non-normal distribution, the slope coefficient on orthogonal standardized currency co-skewness in Equation (5) should be significantly negative, i.e., $\lambda_2 < 0$.

We further orthogonalize the expected currency co-kurtosis from $\hat{\beta}_t$ and $\widetilde{cos}^{c}_{t}$ to examine additional pricing effect of currency co-kurtosis. If investors display the kurtosis preference with a non-normal distribution, the slope coefficient on orthogonal standardized currency co-kurtosis in Equation (5) should be significantly positive, i.e., $\lambda_3 < 0$.

Moreover, following Menkhoff et al. (2012), we include other possible risk factors, and orthogonalize them by the order of moments to separate the additional effect of high-order moment factors from low-order moment factors as follows:

$$\overline{r}_{\mathrm{t,t+m}} = c_0 + c_1 \hat{\beta}_t + c_2 \widetilde{std}^{c}_{t} + c_3 \widetilde{cos}^{c}_{t} + c_4 \widetilde{skew}^{c}_{t} + c_5 \widetilde{cok}^{c}_{t} + c_6 \widetilde{kurt}^{c}_{t} + e^{c}_{t} \tag{6}$$

where the first pricing factor is the traditional beta risk, $\hat{\beta}_t$. The second risk factor, $\widetilde{std}^{c}_{t}$, is estimated currency idiosyncratic volatility, proxied by the residual from the auxiliary regression of conditional standard deviation orthogonal to $\hat{\beta}_t$. The third factor, $\widetilde{cos}^{c}_{t}$, is the residual of currency standardized conditional co-skewness orthogonal to $\hat{\beta}_t$ and $\widetilde{std}^{c}_{t}$. The fourth factor, $\widetilde{skew}^{c}_{t}$ is the estimated currency conditional idiosyncratic skewness, which is the residual of currency conditional skewness orthogonal to $\hat{\beta}_t$, $\widetilde{std}_t^c$ and $\widetilde{cos}_t^c$. The fifth factor, $\widetilde{cok}_t^c$ is the estimated currency standardized conditional co-kurtosis orthogonal to $\hat{\beta}_t$, $\widetilde{std}_t^c$, $\widetilde{cos}_t^c$ and $\widetilde{skew}_t^c$. The final factor $\widetilde{kurt}_t^c$ is the estimated currency conditional idiosyncratic kurtosis, which is the residual of currency conditional kurtosis orthogonal to $\hat{\beta}_t$, $\widetilde{std}_t^c$, $\widetilde{cos}_t^c$, $\widetilde{skew}_t^c$ and $\hat{\beta}_t$, $\widetilde{std}_t^c$, $\widetilde{cos}_t^c$ and $\widetilde{cok}_t^c$.

The regression produces an estimate of the risk exposure vector, $\mathbf{c} = [c_1, c_2, c_3, c_4, c_5, c_6]'$. We want to see whether the "pure" effects of currency conditional co-skewness (co-kurtosis) risk are negatively (positively) priced in currency returns beyond traditional beta and volatility risks, i.e., $c_3 < 0$ and $c_5 > 0$.

As the regressions are conducted using estimates from the regime-switching model, the variables may be measured with noises. To deal with the errors-in-variables problem, coefficient estimates are adjusted for a serial correlation of 12 lags and heteroskedasticity following Newey and West (1987).

4. Empirical Results

4.1. Results on Regime-Switching Model Estimation

The analysis will proceed with the estimation of the single regime model as a benchmark and the two-state regime switching model. The estimation results of two-state regime-switching models for the USD-denominated world stock and currency premiums are reported in Table 2. Based on estimated likelihood functions and the resulting likelihood ratio tests (not reported here), the regime-switching model for each currency fits significantly better than the corresponding single-regime model.

[Insert Table 2 here]

First, examining the parameters for the conditional variance, it is clear that the second regime is a bear state with high volatility for the world stock and currency premiums. Meanwhile, all currency premiums are less volatile in both regimes than the world stock premium except for the JYP in bull state. In the second regime, the stock-currency correlations are lower for the Japanese Yen, but higher for CNY and CNH. It suggests that the Japanese yen may offer better diversification opportunities in the regime of high volatility than onshore and offshore RMB do.

Next are the parameters for the conditional mean. The estimates of λ_1^s are all significantly negative in the regime of low volatility, indicating a robust negative association between the US interest rate and the world stock premium in during the good time. More importantly, there is regime-dependent evidence of carry trade, in line with Christiansen et al. (2011). The estimates of λ_2^s follow a similar pattern during the bad time and are always bigger than λ_1^s in absolute value. The estimates of λ_1^c are all significantly negative in both regimes for JPY. It indicates that, following higher interest rate differentials, currency premiums in the next period for the Japanese Yen tend to be significantly lower, while such a negative association is not significant for onshore and off shore Renminbi.

For the parameters about the transition probabilities, the coefficient a_i measures the constant probability of staying in regime *i* if the interest rate differential is zero. For the Japanese Yen and onshore Renminbi, a_2 is significantly negative, implying that it is more likely to stay in the low volatility regime even if the time variation of the probability is ignored. The coefficient b_i measures further time-variation of the probability of staying in regime *i* depending on the interest rate differential. For both JPY and off shore RMB, the estimates of b_1 are all negative and mostly significant. The evidence suggests that as interest rate differentials increase, the probability of staying in the lower volatility regime declines, pointing to the inherent risk of the carry trade.

4.2. Results on Conditional Currency Co-skewness and Co-kurtosis

The summary statistics of conditional foreign currency premiums are presented in Table 3. Panel A shows the averages of conditional moment estimates derived as in Equations (13)-(17). On average, the conditional currency premiums for the JPY are substantially higher than its unconditional counterparts. Meanwhile, the conditional standard deviations of all currency premiums and the conditional stock-currency correlations are very close to their unconditional counterparts as shown in Table 1. The evidence hints at the adequacy of the regime-switching model specification in describing the data generating process up to the second moment, and the well-known challenge in modeling the expectation about third and fourth moments (e.g., Harvey and Siddique, 1999; Yang et al., 2010). Furthermore, the JPY premiums have negative expected correlation, suggesting better diversification benefit than other currencies. Although the conditional skewnesses may not be directly comparable with univariate unconditional skewness in Table 1, the JPY premium is still the most positively skewed, implying that the Japanese yen is least likely to crash in the future.

More importantly, as shown in Panel A of Table 3, co-skewnesses of JPY is positive while currency co-skewnesses are negative for onshore and offshore Renminbi, meaning increasing JPY premiums and decreasing premiums for other currencies when the world stock market becomes more volatile. Moreover, co-kurtosises of JPY is negative, suggesting smaller decrease in the JPY premiums when the stock market experiences large downward movements. The patterns imply that JPY is “hard” currencies because they are not only a good hedge against the world stock market decrease due to their negative or relatively low correlation with stock premium, but also a good hedge against the world stock volatility and the world stock market crash captured by the negative skewness.

[Insert Table 3 here]

Panel B of Table 3 shows the standard deviation of (orthogonalized) conditional co-skewnesss, idiosyncratic skewness, and co-kurtosis derived as in Equations (12)-(17). We are particularly interested in economic significance of these higher moments and will investigate the change of conditional currency premiums if co-skewnesss, idiosyncratic skewness, and co-kurtosis increase by a one standard deviation in the next subsection. Note that one standard deviations of idiosyncratic skewness are typically higher than co-skewness and co-kurtosis counterparts.

We also compare time-varying patterns of hedging benefits across currencies. Figure 1 plots the conditional betas between currency excess returns and the world stock excess returns. Whereas the JPY beta is negative in the whole sample, currency betas for CNY and CNH are mostly positive. Figure 2 plots the standardized conditional co-skewnesses of currencies with the world stock market. The JPY co-skewness is almost always positive. Interestingly, the JPY co-skewness decreased sharply since the global financial crisis and came back to roughly the original level in 2011. Conversely, the CNY co-skewness jump from negative to positive since the JPY co-skewness dropped. The CNY co-skewness kept being positive from 2008 to 2017, which indicates that CNY played the role of hedging against stock market volatility to in the period. But we didn't find the similar pattern for CNH. The CNH co-skewness kept being negative for the whole sample which imply that CNY can only hedge against stock market volatility to some extent while CNH can't. This shows that the JPY are safe-haven currencies from the perspective of hedging against stock market volatility. And the CNY only became safe-haven currencies from view of co-skewness during a special time period. Figure 3 plots the standardized conditional co-kurtosis of currencies with the world stock market. The JPY co-kurtosis is always negative for the whole sample. This implies that the JPY can hedge against world stock market crash. In contrast, the co-kurtosises for the CNY and CNH are always positive. This implies that both onshore and offshore Renminbi are not safe haven currencies in the full sense especially from view of co-kurtosis.

[Insert Figures 1-3 here]

4.3. Results on Currency Conditional Co-skewness and Co-kurtosis Pricing Effects

To investigate how currency co-skewness and co-kurtosis are priced in currency premiums beyond conventional beta factor. We run regression according to equation (9). The 3-factor estimation results of foreign currency pricing effects are reported in Table 4. Almost all coefficients for the CNY and CNH are not statistically significant at conventional significance levels with expected signs. Only coefficients of currency co-skewness for JPY are statistically significant with expected signs in 1-month, 3-moth and 12-month future excess returns. Specially, for JPY, the slope estimates of currency co-skewness, λ_2 are statistically negative at the 10 percent level at least for 1-month, 3-month and 12-month future excess returns. In contrast to the relatively robust pricing effects of the JPY co-skewness, the coefficients of co-kurtosis, λ_3, are insignificant. We further include other possible risk factors and run regression according to equation (20). After taking control of other risk factors. All coefficients of currency co-skewness for JPY are statistically significant with negative signs at the 10 percent level at least. Still, the coefficients of the CNY and CNH don't display expected patterns as a safe haven currency should do.

[Insert Table 4 and 5 here]

4.5. Robustness Check

In this section, we conduct similar analysis of CNY and CNH based on the Asian or Emerging market stock world index and provide further evidence on the robustness of conditional currency co-skewness and co-kurtosis pricing effects.

As shown in Table 6, the estimation results for the regime-switching model are generally in line with the main findings in Table 2. In Panel A for the Asian stock market, the stock-currency correlations are higher for CNY and CNH in the bear regime. Again, focusing on the parameters about the transition probabilities. For the onshore Renminbi, a_2 is significantly negative, implying that it is more likely to stay in the low volatility regime even if the time variation of the probability is ignored. At last, we find similar patterns in Panel B for the Emerging market.

[Insert Table 6 here]

As presented in Table 7, the averages of conditional moments of currency premiums are also consistent with the previous results with even clearer patterns. The average co-skewnesses and co-kurtosises of CNY and CNH are negative and positive respectively in Asia and Emerging markets. It implies that neither CNY nor CNH is a good hedge against stock market volatility and crash in both markets.

[Insert Table 7 here]

Figures 4-6 plot that conditional beta, co-skewness and co-kurtosis of currencies with Asian stock market, Emerging stock market and Asian Emerging stock market. These figures are quite close to those with the world stock market despite the conditional beta of JPY with Asian and Asian Emerging stock market. They became positive during 2013 to 2016.

[Insert Figures 4-6]

Tables 8 and 9 summarize the estimation results of pricing effects for Asian stock market and Emerging stock market respectively. We find that the co-skewnesses of CNY and CNH aren't priced in Asian and emerging stock. The results implying that temperate investors use neither CNY nor CNH to hedge against global or Asian stock market crisis.

[Insert Tables 8 and 9 here]

6. Concluding Remarks

This study examines whether the RMB is a safe-haven currency in terms of currency co-skewness and co-kurtosis with the global or regional stock market. Currency co-skewness and cokurtsis directly address the essential characteristic of a safe-haven currency since they refer to the currency with stable performance (as measured by currency return) during times of financial stress (as measured by global or regional equity volatility and skewness).

We find that onshore RMB (CNY) has positive co-skewnenss with equity market in some period while the offshore RMB (CNH) has negative co-skewness. The patterns imply that CNY can only hedge against stock market volatility to some extent while CNH can't. In contrast, JPY has positive co-skewness in all period and is a better hedge in the volatile market, as it appreciates when the equity volatility increases. Moreover, both onshore and offshore RMB co-kurtosises with the equity market are positive and thus can't hedge against stock market crash. In contrast, JPY co-kurtosis is negative, suggesting even higher hedging effectiveness during extreme stock market downturns.

We also document that RMB co-skewness with stock markets is not priced in the RMB return while JPY counterpart is priced, which suggests that prudent equity investors use JPY rather than RMB to hedge against global stock market volatility. Moreover, both JPY and RMB co-kurtosises are not priced, implying that temperate investors use neither RMB nor JPY to hedge against global stock market crisis. Therefore, RMB is not a safe haven currency yet, while JPY exhibits some degree of safe-haven property.

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Table 1
Summary Statistics

Statistics	Mean	Std dev	Skewness	Excess kurtosis
World stock premium	0.022	0.532	-1.095***	3.374***
Asian stock premium	0.015	0.591	-0.905***	2. 536***
Emerging market stock premium	0.023	0.773	-0.913***	3.723***
Asian emerging stock premium	0.039	0.757	-0.729***	2.250***
CNY premium (July 2005-Dec. 2018)	0.025	0.099	-1.405***	9.531***
CNH premium (Oct. 2010-Dec.2018)	0.016	0.146	-1.045***	8.603***
JPY premium (July 2005-Dec.2018)	-0.015	0.323	-0.260	0.720*

Note: The table reports summary statistics for the monthly US stock premiums, and currency premiums. Stock market indices are from the Morgan Stanley Capital International (MSCI) Database. All other variables are from the IMF's IFS database, except for the US dollar index from the Federal Reserve and the Eurozone interest rate from Datastream. Stock premiums are the log differences of MSCI indices minus the US 3-month Treasury bill rate, a proxy for the US and world risk free rate. Interest rates are log 3-month Treasury bill rates with the exception of the 3-month CNH deposit rate. Currency premiums are log interest rate differentials (foreign interest rate-US interest rate) minus the rates of foreign currency depreciation against the US dollar. All measures are annualized.

Table 2
Regime-Switch Model Estimation for the World Stock and Currency Premiums

	CNY (2005-2018)		CNH (2010-2018)		JPY (2005-2018)	
	Regime 1	Regime 2	Regime 1	Regime 2	Regime 1	Regime 2
μ_i^s	0.057*	0.191	0.128	0.05*	0.132	0.042**
t-stat.	1.09	3.221	2.806	0.793	4.17	0.544
μ_i^c	0.023**	-0.032***	-0.039***	-0.026***	-0.14***	0.073*
t-stat.	6.99	-1.573	-5.317	-1.192	-4.522	1.785
λ_i^s	-0.176***	-13.582***	2.423	-5.896***	-0.034***	-14.356***
t-stat.	-0.044	-4.388	0.21	-1.231	-0.026	-1.69
λ_i^c	0.703	2.539	3.983	1.668	-1.967***	-3.804***
t-stat.	5.349	1.78	11.824	1.016	-1.315	-0.635
h_i^s	0.299	0.208	0.075*	0.239	0.064*	0.459
t-stat.	11.38	5.575	3.523	5.283	4.793	6.292
h_i^c	0.001***	0.029**	0.002***	0.029**	0.067*	0.114
t-stat.	8.373	6.806	3.353	5.035	6.202	8.026
ρ_i	0.117	0.334	0.063*	0.355	-0.095***	-0.17***
t-stat.	1.289	3.697	0.268	3.183	-0.884	-1.993
a_i	1.9	-2.134***	-0.332***	-1.01***	1.53	-1.803***
t-stat.	7.612	-7.785	-1.179	-3.374	6.796	-6.865
b_i	-0.354***	31.575	52.824	21.455	10.801	-62.932***
t-stat.	-0.024	2.213	4.004	1.197	1.036	-3.513

Note: The table estimates regime switching model for the monthly world stock market and developed market currency premiums using $\begin{pmatrix} r_t^s \\ r_t^c \end{pmatrix} = \begin{pmatrix} \mu_i^s \\ \mu_i^c \end{pmatrix} + \begin{pmatrix} \lambda_i^s & 0 \\ 0 & \lambda_i^c \end{pmatrix} \begin{pmatrix} RF_{t-1} \\ RD_{t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{it}^s \\ \varepsilon_{it}^c \end{pmatrix}$, where $\begin{pmatrix} \varepsilon_{it}^s \\ \varepsilon_{it}^c \end{pmatrix} \sim \text{IIN}\,(\mathbf{0}, \mathbf{H}_{\mathbf{it}})$, and $\boldsymbol{H_{it}} = \boldsymbol{D_{it}} \boldsymbol{R_{it}} \boldsymbol{D_{it}}, \boldsymbol{D_{it}} = \begin{bmatrix} \sqrt{h_i^s} & 0 \\ 0 & \sqrt{h_i^c} \end{bmatrix}, \boldsymbol{R_{it}} = \begin{bmatrix} 1 & 0 \\ \rho_i & 1 \end{bmatrix}, i \in \{1,2\}$, and transition probabilities $p_{ii,t} = p(S_t = i | S_{t-1} = i, \mathbf{F}_{t-1}) = \Phi(a_i + b_i RD_{t-1}), i \in \{1,2\}$, where RF_{t-1} is the first lagged US risk free rate and RD_{t-1} is the first lagged interest rate difference (foreign interest rate-US interest rate). S_t is the unobserved regime at time t. $\mathbf{F}_{t-1}$ is the past information set. Φ is the cumulative normal distribution function. The parameter estimates are the QMLE. The t-statistics are reported in parentheses. *, **, and *** denote significance at 10%, 5%, and 1% respectively.

Table 3

Summary Statistics of Conditional Moment Estimates derived from the world stock-currency regime-switching models and orthogonal regressions

Panel A: the average of conditional moment estimates

Variable name	CNY	CNH	JPY
conditional currency beta	0.043	0.085	-0.114
conditional currency standard deviation	0.086	0.144	0.313
conditional currency skewness	-0.582	-0.265	0.148
conditional currency correlation with the world stock premium	0.197	0.246	-0.171
conditional currency covariance with the world stock premium	0.010	0.015	-0.027
conditional currency standardized co-skewness	-0.006	-0.121	0.249
conditional currency co-skewness with the world stock premium	0.000	-0.003	0.015
conditional currency standardized co-kurtosis	0.564	1.099	-1.035
conditional currency co-kurtosis with the world stock premium	0.006	0.012	-0.034

Panel B: standard deviation of orthogonal conditional moment estimates

Variable name	CNY	CNH	JPY
orthogonal conditional currency co-skewness with the world stock premium	0.058	0.010	0.055
orthogonal conditional co-kurtosis with the world stock premium	0.025	0.001	0.084

Note: The table reports summary statistics of conditional moment estimates and their orthogonal components for foreign currency premiums with respect to the US dollar.

Table 4
Pricing effects of currency co-skewness and co-kurtosis with the world stock market

Currency	Intercept	$\hat{\beta}_t$	$\widetilde{cos}_t^c$	$\widetilde{kurt}_t^c$	R^2	Economic Impact $\widetilde{cos}_t^c$	Economic Impact $\widetilde{kurt}_t^c$
Panel A: 1-month future excess returns							
JPY	0.15*	1.436**	-1.018**	0.028	4.8%	-6.1%	0.0%
	(0.08)	(0.712)	(0.416)	(0.056)			
CNY	0.032***	-0.174	0.02	-0.721	3.5%	0.0%	0.0%
	(0.011)	(0.277)	(0.144)	(0.462)			
CNH	-0.077	1.103	1.237	0.211	2.2%	0.0%	0.0%
	(0.291)	(3.448)	(0.942)	(1.296)			
Panel B: 3-month future excess returns							
JPY	0.037	0.399	-0.81**	0.006	2.4%	-4.9%	0.0%
	(0.101)	(0.852)	(0.371)	(0.066)			
CNY	0.04***	-0.339	0.038	-0.311	2.8%	0.0%	0.0%
	(0.011)	(0.299)	(0.145)	(0.318)			
CNH	0.175	-1.911	0.887	1.649	2.4%	0.0%	0.0%
	(0.226)	(2.749)	(0.847)	(1.867)			
Panel C: 6-month future excess returns							
JPY	0.086	0.853	-0.518	-0.053	1.6%	0.0%	0.0%
	(0.093)	(0.737)	(0.317)	(0.068)			
CNY	0.033**	-0.19	-0.12	0.261	1.5%	0.0%	0.0%
	(0.014)	(0.304)	(0.188)	(0.578)			
CNH	0.675**	-7.825**	0.22	1.662	4.3%	0.0%	0.0%
	(0.263)	(3.117)	(0.846)	(1.939)			
Panel D: 12-month future excess returns							
JPY	-0.108	-0.896	-0.906*	-0.036	3.4%	-5.5%	0.0%
	(0.151)	(1.352)	(0.489)	(0.051)			
CNY	0.036**	-0.263	-0.237*	0.466*	4.2%	-1.4%	1.2%
	(0.015)	(0.361)	(0.136)	(0.263)			
CNH	-0.453	5.493	0.739	-0.688	2.7%	0.0%	0.0%
	(0.468)	(5.517)	(2.267)	(2.777)			

Note: The table presents results of the following regressions: $\bar{r}_{t,t+m}^c = \lambda_0 + \lambda_1\widehat{\beta_t} + \lambda_2\widetilde{cos}_t^c + \lambda_3\widetilde{cot}_k^c + \varepsilon_t^c$, where $\bar{r}_{t,t+m}^c$, is the expected average currency excess return over the future m-month horizon $[\mathrm{t}, \mathrm{t}+\mathrm{m}]$. $\widehat{\beta_t}$ is the traditional beta risk. $\widetilde{cos}_t^c$ is the residual of currency standardized conditional co-skewness orthogonal to $\widehat{\beta_t}$. $\widetilde{cos}_t^c$ is the estimated currency standardized conditional co-skewness orthogonal to $\widehat{\beta_t}$ and $\widetilde{cos}_t^c$.

Table 5
Pricing effects of future currency excess return

Currency	$\hat{\beta}_t$	$\widetilde{std}_t^c$	$\widetilde{cos}_t^c$	$\widetilde{skew}_t^c$	$\widetilde{cok}_t^c$	$\widetilde{kurt}_t^c$	R^2	Economic Impact $\widetilde{cos}_t^c$	Economic Impact $\widetilde{kurt}_t^c$
Panel A: 1-month future excess returns									
JPY	1.444**	3.768*	-0.846**	-0.364	0.007	-1.077	5.9%	-4.7%	0.0%
	(0.658)	(1.969)	(0.35)	(0.419)	(0.246)	(1.323)			
CNY	-0.175	0.85	-0.047	0.077**	-0.471	0.009	5.4%	0.0%	0.0%
	(0.277)	(1.098)	(0.13)	(0.031)	(0.469)	(0.013)			
CNH	1.076	7.795**	1.639	-0.404	-24.066***	-1.14	7.6%	0.0%	-2.6%
	(3.439)	(3.848)	(1.621)	(0.417)	(8.24)	(0.896)			
Panel B: 3-month future excess returns									
JPY	0.423	3.591**	-0.599*	-0.708	-0.118	0.747	4.0%	-3.3%	0.0%
	(0.776)	(1.464)	(0.315)	(0.479)	(0.201)	(1.185)			
CNY	-0.334	1.879***	-0.118	0.016	-0.053	-0.016	5.9%	0.0%	0.0%
	(0.294)	(0.536)	(0.131)	(0.018)	(0.348)	(0.012)			
CNH	-1.901	1.058	2.219	-0.644	0.274	1.455***	5.7%	0.0%	0.0%
	(2.959)	(5.748)	(1.765)	(0.678)	(24.624)	(0.545)			
Panel C: 6-month future excess returns									
JPY	0.858	0.87	-0.527*	-0.757	0.059	0.777	2.3%	-2.9%	0.0%
	(0.715)	(1.414)	(0.314)	(0.599)	(0.196)	(0.894)			
CNY	-0.19	-0.425	-0.118	-0.017	0.203	-0.024*	2.8%	0.0%	0.0%
	(0.304)	(0.904)	(0.215)	(0.034)	(0.517)	(0.013)			
CNH	-8.036***	-3.076	1.33	-1.417***	25.277**	0.176	8.8%	0.0%	2.8%
	(3.028)	(5.004)	(1.625)	(0.396)	(11.608)	(0.667)			
Panel D: 12-month future excess returns									
JPY	-0.935	1.105	-0.987**	-0.398	0.231	-0.155	4.0%	-5.4%	0.0%
	(1.371)	(2.252)	(0.439)	(0.548)	(0.275)	(1.505)			
CNY	-0.265	-1.366	-0.178	-0.058	0.24	-0.01	5.6%	0.0%	0.0%
	(0.358)	(0.998)	(0.163)	(0.038)	(0.311)	(0.011)			
CNH	5.378*	9.378*	0.392	-3.089***	1.558	2.194***	21.9%	0.0%	0.0%
	(2.845)	(5.283)	(3.498)	(0.916)	(12.586)	(0.71)			

Note: The table presents results of the following regressions: $\bar{r}_{\mathrm{t,t+m}} = c_0 + c_1\hat{\beta}_t + c_2\widetilde{std}_t^c + c_3\widetilde{cos}_t^c + c_4\widetilde{skew}_t^c + c_5\widetilde{cok}_t^c + c_6\widetilde{kurt}_t^c + e_t^c$, where $\bar{r}_{\mathrm{t,t+m}}$, is the expected average currency excess return over the future m-month horizon $[\mathrm{t, t+m}]$. $\hat{\beta}_t$ is the traditional beta risk. $\widetilde{std}_t^c$ is estimated currency idiosyncratic volatility, proxied by the residual from the auxiliary regression of conditional standard deviation orthogonal to $\hat{\beta}_t$. $\widetilde{cos}_t^c$ is the residual of currency standardized conditional co-skewness orthogonal to $\hat{\beta}_t$ and $\widetilde{std}_t^c$. $\widetilde{skew}_t^c$ is the estimated currency conditional idiosyncratic skewness, which is the residual of currency conditional skewness orthogonal to $\hat{\beta}_t$, $\widetilde{std}_t^c$ and $\widetilde{cos}_t^c$. $\widetilde{cok}_t^c$ is the estimated currency standardized conditional co-skewness orthogonal to $\hat{\beta}_t$, $\widetilde{std}_t^c$, $\widetilde{cos}_t^c$ and $\widetilde{skew}_t^c$. $\widetilde{kurt}_t^c$ is the estimated currency conditional idiosyncratic kurtosis, which is the residual of currency conditional kurtosis orthogonal to $\hat{\beta}_t$, $\widetilde{std}_t^c$, $\widetilde{cos}_t^c$, $\widetilde{skew}_t^c$ and $\widetilde{cok}_t^c$.

Table 6: Regime-Switch Model Estimation for the Asian or Emerging Stock Market and Currency Premiums

Panel A: Asian stock market

	CNY (2005-2018)		CNH (2010-2018)		JPY (2005-2018)	
	Regime 1	Regime 2	Regime 1	Regime 2	Regime 1	Regime 2
μ_i^s	0.037**	0.236	-0.3***	0.047**	0.152	0.003***
t-stat.	0.655	3.798	-4.594	0.81	4.573	0.053
μ_i^c	0.023**	-0.034***	0.001***	-0.031***	0.003***	-0.021***
t-stat.	7.059	-1.778	0.19	-1.699	0.129	-0.65
λ_i^s	1.384	-19.712***	103.921	-5.892***	-0.642***	-1.711***
t-stat.	0.397	-5.895	5.945	-1.218	-0.542	-0.417
λ_i^c	0.702	2.714	2.186	2.164	2.981	-2.541***
t-stat.	5.389	1.92	6.349	1.573	3.71	-0.848
h_i^s	0.359	0.257	0.126	0.255	0.04**	0.443
t-stat.	10.792	5.552	3.318	6.426	3.123	8.175
h_i^c	0.001***	0.029**	0.002***	0.026**	0.024**	0.129
t-stat.	8.564	6.968	2.914	5.772	3.92	7.786
ρ_i	0.094*	0.452	0.257	0.474	0.387	-0.147***
t-stat.	1.098	5.534	1.306	5.13	2.379	-1.808
a_i	1.902	-2.164***	0.049**	-2.622***	0.392	-1.294***
t-stat.	7.558	-8.12	0.16	-6.255	1.538	-6.108
b_i	-0.609***	33.597	33.64	98.869	-14.651***	-6.995***
t-stat.	-0.041	2.426	2.514	5.207	-1.262	-0.628

Panel B: Emerging Stock Market

	CNY (2005-2018)		CNH (2010-2018)		JPY (2005-2018)	
	Regime 1	Regime 2	Regime 1	Regime 2	Regime 1	Regime 2
μ_i^s	0.015**	0.307	-0.297***	0.016**	0.242	-0.017***
t-stat.	0.199	4.431	-3.685	0.226	5.523	-0.23
μ_i^c	0.024**	-0.036***	0.069*	-0.037***	0.016**	-0.021***
t-stat.	7.01	-1.969	8.514	-1.873	0.66	-0.681
λ_i^s	4.691	-24.215***	83.375	-4.78***	1.368	0.628
t-stat.	1.112	-6.764	4.287	-0.772	1.073	0.15
λ_i^c	0.698	2.837	-0.785***	1.754	3.895	-2.084***
t-stat.	5.311	2.053	-2.209	1.22	4.329	-0.772
h_i^s	0.646	0.367	0.31	0.334	0.057*	0.677
t-stat.	10.943	5.703	4.049	6.535	3.267	10.078
h_i^c	0.001***	0.029**	0.003***	0.028**	0.017**	0.12
t-stat.	8.638	7.438	3.814	5.363	2.706	8.507
ρ_i	0.069*	0.52	0.563	0.512	0.407	-0.115***
t-stat.	0.757	8.395	5.363	5.234	2.383	-1.397
a_i	1.92	-2.172***	-0.977***	-1.588***	0.835	-1.835***
t-stat.	7.636	-7.481	-2.909	-3.71	2.955	-7.242
b_i	-0.331***	32.417	91.553	54.364	6.586	-24.136***
t-stat.	-0.022	2.125	6.132	2.312	0.619	-2.19

Note: The table estimates regime switching model for the monthly Asian or Emerging stock market and currency premiums using $\begin{pmatrix} r_t^s \\ r_t^c \end{pmatrix} = \begin{pmatrix} \mu_i^s \\ \mu_i^c \end{pmatrix} + \begin{pmatrix} \lambda_i^s & 0 \\ 0 & \lambda_i^c \end{pmatrix} \begin{pmatrix} RF_{t-1} \\ RD_{t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{it}^s \\ \varepsilon_{it}^c \end{pmatrix}$, where $\begin{pmatrix} \varepsilon_{it}^s \\ \varepsilon_{it}^c \end{pmatrix} \sim \text{IIN}\,(\mathbf{0}, \mathbf{H}_{\text{it}})$, and $\boldsymbol{H_{it}} = \boldsymbol{D_{it}} \boldsymbol{R_{it}} \boldsymbol{D_{it}}, \boldsymbol{D_{it}} = \begin{bmatrix} \sqrt{h_i^s} & 0 \\ 0 & \sqrt{h_i^c} \end{bmatrix}, \boldsymbol{R_{it}} = \begin{bmatrix} 1 & 0 \\ \rho_i & 1 \end{bmatrix}, i \in \{1,2\}$, and transition probabilities $p_{ii,t} = p(S_t = i | S_{t-1} = i, \mathbf{F}_{t-1}) = \Phi(a_i + b_i RD_{t-1}), i \in \{1,2\}$, where RF_{t-1} is the first lagged US risk free rate and RD_{t-1} is the first lagged interest rate difference (foreign interest rate-US interest rate). S_t is the unobserved regime at time t. $\mathbf{F}_{t-1}$ is the past information set. Φ is the cumulative normal distribution function. The parameter estimates are the QMLE. The t-statistics are reported in parentheses. *, **, and *** denote significance at 10%, 5%, and 1% respectively.

Table 7

Summary Statistics of Conditional Moment Estimates derived from the Asian or Emerging stock-currency regime-switching models

Variable name	CNY	CNH	JPY
Panel A: the average of conditional currency moments estimates with Asian stock market			
conditional currency beta	0.048	0.104	-0.070
conditional currency standard deviation	0.085	0.144	0.317
conditional currency skewness	-0.572	-0.256	0.071
conditional currency correlation with the Asian stock premium	0.236	0.340	-0.128
conditional currency covariance with the Asian stock premium	0.014	0.023	-0.027
conditional currency standardized co-skewness	-0.022	-0.094	0.084
conditional currency co-skewness with the Asian stock premium	0.000	-0.003	0.005
conditional currency standardized co-kurtosis	0.733	1.420	-0.740
conditional currency co-kurtosis with the Asian stock premium	0.013	0.021	-0.043
Panel B: the average of conditional currency moment estimates with Emerging stock market			
conditional currency beta	0.042	0.095	-0.020
conditional currency standard deviation	0.086	0.145	0.314
conditional currency skewness	-0.571	-0.258	0.117
conditional currency correlation with the Emerging stock premium	0.237	0.382	-0.072
conditional currency covariance with the Emerging stock premium	0.019	0.032	-0.029
conditional currency standardized co-skewness	-0.015	-0.067	0.188
conditional currency co-skewness with the Emerging stock premium	-0.001	-0.003	0.029
conditional currency standardized co-kurtosis	0.700	1.644	-0.721
conditional currency co-kurtosis with the Emerging stock premium	0.025	0.047	-0.132

Note: The table reports summary statistics of conditional moment estimates for foreign currency premiums with respect to the US dollar.

Table 8

Pricing effects of currency co-skewness and co-kurtosis with Asian stock market

Currency	$\hat{\beta}_t$	$\widetilde{std}_t^c$	$\widetilde{cos}_t^c$	$\widetilde{skew}_t^c$	$\widetilde{cok}_t^c$	$\widetilde{kurt}_t^c$	R^2	Economic Impact $\widetilde{cos}_t^c$	Economic Impact $\widetilde{kurt}_t^c$
Panel A: 1-month future excess returns									
JPY	-1.095**	3.515**	0.21	2.234**	-1.07	0.68	5.3%	0.0%	0.0%
	(0.554)	(1.534)	(0.152)	(1.121)	(0.895)	(1.426)			
CNY	-0.156	1.091	-0.013	0.088*	0.012	0.007	3.7%	0.0%	0.0%
	(0.232)	(1.151)	(0.077)	(0.05)	(0.161)	(0.013)			
CNH	1.743	-52.546	-5.544	0.308	108.441**	-4.858	7.6%	0.0%	-2.6%
	(1.903)	(34.987)	(3.478)	(0.401)	(47.835)	(3.119)			
Panel B: 3-month future excess returns									
JPY	-1.057*	0.606	0.28*	3.352***	-0.365	-1.901*	5.8%	3.4%	0.0%
	(0.587)	(1.266)	(0.154)	(0.749)	(0.699)	(1.093)			
CNY	-0.273	1.945***	-0.046	0.023	0.052	-0.025	6.0%	0.0%	0.0%
	(0.245)	(0.568)	(0.073)	(0.028)	(0.113)	(0.016)			
CNH	-1.212	1.215	-8.737**	0.112	-38.238	0.682	4.2%	-3.0%	0.0%
	(2.419)	(47.873)	(4.274)	(0.679)	(82.217)	(2.415)			
Panel C: 6-month future excess returns									
JPY	-0.306	1.379	0.363***	1.809	0.709	-1.268	3.8%	4.4%	0.0%
	(0.549)	(1.645)	(0.129)	(1.248)	(0.74)	(1.004)			
CNY	-0.158	-0.776	-0.05	-0.021	0.076	-0.032	2.5%	0.0%	0.0%
	(0.25)	(1.122)	(0.119)	(0.052)	(0.145)	(0.014)			
CNH	-6.31***	-7.596	-9.211**	0.446	-54.216	-6.575**	9.6%	-3.1%	0.0%
	(1.904)	(46.58)	(4.3)	(0.807)	(36.754)	(2.919)			
Panel D: 12-month future excess returns									
JPY	-0.672	0.283	0.325**	2.574	-1.788**	2.136**	5.9%	4.0%	-2.9%
	(0.639)	(1.029)	(0.16)	(1.731)	(0.877)	(1.029)			
CNY	-0.221	-1.722	-0.085	-0.081*	0.049	-0.005	5.5%	0.0%	0.0%
	(0.302)	(1.223)	(0.084)	(0.049)	(0.106)	(0.013)			
CNH	4.965**	74.819	-12.22	-1.741	-23.7	7.141**	21.5%	0.0%	0.0%
	(2.129)	(65.46)	(9.059)	(1.146)	(33.694)	(3.376)			

Note: The table presents results of the following regressions: $\overline{r}_{\mathrm{t,t+m}} = c_0 + c_1\hat{\beta}_t + c_2\widetilde{std}_t^c + c_3\widetilde{cos}_t^c + c_4\widetilde{skew}_t^c + c_5\widetilde{cok}_t^c + c_6\widetilde{kurt}_t^c + e_t^c$, where $\overline{r}_{\mathrm{t,t+m}}$, is the expected average currency excess return over the future m-month horizon $[\mathrm{t}, \mathrm{t}+\mathrm{m}]$. $\hat{\beta}_t$ is the traditional beta risk. $\widetilde{std}_t^c$ is estimated currency idiosyncratic volatility, proxied by the residual from the auxiliary regression of conditional standard deviation orthogonal to $\hat{\beta}_t$. $\widetilde{cos}_t^c$ is the residual of currency standardized conditional co-skewness orthogonal to $\hat{\beta}_t$ and $\widetilde{std}_t^c$. $\widetilde{skew}_t^c$ is the estimated currency conditional idiosyncratic skewness, which is the residual of currency conditional skewness orthogonal to $\hat{\beta}_t$, $\widetilde{std}_t^c$ and $\widetilde{cos}_t^c$. $\widetilde{cok}_t^c$ is the estimated currency standardized conditional co-skewness orthogonal to $\hat{\beta}_t$, $\widetilde{std}_t^c$, $\widetilde{cos}_t^c$ and $\widetilde{skew}_t^c$. $\widetilde{kurt}_t^c$ is the estimated currency conditional idiosyncratic kurtosis, which is the residual of currency conditional kurtosis orthogonal to $\hat{\beta}_t$, $\widetilde{std}_t^c$, $\widetilde{cos}_t^c$, $\widetilde{skew}_t^c$ and $\widetilde{cok}_t^c$.

Table 9

Pricing effects of currency co-skewness and co-kurtosis with Emerging stock market

Currency	$\hat{\beta}_t$	$\widetilde{std}_t^c$	$\widetilde{cos}_t^c$	$\widetilde{skew}_t^c$	$\widetilde{cok}_t^c$	$\widetilde{kurt}_t^c$	R^2	Economic Impact $\widetilde{cos}_t^c$	Economic Impact $\widetilde{kurt}_t^c$
Panel A: 1-month future excess returns									
JPY	-0.725**	2.514**	0.358	-1.477	0.159	-0.62	5.6%	0.0%	0.0%
	(0.34)	(1.178)	(0.905)	(0.902)	(0.231)	(1.567)			
CNY	-0.157	0.671	0.009	0.074	0.058	0.002	2.6%	0.0%	0.0%
	(0.238)	(0.906)	(0.083)	(0.055)	(0.164)	(0.01)			
CNH	2.47	-19.925	-1.308**	0.353	43.559	-3.626**	8.9%	-2.0%	0.0%
	(2.97)	(38.458)	(0.597)	(0.284)	(35.997)	(1.485)			
Panel B: 3-month future excess returns									
JPY	-0.564*	0.446	0.546	-0.628	-0.25	-2.093	3.2%	0.0%	0.0%
	(0.317)	(1.44)	(0.952)	(0.975)	(0.293)	(1.664)			
CNY	-0.279	1.733***	-0.023	0.014	0.079	-0.018	5.5%	0.0%	0.0%
	(0.261)	(0.44)	(0.075)	(0.03)	(0.116)	(0.014)			
CNH	-0.69	-44.027	-0.957	0.468	-65.88**	0.587	6.1%	0.0%	-2.9%
	(3.479)	(52.552)	(0.803)	(0.288)	(32.125)	(1.141)			
Panel C: 6-month future excess returns									
JPY	-0.4	-0.217	0.427	0.283	-0.203	0.084	1.2%	0.0%	0.0%
	(0.369)	(1.642)	(0.73)	(0.776)	(0.284)	(1.159)			
CNY	-0.199	-0.359	-0.054	-0.028	0.101	-0.03**	3.8%	0.0%	0.0%
	(0.267)	(0.914)	(0.114)	(0.05)	(0.137)	(0.014)			
CNH	-6.564***	-37.232	-1.236	0.774**	-15.203	-2.109**	7.7%	0.0%	0.0%
	(2.315)	(54.055)	(0.895)	(0.314)	(31.274)	(0.974)			
Panel D: 12-month future excess returns									
JPY	0.095	-1.64	1.597***	0.283	0.315	1.891	4.2%	4.9%	0.0%
	(0.437)	(2.076)	(0.606)	(1.06)	(0.311)	(2.1)			
CNY	-0.271	-1.142	-0.092	-0.088*	0.065	-0.009	5.6%	0.0%	0.0%
	(0.315)	(1.009)	(0.082)	(0.048)	(0.112)	(0.013)			
CNH	5.005*	53.583	-1.556	1.472**	48.666**	3.196**	21.6%	0.0%	2.1%
	(2.886)	(93.966)	(1.692)	(0.609)	(22.072)	(1.534)			

Note: The table presents results of the following regressions: $\overline{r}_{\mathrm{t,t+m}} = c_0 + c_1\hat{\beta}_t + c_2\widetilde{std}_t^c + c_3\widetilde{cos}_t^c + c_4\widetilde{skew}_t^c + c_5\widetilde{cok}_t^c + c_6\widetilde{kurt}_t^c + e_t^c$, where $\overline{r}_{\mathrm{t,t+m}}$, is the expected average currency excess return over the future m-month horizon $[\mathrm{t}, \mathrm{t}+\mathrm{m}]$. $\hat{\beta}_t$ is the traditional beta risk. $\widetilde{std}_t^c$ is estimated currency idiosyncratic volatility, proxied by the residual from the auxiliary regression of conditional standard deviation orthogonal to $\hat{\beta}_t$. $\widetilde{cos}_t^c$ is the residual of currency standardized conditional co-skewness orthogonal to $\hat{\beta}_t$ and $\widetilde{std}_t^c$. $\widetilde{skew}_t^c$ is the estimated currency conditional idiosyncratic skewness, which is the residual of currency conditional skewness orthogonal to $\hat{\beta}_t$, $\widetilde{std}_t^c$ and $\widetilde{cos}_t^c$. $\widetilde{cok}_t^c$ is the estimated currency standardized conditional co-skewness orthogonal to $\hat{\beta}_t$, $\widetilde{std}_t^c$, $\widetilde{cos}_t^c$ and $\widetilde{skew}_t^c$. $\widetilde{kurt}_t^c$ is the estimated currency conditional idiosyncratic kurtosis, which is the residual of currency conditional kurtosis orthogonal to $\hat{\beta}_t$, $\widetilde{std}_t^c$, $\widetilde{cos}_t^c$, $\widetilde{skew}_t^c$ and $\widetilde{cok}_t^c$.

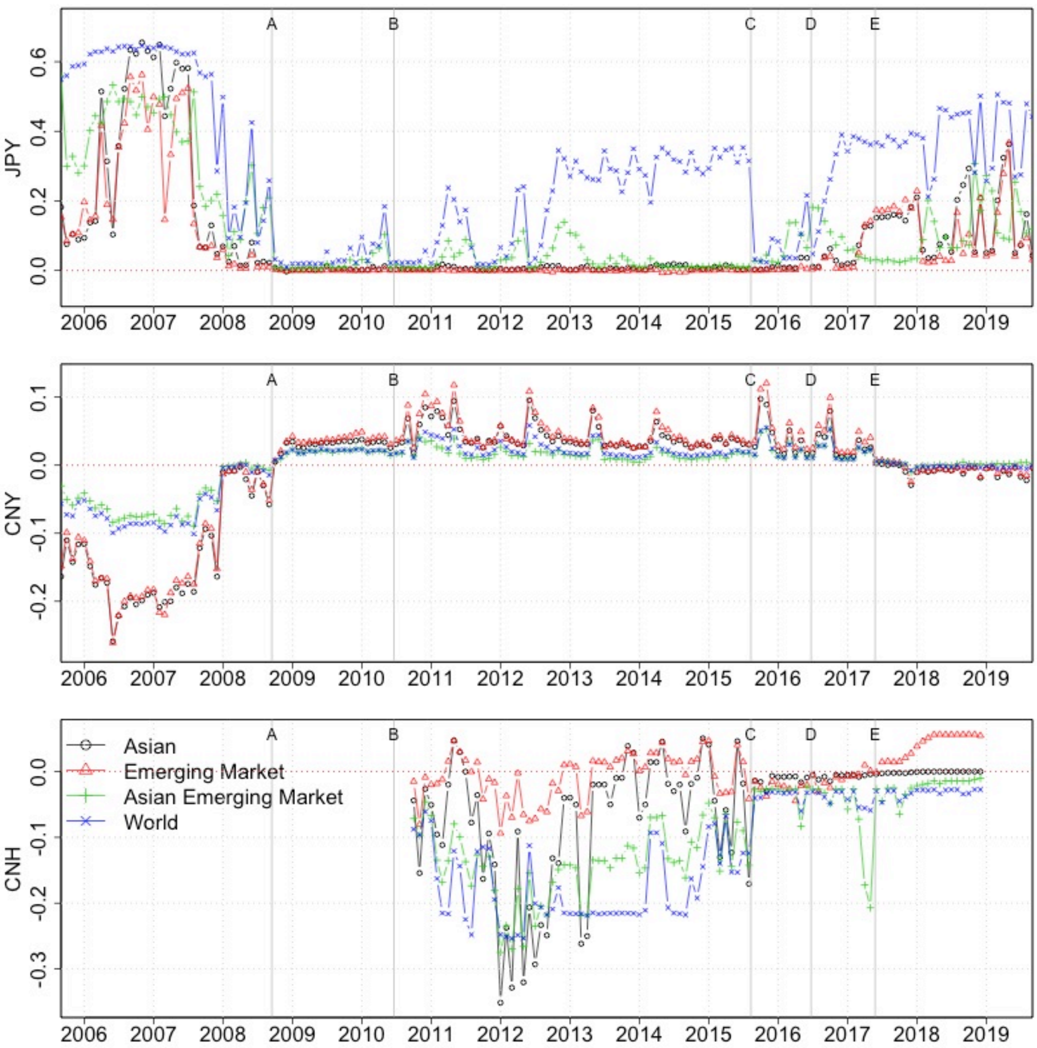

Figure 1 Conditional standardized co-skewness with the stock returns

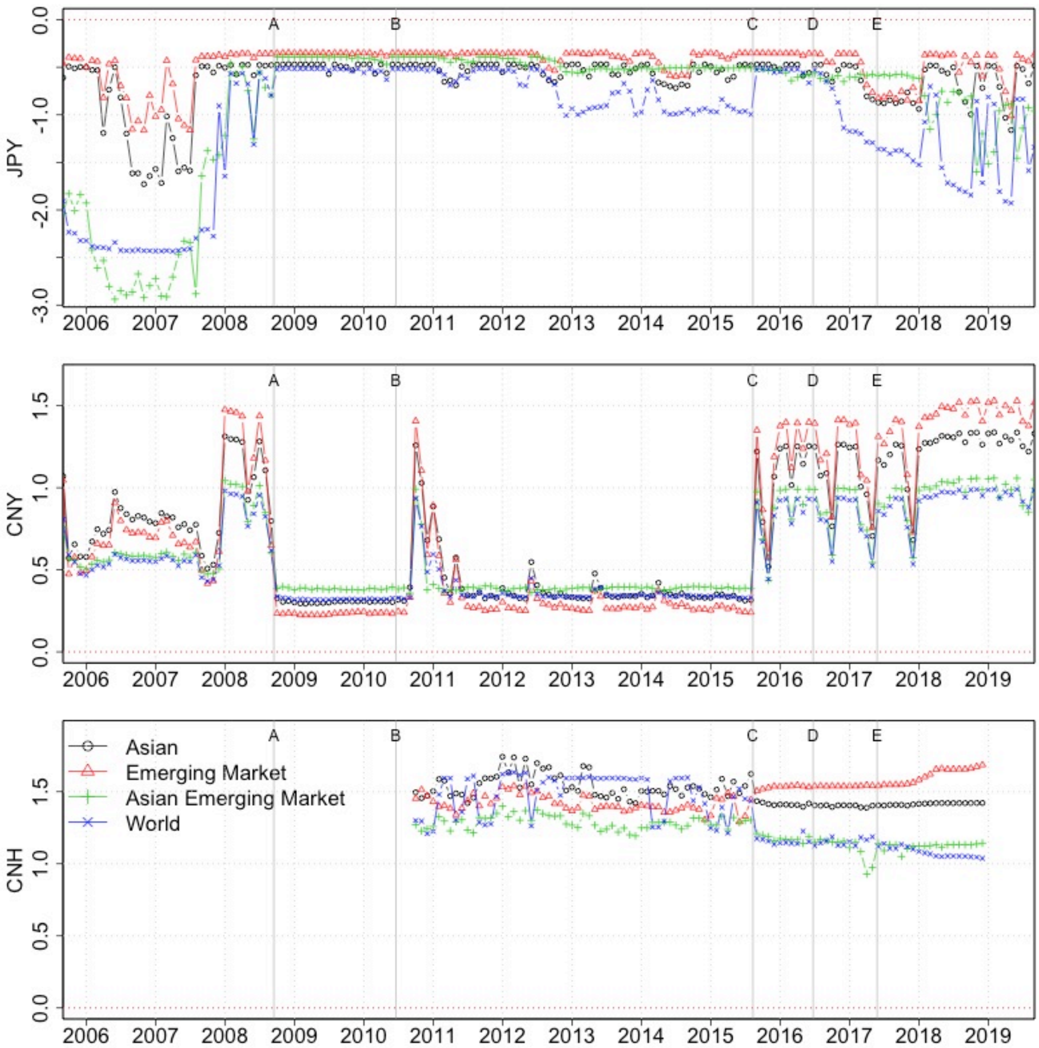

Figure 2 Conditional standardized co-kurtosis with the stock excess returns