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THE SPILLOVER EFFECT OF NEGATIVE INTEREST RATE POLICY ON ASIAN STOCK MARKET

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Abstract: This article explores international spillover effect of negative interest rate policy (NIRP) on Asian stock market by GARCH model. The empirical findings reveal European Union NIRP spillover effect inclines to reduce conditional mean and enlarge conditional variance and the Japan NIRP spillover effect tends to increase conditional mean and contract conditional volatility. Specifically, the NIRP spillover effects are more compelling in Taiwan and Hong Kong stock markets. Our empirical findings for EU NIRP spillover effect agrees the NIRP will cut down the profitability of financial institutions and destabilize the financial market as Arteta, Kose, Stocker, and Taskin (2018). Contemporaneously, we find that JP NIRP spillover effect confirms the capital inflow effect of Asian market from Japan's financial sector as Fukuda (2017).

Keyword: Negative Interest Rate Policy, Spillover Effect, Stock Market, GARCH

1. INTRODUCTION

During central bankers break down the theoretic lower bound of interest rate, the short-term nominal policy rate drops into the negative domain. An unconventional monetary policy, negative interest rate policy (NIRP), triggers a heated debate over policy effectiveness and possible drawbacks. It is a crucial international issue while many countries, nearly one-third of the global national income, implement NIRPs. With little previous knowledge and academic researches for NIRP, a pure policy experiment initiates in a completely uncertain world. To contribute NIRP academic literatures, this article tries to bridge this divergent by checking NIRP effect on financial market, especially for Asian stock market.

The fundamental topics for NIRP commonly encompass the usefulness in accelerating economic recapture and the effect on financial system and market stabilization. Bech and Malkhozov (2016) and Jobst and Lin (2016) present a general descriptive expositions for operating enforcement and monetary transmission of NIRP. Angrick and Nemoto (2017) delivers a succinct review of limited earlier studies for NIRP. Other than above mentioned, the NIRP literatures utilize econometric analysis to uncover the regularity pattern beneath the datasets.

Comparing with monetary transmission, NIRP effect on financial market seems to largely ignore by the researchers. As a special case, Fukuda (2017) inspects the Japan NIRP spillover effect on Asian stock market by GARCH model. In the NIRP period, he documents Asian index return showing negative relationship with Japan's long-term interest rate and excess returns of Japan's finance sector. Because Japan's financial institutions lose their domestic profit, the Japan NIRP tends to benefit other Asian market by searching profitability in Asian market.

In this article, we use the GARCH model to simultaneously investigate the European Union and Japan NIRP spillover effects on Asian stock markets, including Taiwan, Hong Kong, Korea, and China. Due to the commonality of volatility clustering effect in financial market, it is the reason why we choose GARCH model here. In the standard GARCH specification, we model EU and JP NIRP spillover effects as two exogenously independent binary dummy variables for both conditional mean and conditional volatility equations. Likewise the volatility clustering, we also check robustness of NIRP spillover effect for Asian stock market in the environment of existing volatility asymmetric effect and fat-tailed effect.

The major empirical conclusions of this article shows that the European Union NIRP spillover effect inclines to decrease conditional mean and enlarge conditional variance and the Japan NIRP spillover effect leans to increase conditional mean and reduce conditional variance. Additionally, the NIRP spillover effects are more significant in Taiwan and Hong Kong stock markets, but not Korea and China stock markets. Our empirical findings about EU NIRP spillover effect affirms the NIRP will damage the profitability of financial sector and destabilize the financial market as previous conclusion of Arteta, Kose, Stocker, and Taskin (2018). Simultaneously, our empirical results about JP NIRP spillover effect supports the capital inflow effect of Asian market from Japan's financial sector as previous literature of Fukuda(2017). The remainders of this article organize as follows. Section 2 depicts the data, empirical design, and empirical model. Section 3 presents empirical results and discusses finding implications for NIRP spillover effect. Also shows the robustness check. Section 4 concludes this research.

2. DATA AND METHODOLOGY

2.1. Data and Empirical Design

This paper investigates the NIRP spillover effect on Asian stock market, including Taiwan, Hong Kong, Korea, and China. Following the convention, we use the market index to present the whole stock market, TAIEX (Taiwan Capitalization Weighted Stock Index) for Taiwan stock market, HSI (Hang Seng Index) for Hong Kong stock market, KOSPI (Korea Composite Stock Price Index) for Korea stock market, and SHSZ300 (Shanghai Shenzhen CSI 300 Index) for China stock market.

There are five policy enforcement entities executing NIRP that is Denmark, Euro Area, Switzerland, Sweden, and Japan. Although the Denmark, Switzerland, and Sweden have independent monetary policy, their domestic financial markets have integrated into the whole market of European Union. As Bekaert, Harvey, Lundblad, and Siegel (2013) suggest the EU membership, not adoption of Euro, increases the integration degree among financial markets. When we consider the possible NIRP effect from policy enforcement entity spillover into Asia stock market, we treat four EU members as one policy enforcement entity based on above arguments. As a result, we check the NIRP spillover effect from EU and Japan into Asian stock market.

The well-known volatility clustering effect describes a stylized phenomenon that is market volatility tends to largely reacting to huge variation and slightly reacting to tiny variation. The pervasive volatility clustering effect in financial market has led the popularity of GARCH model in empirical finance research. Since we intends to evaluate the possible variation of market volatility by introducing NIRP, the GARCH is a natural choice for our situation. The empirical work of this study inspects the NIRP spillover effect for mean return and conditional volatility at the same time on four Asian market indexes.

Under the structure of GARCH model, we use dummy variable to setup the NIRP spillover effect. The NIRP spillover dummy is defined as a binary indicator variable that is zero before the policy implementation date and one after the policy implementation date. We only regard the NIRP spillover effect originating from EU and Japan, we use two dummy variables to specify such situations. The EU NIRP dummy variable differentiates the absence and presence of NIRP at June 11, 2014 and the JP NIRP dummy variable distinguishes at February 16, 2016.

Because of modeling strategy for dummy variable, the sample periods have to encompass the period before and after the NIRP enforcement date. The history of NIRP execution is short and the fresh information for NIRP is essentially very restricted. Using the lengthy sample period will increase the sample size, therefore the degrees of freedom in parameter estimation. By pushing the starting date of sample period farther back, we get larger sample size and more non-fresh information for NIRP event. If so, the non-fresh information will dilute the fresh information. To preclude such detrimentally informational dilution effect, we conservatively select the starting date of sample period, May 20, 2011, to balance the periods before and after the NIRP policy event.

On the basis of trading day in Gregorian calendar, the trading days in the period between May 20, 2011 and June 10, 2014 are the same as the period between June 11, 2014 (EU NIRP execution date) and June 30, 2017. In this article, we define the sample period of empirical analysis is from May 20, 2011 to June 30, 2017. The trading days in various market are somewhat different. However the trading days before EU NIRP enforcement date reported in Panel A of Table I is almost the same as those after EU NIRP implementation date reported in Panel B and Panel C of Table I. Taking TAIEX as an example, the trading days before EU NIRP execution, 722, is close to those after EU NIRP implementation, 724 (397 plus 327).

All the data series used in this article is on the daily basis and collected from Taiwan Economic Journal (TEJ) database. Table I summarizes the descriptive statistics and sample observations of individual subsample and full sample for four Asian stock market indexes. Panel A of Table I reports the figures of subsample before EU NIRP introducing. Panel B of Table I presents the numbers of subsmaple after EU NIRP event and before JP NIRP event. Panel C of Table I shows the statistics of subsample after JP NIRP enforcement. At last, Panel D of Table I documents the distributional characteristics of full sample.

Table I reveals the common distributional characteristic is highly volatility relative to mean return for all subsamples and markets in all panels. Moreover, the kurtosis is consistently larger than 3, although the skewness is relatively small. It implies the fat-tailed empirical distribution for Asian stock market indexes and fat-tailed risk in normal error assumption for GARCH model. We will handle this problem by using heavy-tail t-distribution assumption for GARCH model in robustness check.

2.2. Empirical Model

Engle (1982) introduced Autoregressive Conditional Heteroskedasticity (ARCH) model to handle the time-varying conditional heteroskedastic problem in the time series analysis. And Bollerslev (1986) extended the ARCH

Table I
Descriptive Statistics for Asian Stock Market Indexes

	Panel A. May/20/2011 ~ Jun/10/2014				*Panel B. Jun/10/2014 ~ Feb/15/2016*			
	TAIEX	*HSI*	*KOSPI*	*SHSZ300*	*TAIEX*	*HSI*	*KOSPI*	*SHSZ300*
AV	0.0022	0.0004	-0.0025	-0.0216	-0.0146	-0.0228	-0.0085	0.0328
SD	0.4516	0.5283	0.5068	0.5676	0.4151	0.5525	0.3540	0.9633
Skew	-0.3631	-0.3478	-0.4565	0.1329	-0.2982	0.0968	-0.0636	-0.9991
Kurt	6.0118	5.5111	7.1617	4.8100	5.7918	7.1532	4.4832	6.0631
Obs	722	718	716	740	397	399	396	410
	Panel C. Feb/16/2016 ~ Jun/30/2017				*Panel D. May/20/2011 ~ Jun/30/2017*			
	TAIEX	*HSI*	*KOSPI*	*SHSZ300*	*TAIEX*	*HSI*	*KOSPI*	*SHSZ300*
AV	0.0337	0.0411	0.0333	0.0282	0.0047	0.0032	0.0040	0.0047
SD	0.3115	0.4064	0.2814	0.3982	0.4137	0.5106	0.4248	0.6725
Skew	-0.3519	-0.3038	-0.5569	-0.6523	-0.3744	-0.2182	-0.4610	-0.7611
Kurt	5.3724	4.5447	6.3195	11.6674	6.2682	6.2441	8.1051	8.4183
Obs	327	326	326	337	1446	1443	1438	1487

The AV, SD, Skew, Kurt, and Obs denote mean, standard deviation, skewness, kurtosis, and observations for stock index return series. Panel A, B, and C report descriptive statistics coming from subsample before EU policy event, subsample after EU policy event and before JP policy event, subsample after JP policy event, and full sample.

model (GARCH) and became the standard model for volatility clustering problem. The ARCH/GARCH model presented a parsimonious model that are extensively applied to analyze and forecast the conditional volatility and continuously generalized to deal with new stylized phenomenon in volatility.

In this article, we utilize the GARCH model with exogenous NIRP spillover dummy to appraise the possible effect of mean return and conditional variance for Asian stock market indexes. We use a GARCH(1,1) with NIRP spillover dummies both in mean equation and variance equation as benchmark model, Model I.

Mean equation: $y_t = \alpha_M + \omega_M^{EU} D_t^{EU} + \omega_M^{JP} D_t^{JP} + \varepsilon_t$ (1.1)

Variance equation:

$$\sigma_t^2 = \alpha_V + \beta\varepsilon_{t-1}^2 + \gamma\sigma_{t-1}^2 + \omega_V^{EU} D_t^{EU} + \omega_V^{JP} D_t^{JP} \tag{1.2}$$

Where y_t is the conditional mean return of testing stock index at time *t*, σ_t^2 is the conditional variance for return of testing stock index at time *t*, D_t^{EU} is the EU NIRP spillover dummy at time *t*, and D_t^{JP} is the JP NIRP spillover dummy at time *t*. For mean equation, α_M is the constant term, ω_M^{EU} is the coefficient of D_t^{EU} term, ω_M^{JP} is the coefficient of D_t^{JP} at time *t*, and ε_t is the market shock at time *t*. For variance equation, α_V is the constant term, β is the coefficient of squared market shock at time *t*-1, γ is the coefficient of conditional variance at time *t*-1, ω_V^{EU} is the coefficient of D_t^{EU} term, and ω_V^{JP} is the coefficient of D_t^{JP} at time t. Assume ε_t follows the normal distribution. The estimation result of Model I reports at Table II in section 3-1 and conclude the basic conclusion for NIRP spillover effect.

Besides volatility clustering effect, there is another widespread leverage effect or volatility asymmetric effect. The volatility asymmetric effect refers to the market volatility responding to bad news exceeds over responding to good news in the financial market. It is an issue beyond ignored, we follows the modeling strategy of the benchmark model by adding the NIRP spillover dummies into both equations of Threshold GARCH model proposed by Zakoian (1994). Model II as follows.

Mean Equation: $y_t = \alpha_M + \omega_M^{EU} D_t^{EU} + \omega_M^{JP} D_t^{JP} + \varepsilon_t$ (2.1)

Variance Equation:

$$\sigma_t^2 = \alpha_V + \beta\varepsilon_{t-1}^2 + \lambda\varepsilon_{t-1}^2 I_{t-1} + \gamma\sigma_{t-1}^2 + \omega_V^{EU} D_t^{EU} + \omega_V^{JP} D_t^{JP} \tag{2.2}$$

Where $I_{t-1} = 1$ if $\varepsilon_{t-1} < 0$ and 0 otherwise.

Moreover, there is another famous problem regarding fat-tailed risk for model selection in the empirical research of financial market. To address such issue, we re-estimate the TGARCH model with NIRP spillover dummies in both equations by t-distribution error assumption, as Model III. For the reason that Model III is the same as Model II, we omits the redundancy reporting here. Table III and Table IV summarize the empirical results of Model II and Model III in the section 3-2.

3. EMPIRICAL RESULTS

3.1. Benchmark Model

Table II summarizes the empirical results of the benchmark Model I. In addition to endogenous variables of GARCH model, Table II tabulates the estimated coefficients of NIRP spillover dummies and the marginal significance level to reject the hypothesis NIRP dummy is different from 0. We focus on interpreting and analyzing the NIRP spillover dummy variables here. All of Asian stock market indexes cannot show statistical significance on NIRP effect of conditional mean, except for EU NIRP effect transmitting to SHSZ300 index at 95% significance level. Albeit the statistical evidence failed, the EU NIRP spillover effect on conditional mean tends to negative and JP NIRP spillover effect on conditional mean tends to positive in four Asian stock market.

Conversely, the NIRP spillover effect prevalently demonstrate on conditional volatility of Asian stock market at the statistical significance meaning. The EU NIRP spillover effect shows positively statistical significance in the three indexes, 90% for TAIEX, 90% for HSI, and 95% for SHSZ300, out of four Asian stock markets. Concurrently, the JP NIRP spillover effect presents negatively statistical significance for all of four indexes, 95% for TAIEX, 99% for HSI, 95% for KOSPI, and 99% for SHSZ300, in Asian stock markets. The basic empirical results show that EU NIRP spillover effect increases the conditional volatility and destabilizes Asian stock market. As well as JP NIRP spillover effect reduces the conditional variance and stabilizes Asian stock market.

Putting both equations together, the NIRP enforcement of European Union tends to reduce the conditional mean return and enhance the conditional variance in the Asian stock market. Contrarily, the NIRP execution of Japan tends to increase the conditional mean return and decrease the conditional volatility of four Asian stock market indexes. This contradiction seems to imply the different nature between EU NIRP effect and JP NIRP effect on Asian stock market. As Fukuda(2017) suggests that Japan's financial institutions looks for foreign profitability in Asian market, replacing with domestic investment opportunities, after Japan's NIRP introducing. Our results for Japan NIRP spillover effect support the capital inflow effect on Asian market and obey the conclusion of Fukuda(2017).

However, the EU NIRP spillover effect take contrarily direction with JP NIPR spillover effect and tends to reduce the conditional mean and increase the conditional variance. Since the European financial institutions may not search lucrative investment chance over Asian market, the EU NIRP tends to signal the informational effect of expected underperformance for European financial institutions rather than the capital inflow effect on Asian market.

Table II
NIRP Spillover Effect on Conditional Mean and Conditional Variance

		TAIEX		*HSI*		*KOSPI*		*SHSZ300*	
		Coef.	*Prob.*	*Coef.*	*Prob.*	*Coef.*	*Prob.*	*Coef.*	*Prob.*
C. M.EQ	α_M	0.0202	0.13	0.0114	0.52	0.0059	0.69	-0.0198	0.33
	ω_M^{EU}	-0.0263	0.28	-0.0091	0.77	-0.0073	0.75	0.0852	~~0.04~~
	ω_M^{JP}	0.0403	0.12	0.0323	0.33	0.0289	0.22	-0.0408	0.31
C. V.E.Q.	α_V	0.0015	0.01	0.0027	0.01	0.0053	0.00	0.0050	0.00
	β	0.0457	0.00	0.0391	0.00	0.0738	0.00	0.0414	0.00
	γ	0.9443	0.00	0.9498	0.00	0.8944	0.00	0.9454	0.00
	ω_V^{EU}	0.0010	0.06*	0.0012	0.10*	-0.0004	0.63	0.0035	~~0.04~~
	ω_V^{JP}	-0.0015	~~0.01~~	-0.0025	0.00	-0.0019	~~0.02~~	-0.0073	0.00

The parameters please refer to Model I. The sample period is full sample on Table I. Coef is the estimated coefficient and Prob is the p_value of univariate t test for testing estimated coefficient different from 0. Underlined figure, strikethrough figure, and star signed figure stands for significance level at 1%, 5%, and 10%.

3.2. Robustness Check

There is a category of asymmetric model in GARCH family to handle with asymmetric volatility effect in equity market. The widespread asymmetric volatility phenomenon shows that there are higher market volatility levels following market downturns than following market upturns with the same size. If we do not consider such phenomenon, it will misidentify the possible NIRP spillover effect in Asian equity markets. We use model II to address this concern and report the estimation results in Table III.

The asymmetric volatility effect is statistically significant, 99% for TAIEX, 99% for HSI, 99% for KOSPI, and 90% for SHSZ300, in all four Asian stock markets. With more statistical significant evidence, the EU NIRP and JP NIRP spillover effects present statistical significance at 90% level both in the conditional mean and volatility equations for Taiwan stock market. Furthermore, the EU NIRP and JP NIRP spillover effects in conditional volatility is still statistically significant in Hong Kong and China stock markets. Controlling for the asymmetric volatility effect, the pattern of EU NIRP and JP NIRP spillover effect is mostly the same as the empirical results for benchmark model in the Taiwan, Hong Kong, and China stock markets. On the other hand, the Korea market has not any NIRP spillover effect coming from European Union or Japan.

Table III
NIRP Spillover Effect with Asymmetric Volatility Effect on Equity Market

		TAIEX		*HSI*		*KOSPI*		*SHSZ300*	
		Coef.	*Prob.*	*Coef.*	*Prob.*	*Coef.*	*Prob.*	*Coef.*	*Prob.*
C. M.EQ	α_M	0.0136	0.29	-0.0031	0.84	-0.0028	0.84	-0.0227	0.27
	ω_M^{EU}	-0.0387	0.07*	-0.0057	0.84	-0.0114	0.60	0.0894	~~0.04~~
	ω_M^{JP}	0.0474	0.06*	0.0330	0.33	0.0352	0.13	-0.0442	0.29
C. V.EQ	α_V	0.0014	0.00	0.0017	0.00	0.0041	0.00	0.0060	0.00
	β	-0.0252	0.00	-0.0251	0.00	-0.0123	0.14	0.0326	0.00
	λ	0.0910	0.00	0.0601	0.00	0.1092	0.00	0.0170	0.05*
	γ	0.9664	0.00	0.9848	0.00	0.9277	0.00	0.9422	0.00
	ω_V^{EU}	0.0010	0.06*	0.0022	0.00	-0.0001	0.89	0.0048	~~0.01~~
	ω_V^{JP}	-0.0014	~~0.01~~	-0.0034	0.00	-0.0010	0.11	-0.0092	0.00

The parameters please refer to Model II. The sample period is full sample on Table I. Coef is the estimated coefficient and Prob is the p_value of univariate t test for testing estimated coefficient different from 0. Underlined figure, strikethrough figure, and star signed figure stands for significance level at 1%, 5%, and 10%.

As shown in Panel D of Table I, the kurtosis of empirical distribution, from 6.24 of HSI to 8.42 of SHSZ300, reveals the leptokurtic distribution for Asian stock markets. To account for fat-tailed risk in Asian stock market, we re-estimate the Model II, standard TGARCH with NIRP dummy, by havey-tailed t-distribution. The Table IV documents the estimation results of heavy-tailed TGARCH with NIRP dummies.

Comparing Table IV with Table III, the asymmetric volatility effect is still pervasive in all four Asian stock markets under statistical significance meaning. The JP NIRP spillover effects, positive conditional mean and negative conditional volatility, exhibit statistical significance at 90% level in both equations for Taiwan and Hong Kong stock markets. The EU NIRP spillover effects, negative conditional mean and positive conditional variance, display statistical significance at 90% level in both equations for Taiwan stock market and in variance equation for Hong Kong stock market. Otherwise, there is not any NIRP spillover effect on Korea market.

Given the asymmetric volatility effect and fat-tailed distribution effect, the Taiwan and Hong Kong stock markets, but not Korean and China stock market, show the EU NIRP and JP NIRP spillover effects. There is still one point should be noted about China stock market. The EU NIRP and JP NIRP spillover effects on SHSZ300 index does not obey the pattern of Taiwan and Hong Kong stock market. As noted by Fukuda(2017), the outstanding development of China has been improving the importance of China in Asia. After the global financial crisis, China seems to be the stock market with informational spillover into the other Asian stock market rather than the market accepting the informational shock from Japan stock market.

Table IV
NIRP Spillover Effect with Fat-tailed Distributional Effect on Equity Market

		TAIEX		*HSI*		*KOSPI*		*SHSZ300*	
		Coef.	*Prob.*	*Coef.*	*Prob.*	*Coef.*	*Prob.*	*Coef.*	*Prob.*
C. M. EQ	α_M	0.0235	0.06*	0.0130	0.39	0.0061	0.65	-0.0369	~~0.05~~
	ω_M^{EU}	-0.0366	0.08*	-0.0259	0.35	-0.0127	0.53	0.1402	0.00
	ω_M^{JP}	0.0439	0.06*	0.0559	0.07*	0.0309	0.14	-0.0834	~~0.02~~
C. V. EQ	α_V	0.0011	~~0.01~~	0.0023	0.01	0.0052	0.00	0.0135	0.00
	β	-0.0248	~~0.02~~	-0.0152	0.07*	-0.0143	0.21	0.0171	0.22
	λ	0.0827	0.00	0.0715	0.00	0.1258	0.00	0.0469	~~0.02~~
	γ	0.9705	0.00	0.9658	0.00	0.9171	0.00	0.9271	0.00
	ω_V^{EU}	0.0010	0.08*	0.0029	0.01	-0.0006	0.61	0.0065	0.15
	ω_V^{JP}	-0.0014	~~0.02~~	-0.0041	0.00	-0.0015	0.14	-0.0162	0.01

The parameters please refer to Model III. The sample period is full sample on Table I. Coef is the estimated coefficient and Prob is the p_value of univariate t test for testing estimated coefficient different from 0. Underlined figure, strikethrough figure, and star signed figure stands for significance level at 1%, 5%, and 10%.

As last, the robustness check over asymmetric volatility effect and fat-tailed distributional effect in this section give the evidence to the generality of our main conclusions in this article. Therefore, the EU NIRP and JP NIRP spillover effects demonstrate contrary effect and simultaneously present in Taiwan and Hong Kong stock market.

4. CONCLUSION AND DISCUSSION

This article examines the European Union NIRP spillover effect and Japan NIRP spillover effect on four Asian stock markets, including Taiwan, Hong Kong, Korea, and China. Using the GARCH model, we find that EU NIRP spillover effect tends to reduce conditional mean and amplify conditional variance and JP NIRP spillover effect inclines to increase conditional mean and contract conditional variance. As well as the NIRP spillover effects are more pronounced in Taiwan and Hong Kong stock markets, but not Korea and China stock markets.

Our finding on JP NIRP spillover effect largely supports the capital inflow effect on Asian stock market and confirms the previous literature of Fukuda(2017). Since the spillover effects are more noticeable in Taiwan and Hong Kong market, this point implies the most significant pattern of capital inflow to Taiwan and Hong Kong from Japan's financial sector. However, the EU NIRP spillover effect tends to contract the average market return and amplify the market volatility. Since the capital inflow effect on Asian stock market seems not to show in European financial institutions, the EU NIRP tends to signal the informational content that is expected profit shrinkage of European financial institutions and destabilizing effect on European financial markets. The empirical findings on EU NIRP spillover effect obey the conclusions of previous literature of Arteta, Kose, Stocker, and Taskin (2018).

There is an interesting issue about European financial institutions. Whether they search over foreign profitable investment opportunities in the market near Europe, as the Japan's financial sector. For example, the other European countries those are not in the Euro area and without implementing NIRP or the emerging markets those are located in the area of Middle East and North Africa. Moreover, the NIRP spillover effect on above mentioned markets is the future research topic in negative interest rate policy study.

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