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AN ANALYSIS FOR UNIT ROOT TESTING OF EMERGING ASIAN EQUITY MARKETS

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ABSTRACT:

The present research article examined the descriptive statistics and unit-root among Asianequity markets. Present study has used daily closing price for 09 stock indices from Asian region over the period from 03 January 2003 to 31 August 2018. As the test of summary statistics and unit root are more sensitive towards the duration of the crisis period, underlying study has taken as the period of GFC (Global Financial Crisis) from 1 August 2007 to 31 March 2009; for ESDC (European sovereign debt crisis) from 02 May 2010 to 09 June 2013 and the rest of the period is considered as the post crisis period until the end date of the data collection. Present investigation helps to realize the detailed features and stationarity in the sample time-series data. The conclusive results of descriptive statistics and unit root are concerned, the lowest returns are to be found in Taiwan stock exchange but highest returns are found in various markets, say, Pakistan, Indonesia and Malaysia. Secondly, the highest volatility is found mostly in Chinese, Indian and Pakistanis stock exchanges. The lowest volatility found in Malaysian stock exchanges in all sample periods and structural breaks. So far stationarity is concerned, all the sample time periods show stationarity at first difference. Present study also establish relevant information for investors, policymakers, researchers and hedgers for future and further analysis with emerging financial modelling.

1. INTRODUCTION:

In this complex and highly integrated market scenario, allocation of the funds to different asset classes as well as financial risk managements became a debatable topic for the financial along with the non-financial persons. Over the period of financial crisis (spread of financial contagion), when the major risk management model does not work or fall to identify a well-diversified portfolio, it became a serious headache for the fund managers, policy makers including the retail investors at all. The diversification behaviours of the international investors are strongly influence by the following four factors: more liberalized government regulation (for example Eurozone), increasing awareness among the investors about the benefits of cross border diversification, continuous increase in establishment of new Multinational Companies (MNCs) and well established computer technology, which help to disseminate the information quickly and creates more flexibility to the global trading platform (Eun and Resnick, 2010). In otherward frequent liberalization of cross border investment and trade (i.e. import and export) policies, increasing communication and transportation facilities in the global markets helps to create a strong integration among the global financial markets (Khositkulporn, 2013).

1.1 A short overview on crisis events:

The annual percentage of world real Gross Domestic Product (GDP) growth was maximum for 2007 (i.e. 5.6%) since 2000. In addition to that, the percentage of annual growth rate for the global emerging markets (i.e. 8.5%) was significantly higher than the global advance economy (i.e. only 2.7%) for 2007. Over the period of global recession the annual growth rate of the world GDP reduce to 3 percent for 2008 and (-0.1) for 2009, again it returned to its track during 2010 with 5.4 percentage of annual growth rate. Although the global emerging economies were affected due to the global recession, but recovered very quickly compare to global advance economies and reported annual growth rate 7.4 percentage for 2010, which is more than 2.6 times of 2009 growth rate and approximately 3 percent higher to 2008 growth rate. Over the period of European debt crisis the world GDP growth rate are approximately consistence with the rate of 2010.

1.2. Global Financial Crisis (GFC):

Although the Global Financial Crisis started its journey from August 2007, it came to the peak on mid-September 2008, after the collapse of major financial institution from USA. Due to this incidents, the annual growth rate sharply decreased for 2008 but did not reported negative for any of the global regional markets except North America (i.e. -0.1%). But the annual growth rate was subsequently low even if it was negative for Europe (-4.8%), North America (-3%) and overall global advance economies (-3.4%). Regional as well as the global annual growth rate had started to grow from 2010, where the recovery rate was highest for Middle East followed by Asian and Pacific region over the period from 2009 to 2010. The real GDP growth rate was subsequently high for Asian and Pacific region for 2007 (i.e. 8.6%) and it continued to stand as the high growth region worldwide and the growth rate was (always) more than five percentage (except for 2009) over the period from 2007 to 2018.

1.3. European Sovereign Debt Crisis (ESDC):

Followed by the Global Financial Crisis, at the end of first quarter 2010, European sovereign debt crisis again started to spoil the worse economy condition of the Eurozone countries. Eurozone is basically known as a monetary union, as a single currency for all the Eurozone members. But on other hand each individual country having its own fiscal structure i.e. different by the structure of tax and fiscal expenditures. Major fiscal problem, political

imbalance and downgrade of sovereign bond rating was the prime elements of ESDC. According to Suh (2015), although the ESDC started in form of fiscal crisis within the Euro area, with the span of time it became a financial crisis and significantly affected the Eurozone economies as well as the other economy globally. At the beginning of 2009, Greece became the center of ESDC. The government bond yield significantly increased at the end of October 2009, Fitch downgrade the sovereign debt from A to (-A) and Greece reported its revised budget deficit 12.7 percentage of GDP which was the twice of previous estimates for 2009 (Papavassiliou, 2014). The 10-year government bond yield of Greece stood at 9.51 points for May6 2010 and increased exponentially after the declaration of Greece government bond rating downward and stood at maximum point on 8th March 2012 at 39.85. Similarly, Portugal bond yield touched the peak at the end of January 2012 (i.e. 17.36); Spain 7.56 on 18th February 2011, Ireland 14.45 on 18th July 2011 and Italy 7.29 on 25th November 2011.

2. LITERATURE REVIEW:

A glut literature[1] on empirical explanation(Chopra and Bessler, 2005; Easwaran and Ramasundaram, 2008; Elumalai et al., 2009; Kumar and Pandey, 2010; Kumar and Pandey, 2011; Mukherjee, 2011; Sehgal et al., 2012; Kumar and Pandey, 2013; Malhotra and Sharma, 2013; Ravi, 2013; Aggarwal et al., 2014; Shakeel and Purankar, 2014; Vasantha and Mallikarjunappa, 2015; Gupta and Varma, 2016; Inani, 2017; Agrawal et al., 2019)are already existed which relates the financial time-series. Out of the vast literature on unit root and descriptive statistics with a large variety of financial asset markets and methodology, the scope of this present study is outlined on the summary statistics and unit root among the global stock markets. The objectives of the present research articles are:

1. To examine the basic features of the sample time-series.
2. To test the stationarity in International equity markets.

3. DATA AND RESEARCH METHODOLOGY:

The present study identifies the specific lengths of GFC and ESDC on the basis of major economic and financial events (economic approach), and by paying specific attention to longer crisis periods. Firstly, we analyzes the dates of financial event published by the official sources i.e. the Bank of International Settlements, the Luther institute at Wharton and Federal Reserve Board for the GFC and European Central Bank[2]. By following the official timeline, the GFC can be divided into four phases; from 1st August, 2007 to 15th September, 2008, from 16th September, 2008 to 31st December, 2008, from 1st January, 2009 to 31st March, 2009 and 1st April, to 1st November, 2009. The sample countries are selected as per the classification done by World Bank.

Table 3.1: List of Sample Markets and Respective Code

China	Shanghai SE Comp.	SHCOMP
India	India BSE 100	BSE100
South Korea	KOSPI	KOSPI
Taiwan	Taiwan SE Weighted	TWSE
Malaysia	KLCI Comp.	FBMKLCI
Thailand	Bangkok SET	SET

[1]Details of the past literature is available on demand by corresponding author.

[2] The ECB timeline is available at: http://www.ecb.int/ecb/html/crisis.en.html. The Reuters timeline can be found at: http://www.reuters.com/article/2010/08/25/eurozone-crisis-events-idUSLDE67O0YD20100825.

Indonesia	Jakarta SE Comp.	JCI
Philippines	PSEI	PCOMP
Pakistan	Karachi SE 100	KSE100

To begin with, descriptive statistics has been calculated for both the variables under study by taking the natural log for both the sample time-series. Descriptive statistics abridge a set of descriptive coefficients in advantageous way to simplify interpretation of data. Then Unit Root (ADF and PP) testhave been applied for further research work.

3.1.Augmented Dickey-Fuller (1979) test:

To test the stationarity (H_0**:** Series has unit root) in time series, present work employs the Augmented Dickey-Fuller (1979) test. A non-stationary time series is defined as follows:

$$X_t = X_{(t-1)} + \mu_t \qquad (3.1)$$

$$X_t - X_{(t-1)} = \mu_t; \quad \mu_t \sim \text{IIDN}(0, \sigma^2)$$

Where μ_t a weakly stationary series and the above equation is defined as a random walk model without drift. Here X_t is non-stationary but its first difference (i.e. $X_t - X_{(t-1)} = \Delta X_t = \mu_t$) is a stationary time series. The above equation can be written as follows:

$$X_t = \rho X_{(t-1)} + \mu_t \qquad -1 \le \rho \le 1 \qquad (3.2)$$

Equation (3.2) is a Markov first-order autoregressive model. If $\rho \ge 1$, we can face unite root problem in series X_t which identifies a situation of non-stationary and if $|\rho|<1$, then the time series X_t is stationary. The equation (3.2) can be written again as follows by subtracting X_{t-1} from both the sides:

$$X_t = \rho X_{(t-1)} + \mu_t$$
$$X_t - X_{t-1} = \rho X_{(t-1)} - X_{t-1} + \mu_t$$
$$\Delta X_t = (\rho - 1) X_{(t-1)} + \mu_t$$
$$\Delta X_t = \delta X_{(t-1)} + \mu_t ; \qquad (3.3)$$
$$\delta = (\rho - 1); \quad \Delta = \text{first difference operator}$$

If $\delta=0$; $\rho=1$ which indicates the unit root in X_t series and again if $\delta=0$; then $\Delta X_t = \mu_t$and μ_t is a white noise error term, thus, an random walk time series can become stationarity time series by using first difference. On the other hand, a time series can be stationary only if the value of δ is be negative. The test of DF assumes that the error term μ_t was uncorrelated. But if μ_t is correlated; ADF is a more robust test than the DF test. It tests the stationarity of the time series by eliminating the assumption of uncorrelated error terms by adding lagged difference term to the right hand side of equation (3.3) and is defined as:

$$\Delta X_t = \delta X_{(t-1)} + \Sigma_{i=1}^{m} \alpha_i \Delta X_{t-i} + \epsilon_t \quad \text{without drift} \qquad (3.4)$$

$$\Delta X_t = \beta_1 + \delta X_{(t-1)} + \Sigma_{i=1}^{m} \alpha_i \Delta X_{t-i} + \epsilon_t \quad \text{with drift} \qquad (3.5)$$

$$\Delta X_t = \beta_1 + \beta_2 t + \delta X_{(t-1)} + \Sigma_{i=1}^{m} \alpha_i \Delta X_{t-i} + \epsilon_t \quad \text{with drift and trend} \qquad (3.6)$$

Where ϵ_t is a pure white noise error term, and the hypothesis and critical value for ADF is same as DF test. The lag order for ΔX_t selected on the basis of statistical methods. The null hypothesis for the test of unit root set as $\delta=0$ (i.e. the series having unite root) where the alternative one is $\delta<0$ (i.e. series follow stationarity).

3.2. Phillips-Perron (1988) test:

PP test is generally a non-parametric statistical tool to test the unit root by focusing on autocorrelation in the error terms without adding lagged differenced terms (Gujarati, 2011). The test statistics and critical value of PP test is also same as ADF test statistic. The regression equation for PP analysis is a (1) process:

$$\Delta Xt-1=\alpha 1+\beta Xt-1+\epsilon t \quad (3.7)$$

Here X_{t-1} is an exploratory variable and β is an autoregressive (1) coefficient. The null hypothesis of stationarity ($for\ \Delta X_{t-1}$) can be tested against β=1:

$$\mathrm{H0}: \beta = 1\ (\text{unit root and non} - \text{stationarity})$$
$$\mathrm{Ha}: \beta < 1\ (stationarity)$$

If $\beta \geq 1$, indicates the series ΔX_{t-1} is non-stationary, If β=1, indicates the series ΔX_{t-1} contains a unit root and non-stationary, and if β<1, indicates the series ΔX_{t-1} follows stationarity.

4. RESULTS AND INTERPRETATION:

The summary statistics describes the average daily return percentage, standard deviation (SD), skewness, kurtosis, Jarque-Bera (JB) test, ARCH-LM test, Ljung-Box (Q) statistic, ADF, PP and number of observations in the sample series. The symmetric and asymmetric properties of the return series are pointed by skewness, while the peak and fat of the distribution is displayed by the statistics of kurtosis. JB test compares the deviation of return series from normal distributions. The presence of ARCH effect in the return series is captured by ARCH-LM test with lag ten. Finally, the evidence of significant auto-correlation within the return as well as square return are presented by LB statistic, and the stationarity of the stock indices return is pointed out by ADF and PP tests.

4.1. Whole Period (2003-18):

The summary statistics of sample indices return percentage for the period of January, 2003 to August, 2017 is presented in Table 4.1. Firstly, highest daily return was 0.073 for Pakistan and lowest (0.023) for Taiwan. It can be pointed /concluded out that most of the emerging Asian markets performed very well during the whole sample period regardless of the influence of financial crisis. Secondly, the market volatility was measured by SD of daily return indices. China (1.140) had the highest and Malaysia (0.537) the lowest SD as compared to others. The distribution of the return SD reported that the Chinese and Indian markets had higher SD than the other markets. The empirical distributions of all the return series were negatively skewed. This implies that the proportion of the negative return was greater than the positive one. All sample indices were highly leptokurtic in nature. The null hypothesis of normality in return series was strongly rejected by the JB test, whereas ARCH-LM showed the existence of ARCH effect in all the series. Again, LB statistics displayed significant autocorrelation for both, the returns as well as square return series. Finally, the stationary in return series was pointed by ADF and PP tests.

Table 4.1: Summary Statistic for Full Sample Period (2003-17)

Countries	Mean	SD	Skewness	Kurtosis	JB	ARCH-LM(10)	Q(10)	Q^2(10)	ADF	PP	Obj.
China	0.025	1.140	-0.340	4.393	3091.84***	809.76***	1011.41***	1408.01***	-13.99*	-1636.16*	3748

									**	**	
India	0.063	1.060	-0.458	8.717	12014.33***	779.41***	1124.8***	1474.42***	-13.92***	-1406.65***	3748
South Korea	0.035	0.920	-0.760	8.003	10377.46***	1485.71***	978.97***	3677.4***	-16.07***	-1452.31***	3748
Taiwan	0.023	0.867	-0.378	3.925	2499.14***	933***	1062.05***	1669.57***	-14.52***	-1398.72***	3748
Malaysia	0.027	0.537	-0.498	6.591	6950.67***	997.66***	1218.73***	1959.77***	-15***	-1365.46***	3748
Thailand	0.041	0.893	-0.794	8.352	11303***	714.63***	1071.89***	1254.96***	-14.21***	-1428.14***	3748
Indonesia	0.071	0.976	-0.671	6.665	7228.7***	1254.16***	1194.25***	2664.2***	-14.51***	-1267.76***	3748
Philippines	0.055	0.918	-0.573	5.438	4830.57***	1072.89***	1212.41***	2343.64***	-15.49***	-1252.33***	3748
Pakistan	0.073	0.960	-0.882	5.748	5655.3***	975.91***	1297.03***	2591.8***	-12.95***	-1419***	3748
*** shows results at 1% level of significance.											

4.2. Full Crisis (2003-2013):

The descriptive statistics for full crisis period (including the period of pre-crisis, GFC and ESDC) is presented in Table 4.2. The summary statistics for this period also exhibited the same result as reported during the full crisis period for skewness, Kurtosis, JB, ARCH-LM, LB, ADF and PP tests. During this period, all the sample countries from Emerging Asian region showed average positive returns. Highest return is found in Indonesia (0.093) and lowest is found in China (0.019). India (1.178) presented as the most volatile market and Malaysia (0.584) as the least volatile whereas during this period, which is similar to the whole sample period results.

Table 4.2: Summary Statistic for Full Crisis Period (2003-13)

Countries	Mean	SD	Skewness	Kurtosis	JB	ARCH-LM(10)	Q(10)	Q^2(10)	ADF	PP	Obj.
China	0.019	1.149	-0.014	3.146	1102.39***	363.27***	686.49***	632.47***	-12.53***	-1183.66***	2665
India	0.068	1.178	-0.454	7.614	6542.77***	532.65***	821.76***	963.52***	-12.49***	-997.45***	2665
South Korea	0.042	1.042	-0.738	6.335	4708.2***	1035.88***	689.94***	2441.18***	-14.02***	-1038.46***	2665

Taiwan	0.022	0.963	-0.356	3.110	1133.44***	652.83***	753.78***	1051.04***	-12.13***	-995.12***	2665
Malaysia	0.039	0.584	-0.551	6.265	4503.68***	703.77***	872.39***	1309.86***	-13.25***	-980.65***	2665
Thailand	0.054	0.974	-0.833	7.834	7137.12***	494.6***	787.89***	821.22***	-12.02***	-1005.83***	2665
Indonesia	0.093	1.059	-0.690	6.156	4428.61***	890.67***	853.28***	1872.43***	-12.53***	-908.81***	2665
Philippines	0.071	0.971	-0.569	4.954	2875.42***	827.41***	894.6***	1718.7***	-13.56***	-878.77***	2665
Pakistan	0.079	1.047	-0.920	5.334	3543.21***	686.42***	929.21***	1801.51***	-11.92***	-1034.6***	2665
*** shows results at 1% level of significance.											

4.3. Pre-Crisis Period (2003-2007):

The results demonstrated in Table 4.3 reported the highest daily returns for Indonesia (0.146) and the lowest for Taiwan (0.061). Daily returns of all the sample indices reported positive returns during the pre-crisis period. The lowest market volatility was shown by Malaysia (0.516), whereas Pakistan revealed the highest market volatility (1.116). Majority of sample countries from emerging Asian markets are presented a high return with high volatile global market situation during this period. The empirical distribution for all of the sample markets were negatively skewed except China (0.057) which pointed towards positive skewed market. It can be concluded that the proportion of the negative return was higher than the positive return for the emerging Asian markets before the period of financial crisis. From the kurtosis point of view, half of the countries show highly leptokurtic and some of them show platykurticas compared to normal distribution. The abnormality assumption was confirmed by the JB test. Other test statistics such as ARCH-LM, LB, ADF and PP, reported the same results as discussed for full crisis period.

Table 4.3: Summary Statistic for Pre-GFC (2003-07)

Countries	Mean	SD	Skewness	Kurtosis	JB	ARCH-LM(10)	Q(10)	Q^2(10)	ADF	PP	Obj.
China	0.102	1.027	0.057	2.344	270***	130.32***	302.04***	244.33***	-9.28***	-542***	1168
India	0.133	1.046	-1.193	9.005	4241.87***	111.69***	335.92***	205.37***	-9.25***	-490.02***	1168
South Korea	0.094	0.934	-0.303	1.137	81.65***	201.45***	314.99***	389.97***	-9.99***	-460.74***	1168
Taiwan	0.061	0.838	-0.606	3.013	516.53***	247.06***	319.72***	311.83***	-9.29***	-453.09***	1168

Malaysia	0.065	0.516	-0.196	4.067	817.24***	388.63***	435.9***	751.83***	-8.82***	-398.16***	1168
Thailand	0.077	0.895	-0.611	7.691	2965.44***	71.04***	316.44***	84.24***	-8.76***	-480.03***	1168
Indonesia	0.146	0.908	-0.546	2.441	350.33***	224.23***	339.72***	322.08***	-9.53***	-459.55***	1168
Philippines	0.106	0.882	-0.171	2.077	217.44***	158.29***	375.67***	171.49***	-9.75***	-427.35***	1168
Pakistan	0.139	1.116	-1.033	5.494	1685.22***	229.11***	333***	593.82***	-8.08***	-505.15***	1168
*** shows results at 1% level of significance.											

4.4. GFC (2007-2009):

The summary statistics for the period of GFC is presented in Table 4.4. The average returns percentage for all the sample indices were negative. It can be seen that most of the emerging markets produced high SD. Generally, the SD for the period of crisis is significantly higher than that of pre-crisis period. All the return distributions were negatively skewed except China (0.221). Approximately thirty-five percent of the total sample indices were highly leptokurtic in nature. The results of JB, ARCH-LM, LB, ADF and PP tests described the same result as presented previously for the other sub-periods.

Table 4.4: Summary Statistic for GFC (2007-09)

Countries	Mean	SD	Skewness	Kurtosis	JB	ARCH-LM(10)	Q(10)	Q^2(10)	ADF	PP	Obj.
China	-0.146	1.778	0.221	1.203	29.89***	30.63	112.33***	27.98***	-7.07***	-196.88***	424
India	-0.107	1.874	-0.397	1.684	62.64***	105.14***	155.85***	163.16***	-6.77***	-165.02***	424
South Korea	-0.104	1.603	-0.651	4.602	410.14***	191.37***	114.12***	384.27***	-7.58***	-184.5***	424
Taiwan	-0.127	1.411	-0.067	0.635	7.84**	91.19***	140.96***	106.94***	-7.54***	-171.84***	424
Malaysia	-0.103	0.915	-0.559	2.997	183.91***	94.58***	119.23***	128.19***	-7.16***	-181.5***	424
Thailand	-0.157	1.362	-0.763	6.568	814.02***	129.94***	163.42***	187.37***	-7.79***	-166.81***	424
Indonesia	-0.111	1.645	-0.561	3.471	239.02***	159.86***	194.61***	299.61***	-7.86***	-145.81*	424

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Philippines	-0.126	1.487	-0.482	3.118	191.5***	149.67***	170.52***	292.71***	-8.14***	-150.37***	424
Pakistan	-0.162	1.434	-0.608	2.099	105.95***	156.43***	248.71***	341.25***	-6.77***	-129.31***	424
*** shows results at 1% level of significance.											

4.5. ESDC (2010-2013):

The results demonstrated in Table 4.5 reported the highest daily returns for Pakistan (0.096) and the lowest for Taiwan (0.002). Daily returns of all the sample indices reported positive returns during the ESDC period. The highest SD is found in South-korea (0.847) and the lowest volatility is found in Malaysia (0.432).The sixty percent results show high leptokurtic distribution. The JB statistics rejected the null hypothesis of normality assumptions except India. The empirical results show negative skewness in distribution of the return series, while all other test statistics showed the same result as it was discussed for the whole sample period.

Table 4.5: Summary Statistic for ESDC (2010-13)

Countries	Mean	SD	Skewness	Kurtosis	JB	ARCH-LM(10)	Q(10)	Q^2(10)	ADF	PP	Obj.
China	0.031	0.820	-0.035	0.913	28.47***	100.12***	196.98***	95.56***	-8.55***	-357.09***	797
India	0.011	0.761	-0.108	0.001	1.56	102.38***	246.04***	134.65***	-9.14***	-305.27***	797
South Korea	0.014	0.847	-0.932	4.350	749.55***	248.49***	230.48***	573.22***	-8.65***	-309.62***	797
Taiwan	0.002	0.784	-0.791	3.306	449.87***	193.88***	226.66***	255.27***	-9.24***	-311.51***	797
Malaysia	0.035	0.432	-0.383	3.292	382.85***	147.09***	278.22***	180.64***	-8.98***	-292.01***	797
Thailand	0.086	0.779	-0.868	3.793	582.34***	203.79***	229.46***	414.11***	-8.66***	-317.13***	797
Indonesia	0.064	0.826	-0.943	5.193	1021.24***	197.5***	270.61***	370.05***	-8.98***	-289.63***	797
Philippines	0.088	0.749	-0.527	1.976	168.3***	133.8***	250.53***	200.97***	-8.98***	-293.65***	797
Pakistan	0.096	0.650	-0.334	1.353	76.67***	111.9***	253***	149.31***	-8.45***	-315.56***	797

*** shows results at 1% level of significance.

5. CONCLUSION:

Volatility is always said to be the indicator of optimum trade-off between risk and return in the financial markets. Any unforeseen modification (increased or decreased) inrandomness leads to disorganisation in the pricing of stock prices. If someone is not having proper knowledge of volatility movements then one can not avail the arbitrage benefits. So, for studying the characteristics of volatility and other features of times series data, the present study has used descriptive statistics and unit root testing. So far, conclusive descriptive statistics are concerned, the lowest returns are to be found in Taiwan stock exchange but highest returns are found in various markets (Pakistan, Indonesia and Malaysia). Secondly, the highest volatility is found mostly in Chinese, Indian and Pakistanis stock exchanges. The lowest volatility found in Malaysian stock exchanges in all sample periods and structural breaks. Additionally, stationarity is concerned, all the sample time periods show stationarity at first difference. Present article is only limited to descriptive statistics and unit root testing but further research work will be extended by incorporating more volatility characteristics, research techniques and non-structural shocks during contagion period.

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