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Asymmetric Global Risk Transmission: Evidence from China and Japan's Stock Markets

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ABSTRACT

This paper examines volatility spillover effects among global risk indicators, including the VIX, geopolitical risk, the U.S. term structure, inflation expectations, oil, gold, and the stock markets of Japan and China. Using multi-scale coherence and cross-quantilogram approaches, the study analyzes dynamic and asymmetric risk transmission across different investment horizons. The results show that the Japanese stock market is highly integrated with global risk factors and acts as a strong transmitter and amplifier of external shocks across time scales. In contrast, the Chinese stock market appears partially segmented, with weaker and more episodic linkages that intensify mainly during crisis periods, reflecting the influence of domestic policy and sentiment-driven dynamics. Robustness tests based on cross-quantile dependence confirm asymmetric lead–lag relationships and structural differences between the two markets. While both markets respond to global risk aversion, their sensitivities to geopolitical, commodity, and currency risks differ significantly. The findings contribute to understanding international financial integration and asymmetric risk transmission across major Asian markets.

INTRODUCTION

The question of how global risk factors transmit volatility across financial markets has long been a substantial issue in international finance and macro-financial linkages. With the rise of capital mobility, financial liberalization, and globalization, apprehending external shocks, whether originating from geopolitical tensions, currency fluctuations, or financial volatility, has become largely essential. An in-depth literature review has explained such relationships through different models of volatility spillovers, contagion, and co-movement (e.g., Diebold & Yilmaz, 2009, 2012; Diebold & Yılmaz, 2014; Engle et al., 2012). Such studies have concluded that financial markets are strongly interconnected with global risk factors, including geopolitical risk indices, the VIX, and

major currency flows, thereby forging volatility patterns. For example, (Belkhir, Boujelbène and Mezghani, 2025) examines how Economic Policy Uncertainty and Geopolitical Risk asymmetrically influence connectedness and spillover dynamics across green sukuk, traditional energy markets (oil, coal, and natural gas), renewable energy equities (clean energy, water, wind, and First Solar), and carbon trading markets under bearish, normal, and bullish market conditions. Similarly, Long et al. (2022) explore the connectedness between green bonds in Europe, China, and the US and uncertainty indices. They report that the spillover effect during turbulent times is significantly higher than during calm times. They also show that VIX and OVX highly affect green bonds, specifically in extreme upward markets. Bossman et al. (2023) investigate the asymmetric relationships between EU sectoral stocks and crude oil (WTI), geopolitical risk (GPR), oil implied volatility, and market sentiment during times of tremendous geopolitical unrest. They also display that the sectoral stock returns from the EU are predicted by VIX, WTI, OVX, and GPR asymmetrically. They also show that OVX and VIX offer some hedging and safe-haven features for EU stocks. Nevertheless, such a body of literature has increasingly focused on developed markets or emerging economies as a somewhat homogeneous group and has not taken into consideration the institutional, structural, and policy-driven disparity that characterizes major Asian financial systems.

This limitation represents a substantial gap in the ongoing literature. Even though China and Japan have substantial roles in the global economy, the comparative dynamics of how both markets transmit and absorb global risk remain poorly understood. By leafing through the literature on macro-financial linkages, research has concentrated on either China's evolving financial liberalization or Japan's integration with international markets, rarely analyzing both economies within a unified analytical structure. For example, Wang et al. (2011) studied the dependence structures between the Chinese market and other international markets. They report that the Chinese market is characterized by the strongest levels of dependence and the highest variability in dependence with the Pacific and Japanese markets. Afterwards, previous studies fail to identify the multi-scale and time-varying nature of volatility transmission. Based on this crux, it is worth noting how global risk factors affect markets that substantially differ in terms of institutional maturity, openness, and regulatory framework, and to what extent such linkages vary across various investment horizons. Addressing this gap is crucial for both academic research and practical risk management in a highly complex global financial environment.

From the foregoing, the purpose of our study is threefold. First, we attempt to determine the extent to which global risk factors such as geopolitical risk (GPR), financial market volatility (VIX), safe-haven currency flows, gold, Bitcoin, and U.S. equity dynamics can transmit volatility into the Chinese and Japanese stock markets. Second, we analyze if and how such transmission mechanisms differ in terms of duration, intensity, and frequency across both markets due to their differences in terms of institutional features and openness. Third, we analyze what such asymmetries imply for the broader apprehension of financial integration, contagion, and market resilience for the two largest economies in Asia. From the methodological standpoint, we apply a comparative wavelet coherence analysis that helps to jointly examine volatility comovements in both frequency and time domains.

This research contributes to the literature on volatility transmission and macro-financial linkages in many ways. It offers a comparative perspective on the extent to which global risk factors such as geopolitical risk, safe-haven currency flows, and the U.S. market dynamics influence two different markets, like China and Japan. Using the wavelet coherence method contributes to moving beyond classical time-domain analyses to take into consideration the time-frequency dynamics of volatility spillovers. This leads to highlighting how the persistence and intensity of international relationships change across different horizons. Our study contributes to understanding how the institutional framework, policy intervention, and openness shape domestic market reactions to external shocks. This provides both theoretical insights and practical implications for portfolio management, financial stability policy, and risk management.

The rest of the paper is given as follows. Section 2 presents an overview of current literature. Section 3 presents the methodology. Data and descriptive statistics are reported in Section 4. Section 4 presents the estimation results and interpretations, and Section 5 reports the robustness tests. Section 6 concludes.

1. LITERATURE REVIEW

Huang et al. (2000) explore the causality and cointegration relationships among the stock markets of Japan, the United States, and the South China Growth Triangle region. They report that no cointegration between such markets exists, except for that between Shenzen and Shanghai. Los & Yu (2008) highlight the lack of stationarity, ergodicity, independence, and the degree of persistence of the Shenzhen A shares (SZI), Shanghai (SHI) stock market, and B shares (SZBI), before and after the various deregulations and reregulations. Fan et al. (2009) analyze the relationship between China and the international stock markets, including the UK, the US, Japan, and Hong Kong. The results show a substantial trend of long-run co-movement between the Chinese and international stock markets since 1999. They also report that the Chinese stock market has been influenced in the short run by the international stock markets, which change through different regimes. Lai & Tseng (2010) find that the Chinese stock market has not only been a hedge but also a safe haven for the G7 stock markets. (Wang & Wang, 2010) study stock market linkages between Greater China, Japan, and the US in terms of price and volatility spillovers. The study shows that volatility spillovers are higher than price spillovers among the Greater China markets and the developed markets of Japan and the US. The dominance impact of developed markets over developing markets is not displayed in this research. As well, the extent of influence by the developed market on the developing market is shown to be related to the degree of market openness of the developing economy. Nishimura et al. (2015) examine the mechanism of return and volatility effects from the Chinese to the Japanese stock market. The study shows that China largely influences Japanese stocks through China-related companies in Japan. They also report that this reaction has become higher as the Chinese economy has gained importance in recent years.

Zhang (2018) shows that even though China's stock price volatility is far greater than that of US and Japanese stock prices, China is less impacted by the global financial crisis in 2007 than the U.S and Japan. For China, the stock price volatility was higher in the early 1990s, shortly after the stock market had been established, than in 2007 when the global financial crisis occurred. As well, the empirical results show that the relationship between Japanese, Chinese, and US stock prices has increased since the global financial crisis. Hussain & Li (2018) analyze the dependence structure between the Chinese stock markets and other stock markets (the US, UK, Canada, Germany, Australia, and Japan). They find that the dependence between the Chinese market and the developed markets is weak. They also reveal that the Chinese market is characterized by higher dependence on Europe and Asia than the US. Schuenemann et al. (2020) attempt to identify stock return correlations between companies of selected industries in China and Japan. The empirical results display that the Japanese stock market responds highly to specific events and does not influence the Chinese market in any way. They also report that events linked to the Chinese market immediately affect the Japanese market behavior. Takahashi & Yamada (2021) show that indirect ownership through the exchange-traded fund purchasing program by the Bank of Japan has a positive effect on abnormal returns. They also display that foreign ownership is adversely related to abnormal returns, whereas ownership by traditional business groups is positively related to abnormal returns. Zhu et al. (2025) analyze the relationships between worldwide climate policy uncertainty (CPU) and Chinese volatility risks. The results show that the Chinese CPU has the highest impact, with three network layers displaying unique evolutionary patterns but structurally intertwined linkages. Such effects all show dynamic patterns driven by external shocks, but the Chinese CPU spillovers are more sensitive and drastic.

Zhang et al. (2025) examine the correlation between price fluctuations in the Chinese crude oil futures market and global financial markets under the effect of geopolitical factors. They report

that the significance, dynamic, and heterogeneous features of geopolitical risk are in the Chinese crude oil market and major international financial markets. They also find that the risk spillover of Chinese crude oil futures to major international financial markets under geopolitical risk is mainly concentrated in the short and medium term. (Chen, Yang and Chang, 2025) study the dynamic volatility spillovers among the stock markets of Hong Kong, China, and the U.S., focusing on Hong Kong as the intermediary transmitter. They also display that the U.S. is considered the main transmitter of returns and volatility, with Hong Kong being the major receiver. The empirical results also show dynamic patterns and high sensitivity of such spillover transmissions to the U.S.-China trade war, health crisis, and financial crises. Gao & Yang (2024) analyze higher-order moment risk spillovers in the frequency and time domains and examine their influencing factors and cluster framework. The findings show that inter-sector higher-order moment risk spillovers show pronounced time-varying traits, which are mainly impacted by high-frequency impacts. Gao et al. (2026) report that government cultivation of long-run capital substantially decreases corporate share price synchronization in China.

2. METHODOLOGY

To examine the relationship between the different markets, we use the wavelet method. Such a method is suitable to simultaneously capture time and frequency dynamics, thereby overcoming the shortcomings of static correlations or purely time-domain models Torrence & Compo (1998); Aguiar-Conraria & Soares (2011). In this regard, wavelet coherence (WTC) allows us to identify potential relationships between two processes by taking into consideration frequency bands and time intervals. In particular, WTC improves linear correlation analyses that highlight intermittent correlations between two phenomena Gurley and Kareem, 1999; Gurley et al., 2003). This enables us to distinguish short-, medium-, and long-term drivers of co-movement within a unified setting. The study distinguishes three investment horizons: short term (2–21days), medium term (21–126 days), and long term (126-256 days). Persistent low-frequency coherence is interpreted as evidence of structural adjustments, typically associated with prolonged geopolitical tensions. However, short bursts of high-frequency coherence are linked to episodes of market panic or volatility-driven stress. This decomposition enables us to evaluate not only whether gold provides hedging benefits for emerging markets, but also under what conditions and horizons such benefits materialize.

The starting point is the continuous wavelet transform (CWT) of a time series x(t):

$$W_x(u,\mathrm{s}) = \frac{1}{\sqrt{s}}\int_{-\infty}^{\infty} x(t)\Psi^*\left(\frac{t-\mathrm{u}}{\mathrm{s}}\right)dt,$$

where $\psi(t)$ denotes the Morlet wavelet, s is the scale, and u is the time-shift parameter, and $*$ denotes the complex conjugate. This transformation produces a localized representation of the series in both time and frequency domains.

For two time series x_t and y_t, the cross-wavelet transform (XWT) is defined as:

$$W_{xy}(u,\mathrm{s}) = W_x(u,\mathrm{s})W_y^*(u,\mathrm{s}),$$

with the cross-wavelet power given by $W_{xy}(u,\mathrm{s})$ which highlights regions of high common variance (Grinsted et al., 2004).

The wavelet coherence (WTC) extends this idea by providing a localized correlation coefficient:

$$R_{xy}^2(\mathrm{u},\mathrm{s}) = \frac{\left|S\left(s^{-1}W_{xy}(u,\mathrm{s})\right)\right|^2}{S(s^{-1}|W_x(u,\mathrm{s})|^2)\; S\left(s^{-1}\left|W_y(u,\mathrm{s})\right|^2\right)},$$

where:

- S(·) is a smoothing operator in time and scale. R^2_{xy}(u,s),)∈[0,1] with values close to 1 indicating strong co-movement at a given time-frequency location;
- $R_{y,x1x2}(u,s)$ denotes the squared multiple wavelet correlation between y_t and the set {x_{1t},x_{2t}}.

These measures allow us to capture both the intensity and directionality of co-movement, to separate direct from indirect linkages, and to assess multivariate interdependencies. Such framework provides a rigorous basis for evaluating the relationships between the VIX, the Geopolitical Risk Index (GPR), West Texas Intermediate crude oil, JPY/USD and CHF/USD and US-based macroeconomic risk spread factors in the form of the 10-Year-less-3-Month yield spread, and the 5-Year Breakeven Inflation Expectation, as follows: T10Y3M, as well as the T5YIE on china and Japan markets.

3. DATA AND DESCRIPTIVE STATISTICS

In this study, we use the Nikkei 225 index and the SSE Composite Index of the Shanghai Stock Exchange, based on daily log-returns of the data. We also use other variables that can influence financial markets in capturing the multidimensionality of global volatility: the VIX of the CBOE as a proxy for global risk sentiment; the Geopolitical Risk Index (GPR) estimated by Caldara & Iacoviello (2022); West Texas Intermediate crude oil volatility for energy shocks; foreign exchange volatilities of JPY/USD and CHF/USD; and US-based macroeconomic risk spread factors in the form of the 10-Year-less-3-Month yield spread, and the 5-Year Breakeven Inflation Expectation: T10Y3M and the T5YIE. All volatilities, in squares, with respect to base indices or securities, are computed daily for consistency as well as stationarization. We also use the daily prices of Bitcoin and Gold. We collect all data from the Datastream database, with a total of 1726 daily observations for 11 key financial and economic variables.

The current research uses daily data from January 2, 2019, to September 5, 2025. This is characterized by some key economic and geopolitical disruptions, making it an ideal time for the exploration of volatility spillover: the pre-COVID-19 period (2019), the pandemic and related market crash (2020), the post-pandemic stimulus-driven recovery (2021), the Russia–Ukraine war and related energy crisis (2022), the year of aggressive global monetary tightening as a fight against inflation (2023–2024), and normalization of markets or the imposition of a new economics regime (2025).

Table 1. Descriptive Statistics

Variable	Obs	Mean	SD	Min	Max	Skewness	Kurtosis	ADF	KPSS	JB(p-value)
SSE	1726	3197.62	256.37	2464.36	3883.56	-0.040	2.412	0.2302	0.0100	0.001
Nikkei	1726	29317.72	6330.02	16321.210	43714.31	0.360	2.061	0.2251	0.0100	0.001
VIX	1726	20.29	7.729	11.540	82.69	2.662	15.339	0.0100	0.0100	0.001
GPR	1726	127.32	62.070	9.490	581.540	1.810	10.005	0.0100	0.0100	0.001
T5YIE	1726	2.15	0.551	0.140	3.59	-0.581	3.596	0.5170	0.0100	0.001
T10Y3M	1726	0.082	1.022	-1.890	2.270	0.000	2.034	0.8162	0.0100	0.001
Bitcoin	1726	38591.78	29912.44	3397.70	123344.06	0.945	3.056	0.7705	0.0100	0.001

Gold	1726	1983.29	503.019	1270.86	3586.81	1.292	4.271	0.9900	0.0100	0.001
JPY.USD	1726	0.80	0.116	0.618	0.976	-0.039	1.279	0.6286	0.0100	0.001
CHF.USD	1726	1.088	0.060	0.979	1.26	0.496	3.139	0.5168	0.0100	0.001
WTI	1726	68.573	18.10	10.010	123.70	-0.105	3.619	0.7696	0.0100	0.001

Source: own

Table 1 reports the descriptive statistics for different variables. The equity indices, SSE and Nikkei, show markedly different risk-return features. The Nikkei displays a significantly higher average level and a standard deviation over 24 times greater than that of the SSE, highlighting its substantially higher volatility. The distributional properties also differ: the SSE's near-zero skewness suggests a symmetric distribution of returns, whereas the Nikkei's positive skewness indicates a propensity for more extreme positive returns. This reflects the Nikkei's nature as a developed yet dynamic market sensitive to global capital flows and monetary policy. However, the SSE shows lower volatility, which may be attributed to tighter governmental controls and a distinct investor base. Bitcoin and Gold both exhibit significant volatility. Bitcoin shows a high-risk, high-return speculative asset prone to explosive rallies. Gold also displays positive skewness and substantial volatility.

The 5-Year Breakeven Inflation Rate (T5YIE) averages approximately 2.16%, reflecting the market's medium-term inflation expectation over the period. Its negative skewness suggests that episodes of collapsing inflation expectations (such as during recession scares) are more severe than periods of high inflation. The T10Y3M spread (the difference between 10-Year and 3-Month Treasury yields) serves as a crucial barometer of the yield curve. Its historical minimum of -1.89% confirms a significant inversion, a classic recession signal. The dynamics of this spread are a direct reflection of the interplay between central bank monetary policy (affecting short-term rates) and market growth/inflation expectations (affecting long-term rates).

The Japanese Yen (JPY/USD) shows higher volatility and negative skewness against the USD, indicating that its sharp appreciations are more extreme than its depreciations. Similarly, the Swiss Franc's (CHF/USD) positive skewness indicates strong rallies against the Dollar. These trends are largely driven by interest rate differentials and relative monetary policy stances between the respective countries and the United States.

Finally, WTI Crude oil, with a mean price of around $69 and significant volatility, experienced an extreme range from $10 to $124. This wide swing captures the tumultuous nature of the energy markets over the sample period, reflecting episodes of deep recessionary demand collapse (e.g., the COVID-19 pandemic) and supply-driven price spikes (e.g., geopolitical conflicts).

From Table 1, the results show the non-stationarity of the variables, as confirmed by both ADF and KPSS tests. This indicates that the data-generating process for these series is time-dependent, characterized by underlying trends and evolving variances. This statistical property is critical, as it necessitates the use of specialized modeling techniques, such as analyzing returns instead of price levels, to avoid spurious regression results.

4. EMPIRICAL RESULTS AND INTERPRETATION

The comparative wavelet coherence analysis among the VIX and Japanese and Chinese stock market returns is illustrated in Figure 1. The empirical results show crucial asymmetries in the transmission of global volatility shocks to Asian economies and lay the foundations for

apprehending such a salient fact. For the Japanese case, the strong and persistent coherence which is increasingly shown in medium- to long-term horizons (about one to six months). This clearly indicates strong financial integration with global markets. Such a result confirms earlier insights provided by (Diebold and Yilmaz, 2012), who report that Japan is a key element in global volatility networks. Such increased volatility sensitivity implies that the Japanese market is strongly influenced by risk sentiment from the US, as witnessed in in-phase comovements. This reflects synchronized declines during crises, such as the pandemic of COVID-19 in 2020, the energy price shock of 2022, and episodes of geopolitical tension.

These insights confirm Japan's volatility amplifier role in Asia, consistent with those of (Longin and Solnik, 2001), who show that correlations of global markets deepen in downslides. Nevertheless, the Chinese market displays low coherence with the VIX, showing weak and ephemeral relationships mostly limited to short-term variations. This finding is consistent with (Morales and Andreosso-O'Callaghan, 2018), who report that Chinese financial controls, financially-led State models, as well as relatively lower financial liberalization, act as protection mechanisms for external shocks.

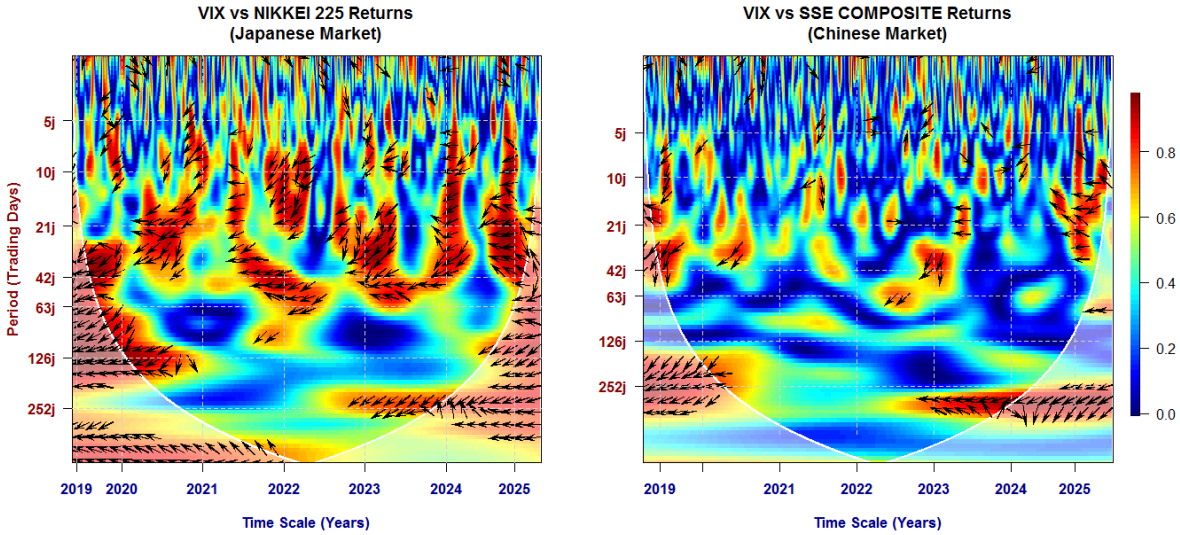


Figure 1. Wavelet coherence analysis between VIX volatility and stock market returns

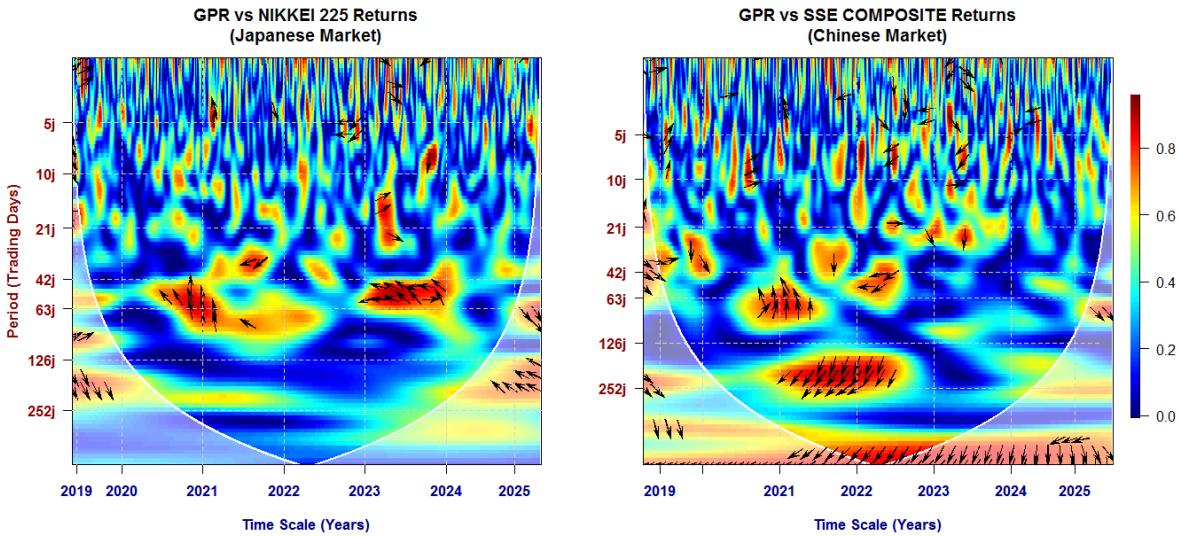


Figure 2. Wavelet coherence analysis between GPR volatility and stock market returns

The heterogeneity of essential financial integration affects the transmission of more precise shocks in a significant manner, as shown by the analysis of geopolitical risk (GPR) and currencies' volatility. Figure 2 illustrates the wavelet coherence analysis, which is used to explore the correlation between Geopolitical Risk (GPR) volatility and the return of stocks during the period 2019-2025. The empirical results present a highly dynamic and scale-dependent interaction. The degree of co-movement of GPR with the return of stocks is far from being stable. Rather, it seems to be heterogeneous in different time spans as well as investment horizons, thus highlighting the nonlinear and inherently complex nature of geopolitical risk transmission. More specifically, time spans that feature higher coherence in medium- to long-term horizons (63–252 trading days) suggest that prolonged geopolitical disputes exert a more significant and longer-lived influence on the performance of stocks compared to fleeting shocks. Such a finding is in accordance with (Caldara and Iacoviello, 2022b), who argue that geopolitical risk shocks tend to induce savings and equity valuation declines for long-time spans by escalating uncertainty and prompting cautionary actions.

On the other hand, the Japanese market displays more consistent responses to volatility in geopolitical risk (GPR), consistent with its heavy dependence on international trade, net energy imports, and integration into the U.S.-led financial and defense system. In this respect, the Japanese market is particularly vulnerable in episodes of global geopolitical stress. The empirical results are consistent with those of (Bouri, Shahzad and Roubaud, 2019), who highlight Japan's susceptibility to geopolitical shocks. However, the Chinese market displays a more selective and episodic correlation with GPR, often converging around large, high-profile international crises, including the U.S.-China trade disputes, the COVID-19 pandemic, as well as the Russia–Ukraine crisis. This lower responsiveness can be attributed to China's more closed capital account, increased state management of financial markets, and domestic demand-driven orientation as the key driver of growth (Zhou et al., 2012). While such insulation prevents direct spillovers of geopolitical risk, it could also reflect a mispricing of risk, with potential inefficiencies in the allocation of capital being the consequence.

Figure 3 reports the wavelet coherence analysis of the JPY/USD volatility and stock market returns relationship, which depicts a strong and changing coherence for the Nikkei 225, especially at medium-to-long horizons (60–252 trading days). In the pre-COVID and early pandemic period (2019–early 2020), the short-to-medium term (10–60 days) clusters reveal high coherence with rightward arrows, which reflects that JPY/USD volatility and Japanese equity returns are moving together. This might have been attributed to global risk sentiment changes. Since mid-2020 onwards, the relationship has been consistently negative, with medium frequencies showing strong coherence with dominant leftward or downward-left arrows. Thus, it can be inferred that periods of greater JPY/USD volatility are always linked to the Nikkei losing ground.

The tightening of this inverse link shows that exchange rate instability and the yen’s safe-haven status are two major factors that determine the direction of the Japanese market. On the other hand, the relationship between JPY/USD volatility and the SSE Composite is much weaker, more fragmented, and mostly limited to short-to-medium intervals. The whole sample shows some irregular clusters with directions of arrows indicating both in-phase and out-of-phase relationships. For example, an in-phase period in 2020-2021 and an out-of-phase patch in 2021 are well-documented. In the longer intervals (more than 120 days), the relationship still remains weak, which means that JPY/USD volatility does not have the same lasting or fundamental impact on Chinese stocks as it does on Japanese ones.

From Figure 4, the Swiss Franc's status is closely associated with the economic integration and structural traits of the equity market under study. The difference between the two markets is monumental. The analysis for Nikkei 225 uncovers major, non-continuous areas of high coherence, especially during the 2020 pandemic crash. These areas are most visible at the medium-term horizon of 16-64 days. The arrows of the phase difference indicate that the two series are moving in a correlated, synchronous manner, which supports the view that the tumult in

the Nikkei and the rises in CHF volatility are closely connected. On the other hand, the coherence for the SSE Composite is much weaker and more scattered. The strongest connections are limited to certain incidents that are specific to China and have global risk aversion as a consequence, such as the initial COVID-19 outbreak or periods of heavy-handed regulation. This weakened relationship is a direct result of China's capital account restrictions, which act as a shield preventing fear in the stock market from translating into a flight of capital to the Swiss Franc. The volatility in the Chinese market is mostly a result of the domestic regulatory environment and liquidity, which makes its link with a global currency pair like CHF/USD inherently weaker and less reliable than that of a fully integrated market like the Japanese market.

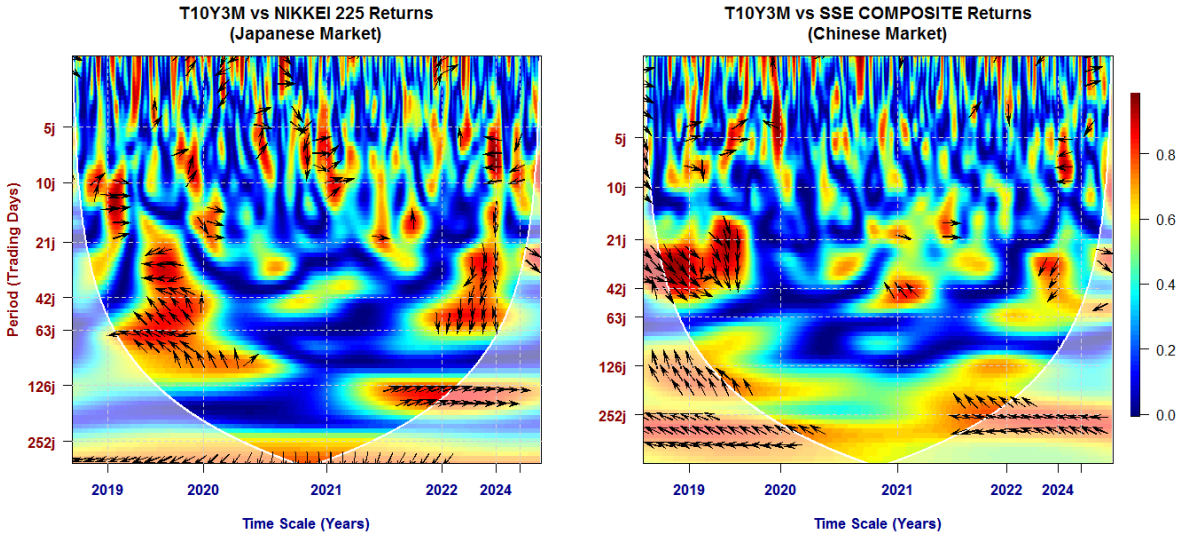


Figure 3. Wavelet coherence analysis : T10Y3M volatility and stock market

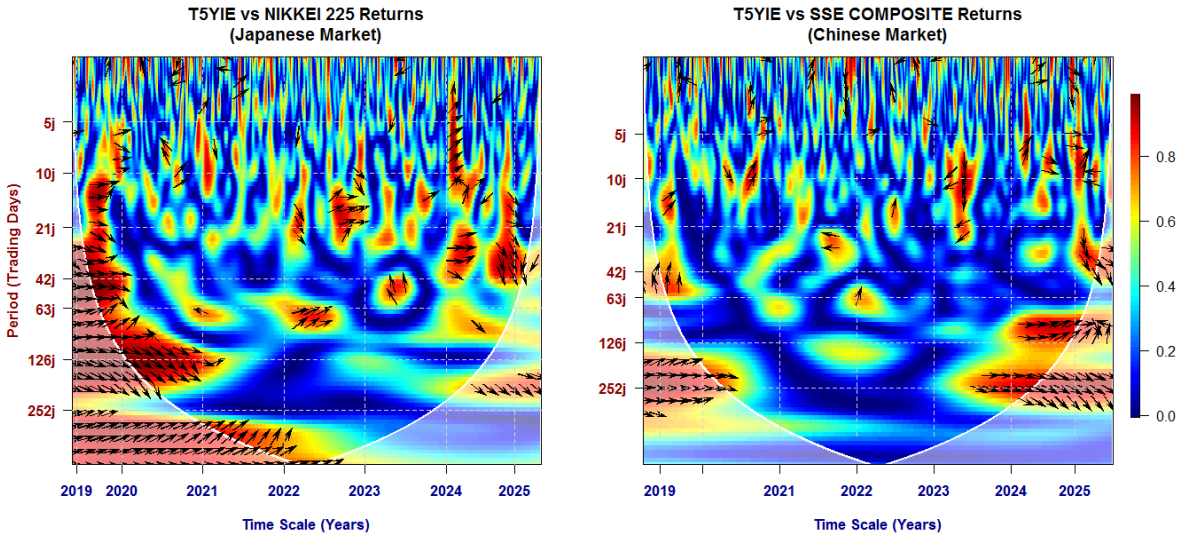


Figure 4. Wavelet coherence analysis: T5YIE volatility and the stock market

Even though there are external shocks, the reactions of the markets to the US macroeconomic indicators, which are also global growth and inflation expectations, still differ in maturity and structure. The wavelet coherence between the volatility of the 10-Year minus 3-Month Treasury Yield Spread (T10Y3M) and stock market returns is depicted in Figure 3. For the Japanese case, the empirical results reveal that strong coherence exists at the medium to long-term periods (21 to 126 trading days), mainly during the years 2019 through 2021. The phase arrows typically indicate T10Y3M volatility leading stock returns, which means that changes in yield curve volatility

occur before changes in the NIKKEI 225 index. This finding is in line with the works of (Okimoto and Takaoka, 2022), who proved that yield curve spreads and their volatility are good indicators of economic cycles and stock market behavior in developed economies like Japan. Herein, the multiscale coherence highlights the fact that the Japanese stock market is sensitive to changes in both short- and long-term interest rates, a nuance that aligns with Japan's long-standing low-interest rate policy and the adoption of unconventional monetary measures (Nakazono et al., 2020). For China, the coherence between T10Y3M volatility and stock returns is somewhat scattered and less intense, mainly at the medium-term scale (42 to 126 trading days). The phase relationships point to yield curve volatility as playing a leading role, albeit with greater variability. This trend backs up research by Chen and Qu (2016), who reported that emerging markets such as the Chinese market have less stable and more complicated ties between the yield curve and stock market due to the ongoing economic reforms, changing monetary policies, and comparatively less developed financial markets.

Likewise, Figure 4 shows the wavelet coherence between 5-Year Treasury Inflation Expectations (T5YIE) volatility and stock market returns. The Japanese stock market exhibits a strong coherence at medium to long-term scales (approximately 21 to 126 trading days) mainly during the period 2020 to 2023. The arrows indicate a rather complicated lead-lag relationship where T5YIE volatility is sometimes ahead of stock returns and sometimes behind them. Such a fact in both directions corresponds to earlier works (Nakazono, Koga and Sugo, 2020b) that point out the uniqueness of Japan's economic environment, which is characterized by low inflation for a long time and large-scale monetary easing. This affects the direction of causality between inflation expectations and stock market performance. Nevertheless, the Chinese market displays less continuous but still significant coherence, especially at medium-term scales (21 to 63 trading days) for the years 2022 to 2024. The direction of arrows shows mainly T5YIE volatility leading the stock market, which means that inflation expectations serve as a forward-looking indicator for equity returns in China during such a period. Such evidence is shown by some studies on emerging markets (e.g. (Burdekin and Tao, 2011)), where inflation expectations mirror the underlying macroeconomic adjustments and policy changes that are very influential in determining investor behavior and market valuations.

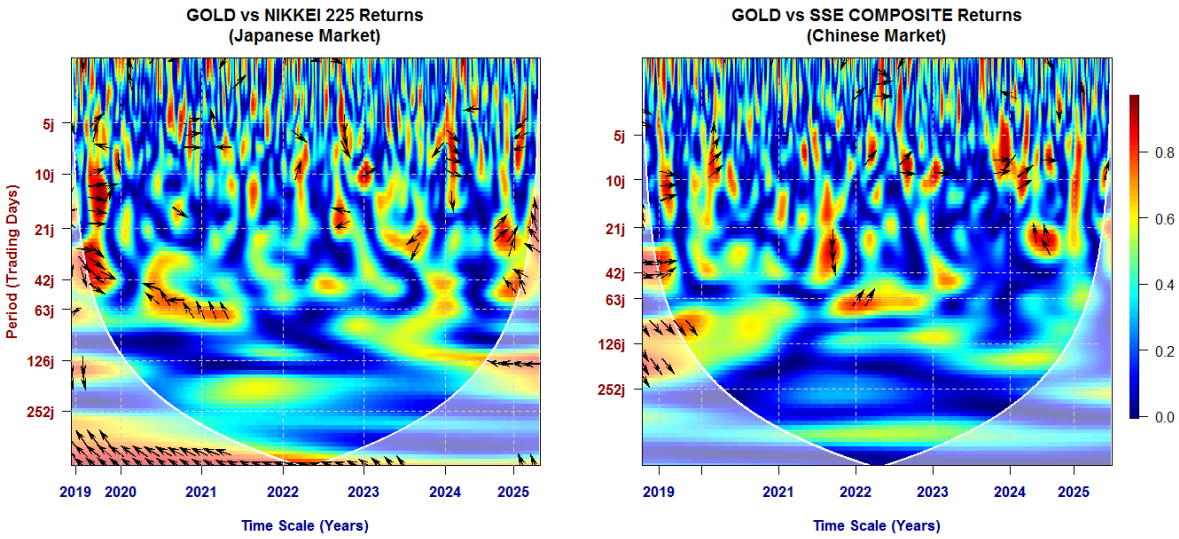


Figure 5. Wavelet coherence analysis: Gold volatility and stock markets

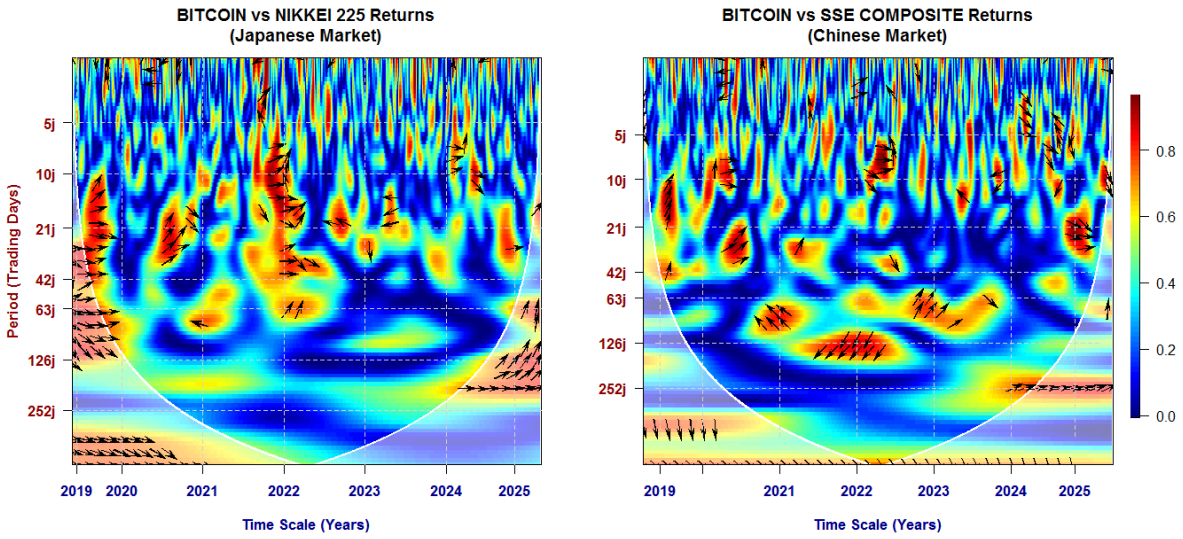


Figure 6. Wavelet coherence analysis: Bitcoin volatility and stock markets

Figure 5 displays the wavelet coherence between gold price volatility and stock market returns. For the Japanese case, the empirical results indicate that the medium to long-term coherence (42 to 252 trading days) is stable and strong to moderately strong in most of the time spans (especially during 2020 to 2023). The phase arrows are mostly pointing to the left and down. This reflects that gold volatility is leading stock market returns. So, changes in gold prices seem to lead those in the equity market in Japan. This is consistent with earlier findings (e.g., (Baur and Lucey, 2010); (Reboredo, 2013) that point to the fact that gold behaves as a hedge and safe haven instrument for equities, in particular, mature markets under economic distress or low real interest rates. Prolonged coherence at higher scales further accentuates the relevance of gold as a portfolio diversification strategic asset in Japan. Meanwhile, the coherence between gold volatility and stock returns in the Chinese market is relatively weaker and sporadic, mainly at the medium-term scales (21 to 126 trading days). The phase is more erratic and has the gold volatility–lead stock returns relation periodically interrupted by the lag and/or contemporaneous relations. Such a pattern has already been reported by Wang & Yang (2011) and Zhang & Wei (2010), indicating that gold is considered a diversification instrument in China, but its safe haven property is not as strong as that in the developed countries, owing to dissimilar investor attitudes and market structure.

On the other hand, by moving to Bitcoin, the plot (Figure 6) shows a significant and persistent area of high coherence emerging around 2019-2020, particularly concentrated at the medium-term horizons for the Nikkei 225 (Japanese Market). This pattern strongly suggests that the COVID-19 market crisis acted as a structural break. The synchronized global monetary and fiscal response, which created a massive "liquidity tide," began to couple Bitcoin with traditional risk assets like Japanese equities. This coherence persists through the subsequent period of monetary tightening, indicating that Bitcoin and the Nikkei became subject to the same global "risk-on/risk-off" sentiment, with their medium-term cycles becoming synchronized. This aligns with research by Corbet et al. (2020), who documented the contagion effects of the pandemic, which broke down previous asset class barriers and reclassified Bitcoin as a speculative risk asset alongside equities. However, based on the wavelet coherence plot for Bitcoin and the SSE Composite, the relationship is defined not by organic financial integration but by sovereign regulatory intervention, resulting in a clear narrative of failed convergence. The brief period of moderate coherence observed at short-to-medium time scales from 2019 to mid-2020, where phase arrows likely pointed **right and up**, suggests that sentiment in the Chinese stock market temporarily led Bitcoin volatility, reflecting the influence of Chinese investors and miners before the crackdown (Sun and Yang, 2025). This nascent linkage was abruptly severed around mid-2020 to 2021, as seen in the rapid disintegration of coherence into a "regulatory cliff" where warm colors fragmented into dominant

blues. This visual rupture corresponds directly to China's escalating prohibitions on cryptocurrency trading and mining, which dismantled existing financial channels (Liu and Tsyvinski, 2021). From 2022 onward, the persistent low coherence, marked by insignificant, randomly directed arrows, confirms a state-enforced decoupling. Unlike Bitcoin's integration with open markets, its relationship with the SSE Composite is pre-emptively suppressed, underscoring how China's capital controls and assertive regulatory stance effectively insulated its equity market from external digital asset volatility (Corbet, Larkin and Lucey, 2020). Thus, the plot visually encapsulates how political authority can override financial linkages, ensuring that global crypto trends remain disconnected from domestic market dynamics.

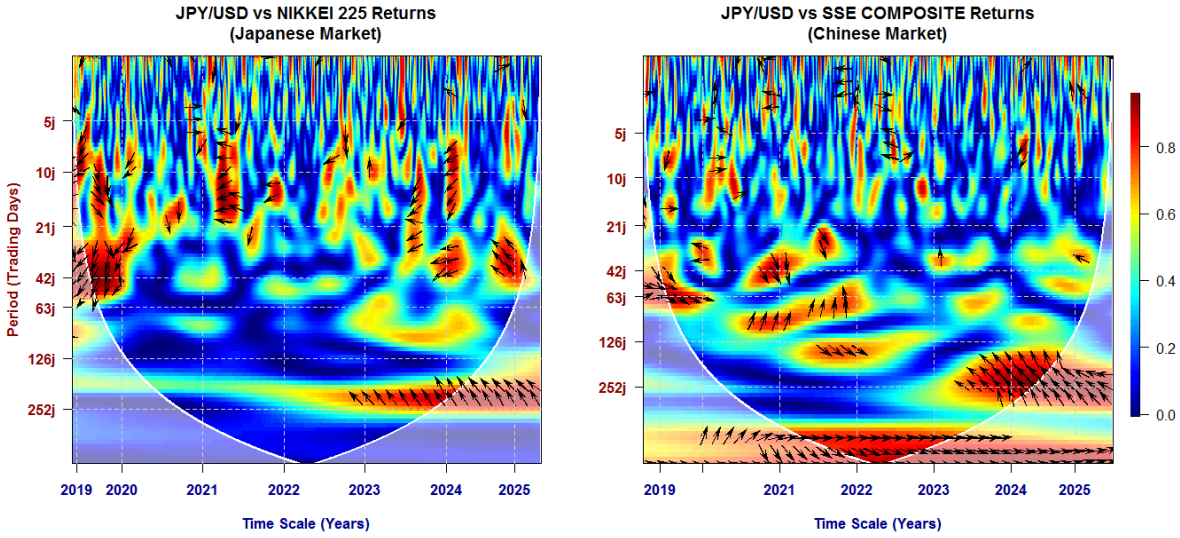


Figure 7. Wavelet coherence analysis: JPY/USD volatility and stock market

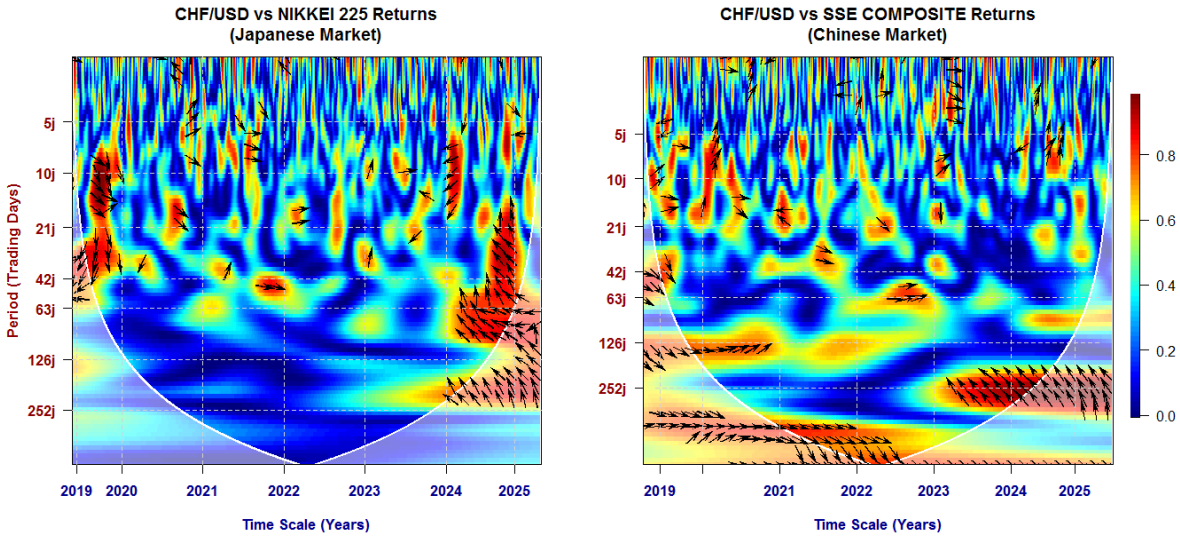


Figure 8. Wavelet coherence analysis: CHF/USD volatility and stock markets

The wavelet coherence results (Figure 7) for JPY/USD and stock market returns in Japan (Nikkei 225) and China (SSE Composite) reveal time-varying and scale-dependent linkages, with meaningful differences across markets. High-coherence regions at short and medium time scales during 2019–2021 correspond to periods of global financial stress, notably the onset of COVID-19, when exchange rate volatility and equity markets were jointly driven by rapid shifts in global risk sentiment and liquidity conditions, a pattern consistent with crisis-driven contagion channels

documented in recent literature (Braiek, Bedoui and Belkacem, 2022). At longer horizons sustained coherence observed from 2023 onward aligns with macroeconomic policy adjustments: in Japan, episodes of strong coherence coincide with the Bank of Japan's gradual revisions to its yield-curve control framework, which re-anchored expectations for the yen and domestic equity valuations; in China, the strengthening of coherence after 2020 reflects the economic and financial impacts of the country's post–zero-COVID reopening and associated shifts in capital flows and growth expectations (IMF, 2023). The phase-arrows further indicate alternating leadership; at times, the JPY/USD movement leads equity adjustments (export competitiveness and risk-off capital flows), while in other episodes, equity shocks precede currency reactions (portfolio rebalancing and return-differential effects). Overall, these results demonstrate that the FX–equity relationship is non-linear, asymmetric, and varies across time horizons, supporting the use of wavelet-based multiscale analysis to uncover market co-movement structures that traditional time-domain models may overlook (Torrence & Compo, 1998; Grinsted et al., 2004).

From Figure 8, the wavelet coherence patterns between CHF/USD and the Nikkei 225 and CHF/USD and the SSE Composite from 2019 to 2025 indicate time-varying and scale-dependent co-movement, reflecting the role of the Swiss franc as a global safe-haven currency. During periods of heightened global uncertainty, most notably at the onset of COVID-19 in 2020, both markets exhibit strong high-frequency coherence, suggesting that rapid shifts in global risk aversion simultaneously affected equity valuations and demand for safe-haven currencies, consistent with prior evidence that the CHF appreciates during global stress episodes (Ranaldo and Söderlind, 2010). At lower frequencies, persistent coherence observed from 2022 onward aligns with macroeconomic normalization and re-pricing of monetary policy expectations, including the Swiss National Bank's post-2022 tightening cycle, which increased CHF sensitivity to international financial conditions. The phase dynamics indicate periods where CHF/USD leads stock market adjustments, reflecting flight-to-quality flows during risk-off events, and periods where equity markets lead, consistent with capital reallocations following market recoveries. The divergence between the two markets is notable: coherence with the Nikkei appears more synchronized and recurrent, reflecting Japan's integration into global financial risk cycles, whereas coherence with the SSE is more intermittent and concentrated at long horizons, in line with China's more regulated capital account and policy-driven market structure. Overall, the results reinforce that safe-haven currencies transmit global uncertainty to equity markets in both the short-run (through risk sentiment) and long-run (through macroeconomic and monetary channels), confirming the value of wavelet methods for uncovering multi-scale dependence patterns that conventional time-domain models may overlook (Torrence & Compo, 1998; Grinsted et al., 2004).

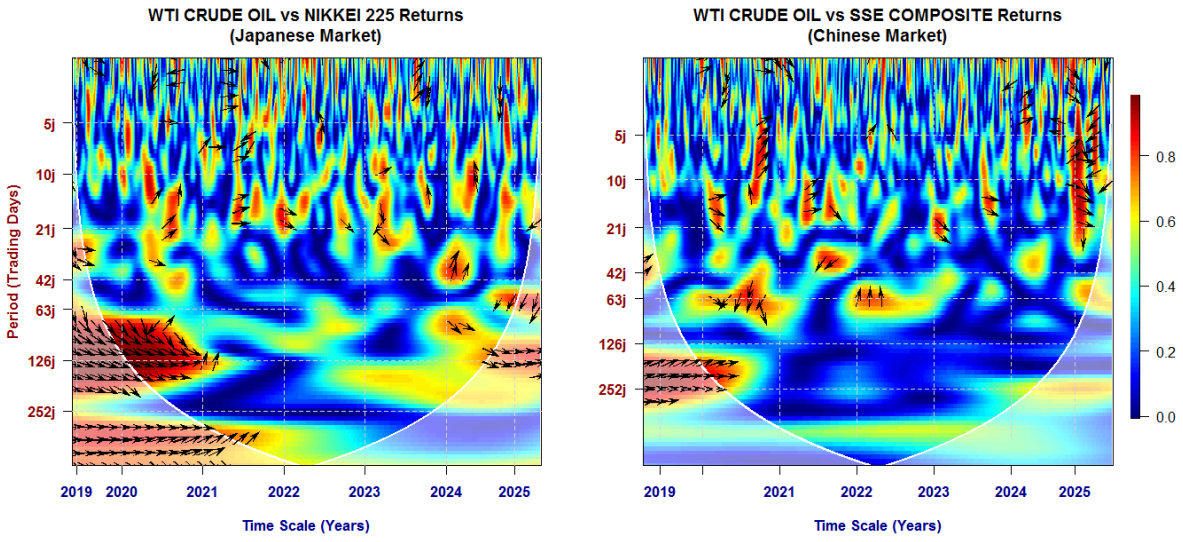


Figure 9. Wavelet coherence analysis: WTI crude oil volatility and stock markets

From Figure 9, wavelet coherence analysis between the WTI crude oil prices and the Japanese and Chinese stock markets exhibits a highly time-varying and multi-scale relationship. The time-varying features not only support but also improve the previous understandings of the oil-stock relation. The increased synchrony at different time scales during 2020-2022 can be attributed to the fact that financial markets are synchronized in large-scale global turmoil. This period of a pandemic and later geopolitical tensions served as a potent "risk-on/risk-off" phenomenon, where all asset classes simply marched in lockstep, ignoring more enduring fundamentals. The dominant phasing critical to oil price leading stock market downturns is also to be found in Kilian (2009) model, in which oil prices serve as a real-time indicator of world demand and a geopolitical risk measure of world aggregate demand. The early pandemic collapse, a huge negative demand shock for oil, and the 2022 price surge, a supply shock of particular magnitude driven by the Russia-Ukraine war, each occurred in front of adjustments in equity markets, emphasizing oil's role as a harbinger of economic downside.

This pattern shows significant differences from country to country. Indeed, as a mature resource-scarce economy, Japan exhibits classic importer sensitivity where higher oil prices signal lower corporate profits and stock returns. China's case, while also crisp at the height of the crisis, is fundamentally more diffuse given its dual status as a manufacturing powerhouse and a managed economy, in which state intervention and sectoral distinctions can shape the transmission channel. The resulting decrease in coherence beyond 2022 is an important result that illustrates the time-varying, transient aspect of this link. This “partial decoupling” represents a return to a regime in which country-specific fundamentals and policy responses mattered again more than all-sharing crisis sentiment. This trend can be attributed to two primary drivers identified in modern literature: converging/different monetary policies and the speeding-up energy transition. While the major global powers, such as the U.S., have been raising interest rates to cool inflation and China has been pushing stimulus, equity markets have reacted to a different set of macro factors, weakening the common signal from oil prices. At the same time, global diversification, strategic petroleum releases, and renewables may have contributed to an alteration in the long-run perception of vulnerability to oil price shocks. For investors, these results illustrate that the usefulness of oil prices as a predictor is strongest during crises. This suggests the value of this tactical leading indicator for rebalancing and hedging strategies, especially for those energy-importing nations. For policymakers, the result highlights that energy price shocks are a direct channel for financial instability and not just a cost-push inflationary worry. It highlights the need for dynamic risk management, macroprudential policies that are robust to cross-market contagion, and the role of buffers such as petroleum reserves in enhancing market resilience in the face of future global shocks.

To sum up, Japan is thus highly prone to all kinds of global shocks (financial volatility: VIX, geopolitical risk: GPR, safe-haven currency flow: JPY, CHF, and changes in U.S. macroeconomic expectations: T10Y3M, T5YIE). Such general sensitivity that can be observed in long-term movements requires devising strong risk hedging. Gold can still be such a tool. Nevertheless, investors in the Japanese stock market face larger risks of contagion from global volatility and therefore need to hedge this risk by investing in safe-haven assets such as gold (see Baur & Lucey, 2010). For policymakers, the Japanese context shows the significance of macroprudential regulation in cushioning external shocks, and that financial market feedback effects need to be vigilantly monitored, particularly in light of the two-way relationship with inflation expectations. This can entail building resilience in financial markets through hedging instruments and regional cooperation mechanisms. The relatively closed nature of China’s capital account and state dominance in its financial sector act as buffers against external volatility. Its synchronization with world shocks is the result of weaker, more selective, episodic, and often short-run shocks. While this insulation may reduce direct contagion from global risk and geopolitical risk, it may also reflect a distortion in the pricing of risk that ultimately results in inefficient allocation of capital. On the other hand, Chinese shares, while even more insulated, may offer diversification gains in global crises, given that they are less sensitive to volatility in the U.S. market, but at the expense of reduced efficiency in risk transmission and pricing. For the Chinese case, greater financial

liberalization might mitigate distortions and facilitate a more efficient channelling of capital in the face of external uncertainty, but it would also make the country more vulnerable to the very shocks from which it is now shielded. For all investors, the results highlight the importance of factoring in geopolitical risk and monitoring macroeconomic volatility when constructing portfolios, particularly for long-term investors who are most likely to benefit from coherence at the medium- to long-horizon. Failure to take into account this exposure might result in an underestimation of downside risks in times of extended international tensions, which, in turn, would lead to inferior risk-adjusted returns. Hedging options, such as including safe haven assets like gold or US Treasuries (Baur & Lucey, 2010; Bouri et al., 2017; Belkhir, 2025) in the diversification strategy, gain prominence in this regard, especially for portfolios invested in integrated markets such as Japan.

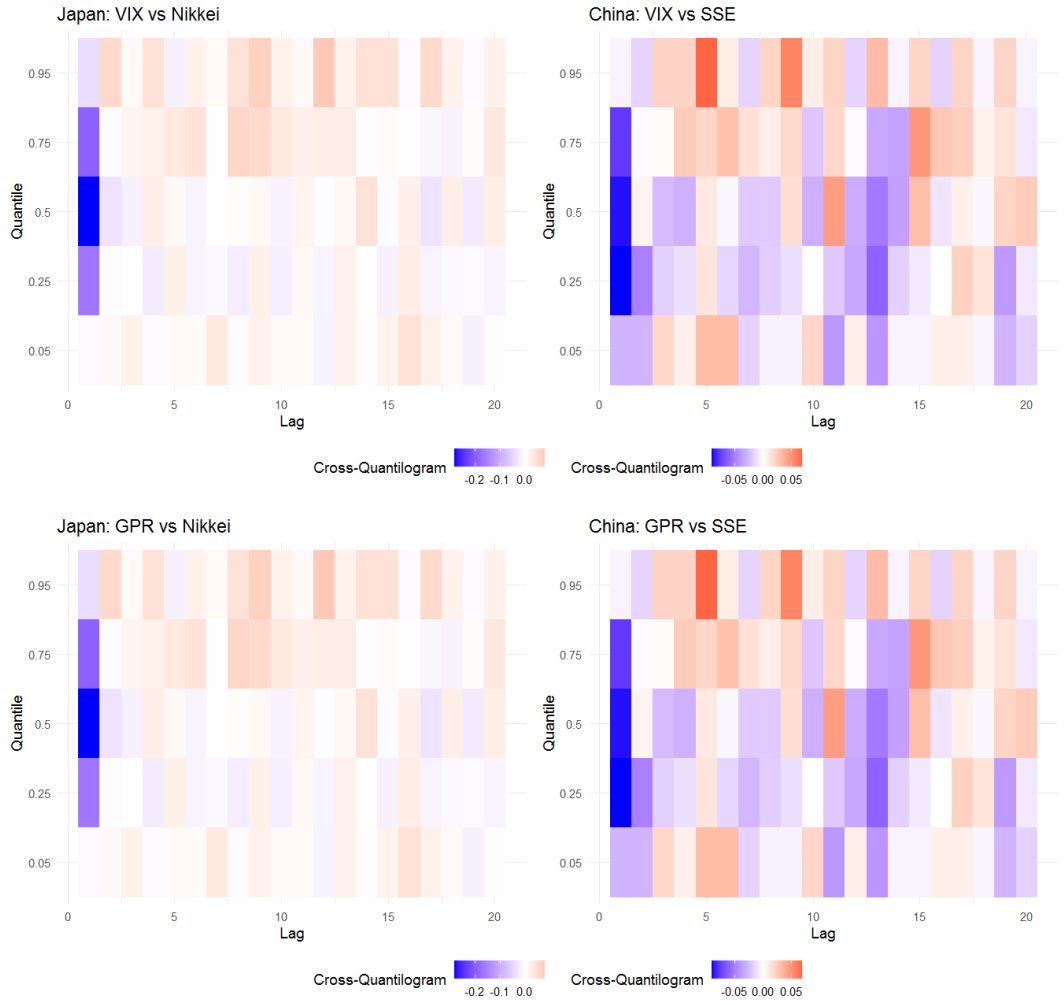
5. ROBUSTNESS CHECKS

To ensure the robustness of our empirical results, we perform a sensitivity analysis based on the cross-quantilogram methodology developed by Han & Lee (2016). This approach goes beyond conventional correlation analysis by estimating how factors predict stock returns at various quantile levels (Figures 10,11 and 12). The variances or volatilities have received a great deal of attention in the literature. We show that Japan's Nikkei takes on the character of a mature, fundamentals-based market, as China's Shanghai Stock Exchange (SSE) follows the track of a market where policy, market sentiment, and direct external shocks preponderate over pure economic forces. These contrasts hold for all four major themes: Macroeconomic fundamentals, risk sentiment, commodities, and currencies.

However, the largest difference emerges when considering the relationship between equity markets and broad macroeconomic variables. For the Japanese case, shocks to the term spread (T10Y3M) and to five-year inflation expectations (T5YIE) both predict Nikkei positively, significantly, and for a long time. This dependence is statistically significant for long periods (up to 15-20 lags) and is robust when considering different market states: with both bearish (lower quantiles) and regular (median) regimes. These results reinforce the view that the Japanese market is firmly tied to its home macro cycle and interpret the rising-slope yield curve and rising inflation expectations as signals of rising growth, which justify high equity valuations. Strikingly, China's SSE is still far away from any such traditional normalization. None of its term spread, expected inflation, and future stock returns are statistically significant; cross-quantilogram coefficients are around zero for all leads and lags for all quantiles. This confirms that the predictive information that such leading indicators embed is nullified under the Chinese financial system. The case has its grounding in the dominant role of policy mandates, regulatory capital controls, and retail investor sentiment, which, when taken together, dislocate the linkage between traditional fundamentals and equity performance.

Both markets are vulnerable to global factors, yet they display subtle differences in sensitivity to certain types of risk. Regarding volatility measured by VIX, both have significant negative correlation at lower quantiles (0.05–0.25) over short lags. This broad-based pattern implies that VIX systematically increases and predicts equity decreases in the future, emphasizing that the global risk-averse attitude is a major and shared cause of downside risk. But their response to Geopolitical Risk (GPR) is different. Japan has a very steep and narrow response function: the reaction to extreme GPR spikes is a strong negative dependence in the short run, predicting steep falls. This effect, however, is fleeting. China, by contrast, has a longer, more complex relationship. Despite showing negative dependence in crises, the effect lasts for longer horizons. Surprisingly, China exhibits sporadic positive dependence in high quantiles (0.75–0.95), which reveals that in rallies, high geopolitical risk would at times accompany or even lead to subsequent gains - a pattern possibly associated with speculative, risk-on trading or market overreaction, particular to its investor group.

The analysis also separates the two markets in terms of sensitivity to hard assets and currency volatility. The effect of Crude oil (WTI) on Japan is very low and irregular. This pattern reflects a mature and diversified economy with a significant buffer. However, for China, a major commodity importer, this relationship is strong and parametrically important if an investor aims to manage risk effectively. The heatmaps indicate strong negative correlations in the lower quantiles, which confirms that the volatility of oil prices serves as a dominant channel of tail risk linked tightly only with the SSE during the period of extreme market stress. We report the same pattern of Japanese rigidity and Chinese volatility in the currency realm. The JPY/USD and CHF/USD exchange rate changes have only mild, insignificant correlations with the Nikkei. For the SSE, currency shocks are direct, strong, and diverse, with high negative dependence for the lower tails.



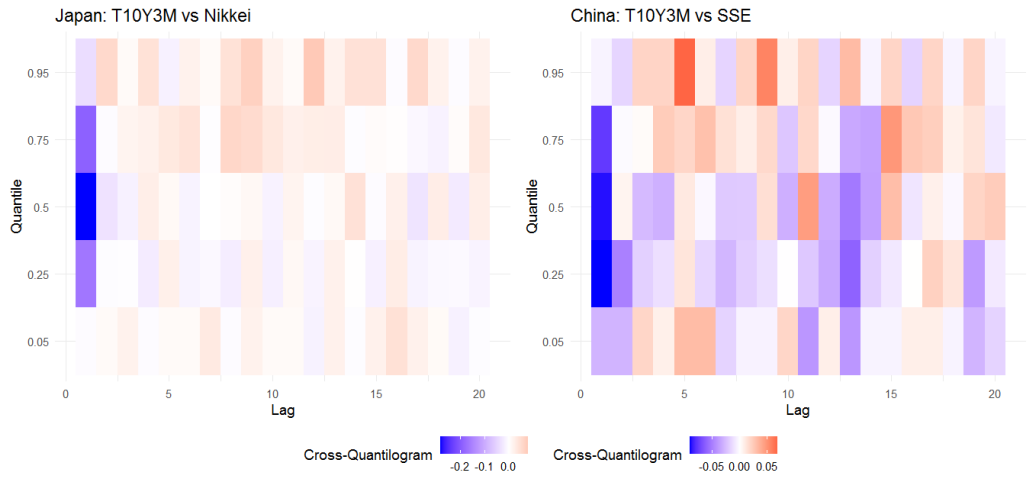
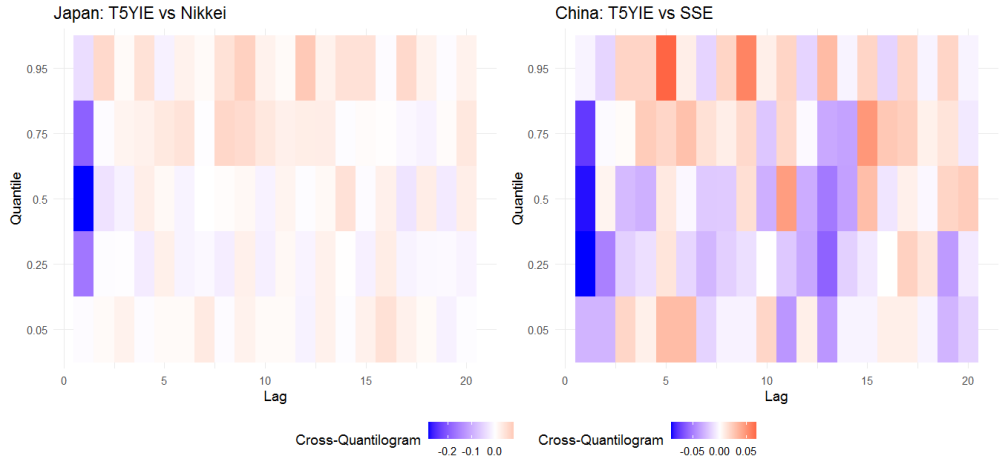
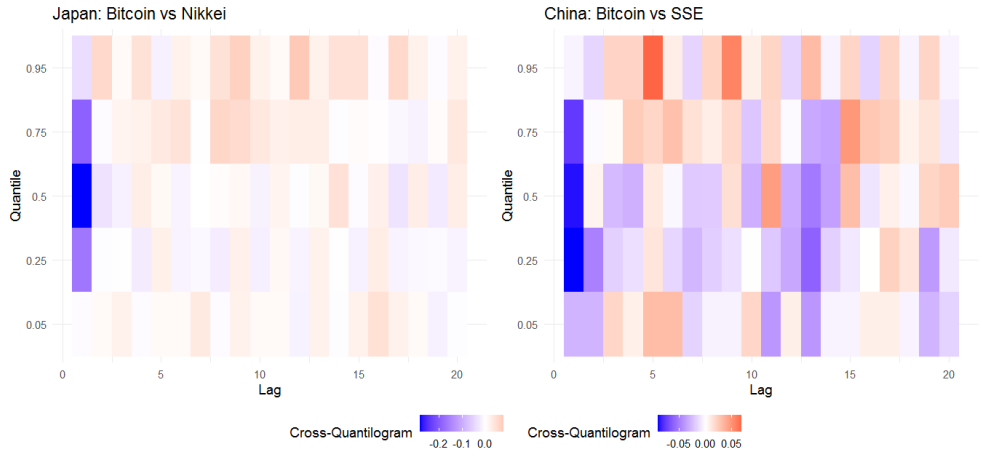


Figure 10. Cross-Quantilogram results for Japan and China.





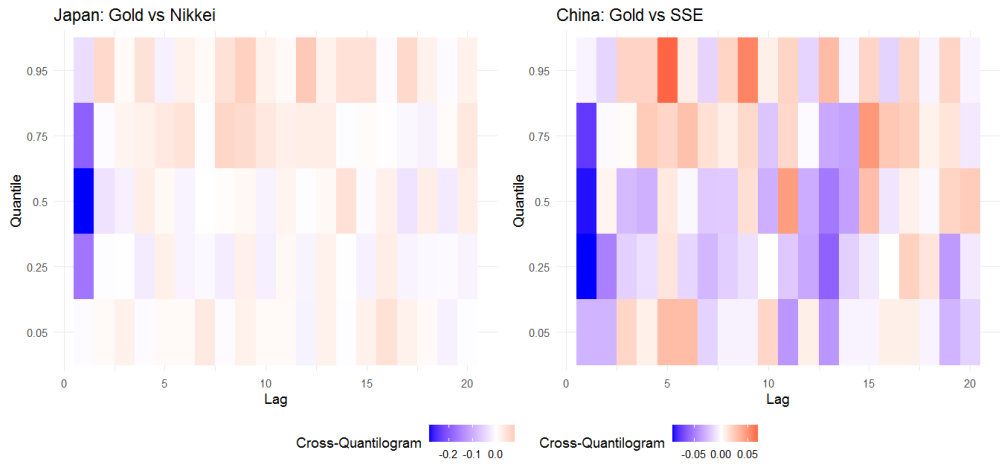
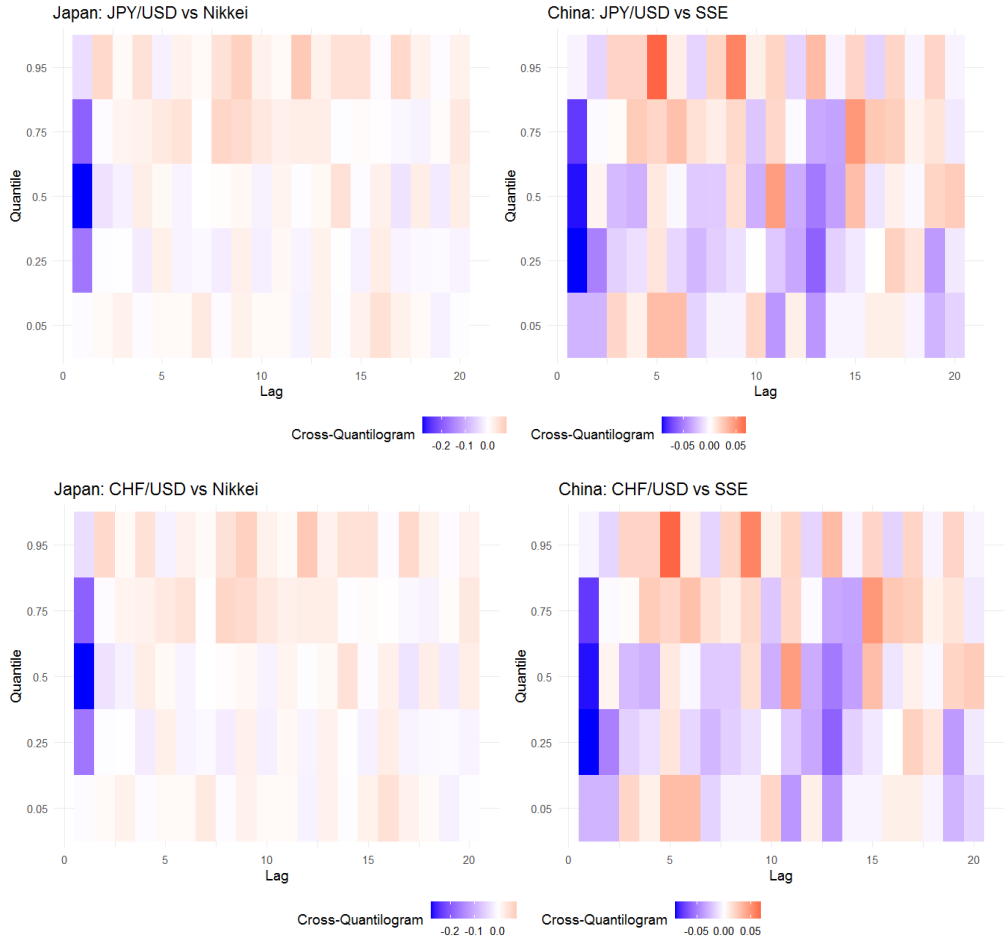


Figure 11. Cross-Quantilogram results for Japan and China (continued)



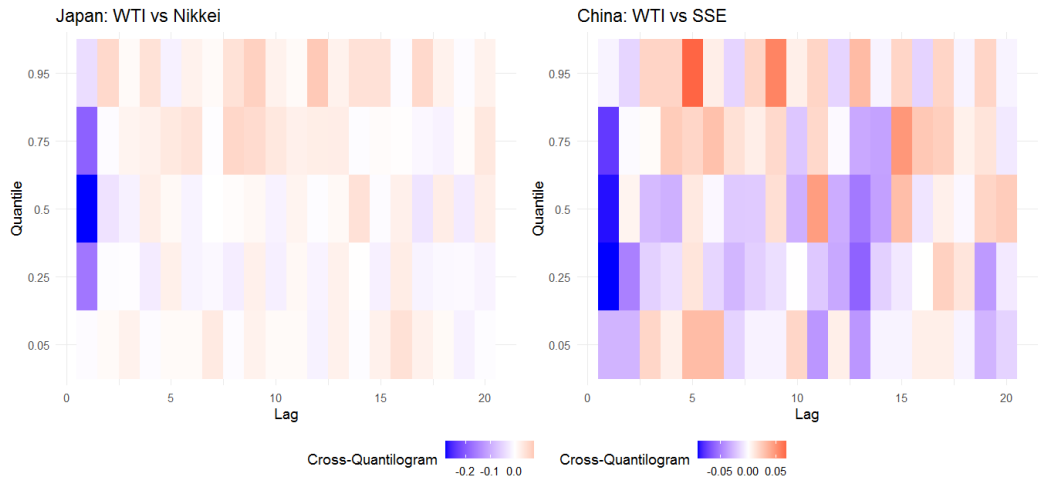


Figure 12. Cross-Quantilogram results for Japan and China (continued)

CONCLUSION

This paper attempts to analyze the volatility transmission processes between the world risk factors and the Japanese and Chinese stock markets. Based on a comparative wavelet coherence analysis, the findings indicate the basic duality of the two markets. Indeed, the deep financial integration of Japan as a developed, open economy keeps its market continuously synchronized with global financial volatility (VIX), geopolitical risk (GPR), safe-haven currency flows, and the U.S. Such pervasive sensitivity to the environment can only be countered by sophisticated, dynamic hedging. On the other hand, China's market, cushioned by capital controls and state interference, shows a vastly contrasting profile. Its synchronization with world shocks is weaker, more chaotic, and mostly temporary, often erupting only in the worst international trouble. While this seclusion insulates the market to a degree against contagion and allows for some diversification for global investors, it may do so by making risk mispricing and resource misallocation more extreme, since the market is at least partially insulated from vital global signals.

Afterwards, the robustness checks based on the Cross-Quantilogram analysis strengthen the results by revealing the lead–lag relations in quantiles and time scales. The findings suggest that the Japanese market is a well-behaved market where a mature model based on fundamentals could be constructed, and key macroeconomic indicators (term spread T10Y3M and five-year inflation expectations T5YIE) shocks significantly and positively predict the equity for the long run (for as many as 15–20 lags). This relationship also holds for bearish as well as normal market regimes, suggesting the tightly coupled nature of Japanese equity to the home country business cycle. However, the Chinese market appears to be completely disconnected from these macroeconomic variables, and the linkages are statistically insignificant, as policy dominance, regulatory constraints, and retail-driven sentiment obscure the predictive power of conventional fundamentals.

Overwhelmingly, both markets are found to be susceptible to periods of global risk aversion, with the VIX imposing a significant and systematic negative effect at the lower quantiles. This suggests a common downside risk exposure to global volatility jumps. While their reactions to geopolitical risk (GPR) differ significantly: Japan's is "strong, but sojourns in the transient", and China's response is described as "much stronger and long incense burner, seemingly more persistent on many time scales" and occasionally even becomes positive in bearish days, implying that some reactions could have speculative or sentiment-driven exaggerations. These asymmetries are also evident in the commodity and currency channels: oil price volatility (WTI) exposure does not amplify Japan's economic fluctuations much and is irregular, as would be expected of a diversified economy, while China's is a substantial oil volatility-driven tail risk magnifier and a key

contributor to tail risk in times of extreme stress. Similarly, currency shocks have a much larger and more varied effect on the SSE than on the Nikkei, underscoring the importance of exchange rate policy as a source of China's financial fragility.

Our empirical results offer many insightful implications for different stakeholders. For investors, holding Japanese equities requires strong hedging against global volatility spikes with traditional safe havens, while holding Chinese equities requires focusing on domestic policy drivers and knowing that the benefits of diversification are state- and crisis-dependent. For policymakers, the trade-offs are just as stark. Japan needs to put priority on macroprudential policies to strengthen the financial system against inevitable external shocks, while Chinese leaders are confronted with a stark choice between further financial liberalization, which would make the system more efficient but also more exposed to global volatility, and protecting existing buffers at the cost of market efficiency and risk transparency.

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