

Linkage between ASIAN and USA Stock Markets: A Cointegration Approach

Samreen Fatima, Rafia, Shafi, Tayyab Raza Fraz,

Abstract—CPEC, a joint venture of Pakistan and China, has now become the most highlighted issue around the globe. In the last three decades China has emerged as one of the largest economies of the world. Chinese market has great potential to capture many markets of the world. CPEC on one side will open many markets for China and on the other side it will become a continuous source of threat to many markets around the globe. Chinese stock market may be considered an influential market with respect to many Asian and USA markets. The current study specifically explores the linkages between Chinese and Asian stock markets and Chinese and US markets. To undertake this study weekly closing returns of fourteen stock markets of Asia and USA are selected namely KSE-100(Pakistan), Nikkie225(Japan), S&P500, NASDAQ and DJI (USA), KLSE (Malaysia), BSESN (India), HIS(Hong Kong), JKSE (Indonesia), SSE(China), KS11(Korea), TWII(Taiwan), CSE(Sri Lanka) and TASI (Saudi Arabia) markets. To explore the linkage, cointegration technique is employed to following groups of markets (1) KSE-100 and selected stock markets (2) SSE and selected stock markets and (3) S&P500 and remaining stock markets of Asia. The findings show that KSE-100 has cointegration with all stock markets except CSE and HIS. On the other hand SSE is also cointegrated with all stock markets except CSE and TASI. Additionally, these two markets have weak correlation indicating less dependency on each other. Therefore, the linkage of KSE-100 and SSE will affect the remaining markets to some extent. However, S&P 500 has also long run relationship with all Asian selected market except CSE. It is interesting to observe that CSE is neither cointegrated with KSE-100 and SSE nor with S&P 500 and also has low correlation with these three markets.

Keywords—Cointegration, CPEC, S&P 500, KSE-100, SSE

1. INTRODUCTION

China Pakistan Economic Corridor (CPEC) is a mega bilateral project among two countries Pakistan and China. It is also known as North-South Economic Corridor. The project was launched on April 20, 2015 when Chinese President and Pakistani Prime Minister signed 51 agreements and Memorandums of Understanding of an approximate worth of \$46 billion. The core objective, of this project is to buildup, expand and improve the means of transportation and trading between China and Pakistan. CPEC in fact, is an extension of China's drive "One Belt One Road program". From last many years, China is rigorously working on the agenda "Made in China 2025".

CPEC will surely augment its agenda by providing China an alternate safest and shortest route to the countries of Eurasia. Through this corridor, the deep-sea port of Gwadar is supposed to be connected to the Chinese border via two routes— eastern route and western route. The

objective of the current study is to find the linkage of Pakistan and China's markets with selected Asian and USA stock markets. There is abundant literature available for exploring the linkage between markets using co integration methods. Co-integration method is found a powerful method to investigate that which returns series have similar structures. A literature review has been done in this context which is as follows.

The collective efficiency of Asian markets for the period of 1987-1995 using co integration method was tested by [1]. Experimental analysis suggested that during the study period Asian markets were not collectively efficient. Despite this fact, linkage among the ASEAN markets was found. [2] found the linkage between Association of Southeast Asian Nations (ASEAN-) namely; Indonesia, Malaysia, Philippines, Singapore and Thailand Stock markets. Daily total market indices measured in terms of US dollar covering the period April 2nd, 1990 to August 31st were used. A VAR based Granger causality test was applied to examine the effect of Asian financial crisis 1997 on the market indices over the selected period. Later on, [3] discussed investigated the integration developed, emerging and frontier Asian stock market for the sample period 1997 to 2014. Furthermore, the selected period was divided into different sub periods including crisis period 2008 to 2011, tranquil periods (2012 to 2014) and entire period (1997-

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2014). ARDL approach of co integration for long-run and for short-run VEC or VAR processes were used respectively. Long-run and short-run association was found among the selected Asian countries. Furthermore, their results support previous work of ([4] and [5]) which showed great degree of closeness in economic relations among Asian countries. Beside this it was found that linkage between the returns of stock market was time variant phenomenon. Similarly, the countries which did not have co integration in the tranquil period had co integration in the financial crisis period.

In the year 2010, [6] used weekly closing price indices of eight Asian stock markets and the US market and explained that the whole system indicates the existence of at least one co integrating vector. Furthermore, Asian financial crisis of 1997/1998 has been analyzed and concluded co integration relationship between some countries, most markedly between the US and Japan. Controlling for different stock indices denominations show that the results are mostly robust to a change to common US dollar denomination.[7] examined the long-run convergence of the United States and 22 other developed and developing countries using daily data and run the test used by [8]and [9] to show that stock markets of most countries became co integrated by 2010. Further, he used short-run diversification opportunities across the countries by comparing the daily returns of the selected markets with the daily returns of the global index (S&P 500). Moreover,[7] concluded that China, Malaysia and Austria stand out as countries with highly favorable diversification opportunities as they are not co integrated with USA. [10] investigated the relationship between stock markets and exchange rates due to the potential prediction power for policy makers and investors. From a sample of seven Australasian countries, the authors found no evidence of long run co integration between stock markets and exchange rates.

The outline of this paper is as follows. Section 2 describes a brief introduction of Co-integration techniques; Section 3 deals with data analysis based on data from 1st January 2001 to 24th March, 2019 for the selected stock markets using weekly closing prices. Section 4 summarizes the conclusion.

2. METHODOLOGY

COINTEGRATION TECHNIQUE

Co integration technique is an important addition to the theory and widely used in Econometrics. It was first introduced by [11] and subsequently enhanced by ([12],

[13]), [14], [15] ,[8], [16] etc. In real world applications most time series are non- stationary but they tend to follow same pattern over the time. This implies that they may have influence on each other. In other words, if two series ‘move together’ then the non-stationary variables indicate that the existence of a stochastic trend that links them. The variables cannot move independently due to equilibrium linkage and are considered co integrated.

If y_t and x_t are two series then they can be estimated directly from the regression model,

$$y_t = a + bx_t + e_t$$

or

$$y_t - a - bx_t = e_t$$

Where e_t is the residual following the assumption of stationarity. If an equilibrium relationship between variables y_t and x_t exists then variables y_t and x_t are said to be co integrated and $e_t \sim I(0)$. Furthermore, if two series are integrated to different orders, then linear combinations of them will be integrated to the higher of two orders. Similarly, if both are integrated of order one ($e_t \sim I(0)$) which means that the process contains a unit root .

If y_t and x_t are non-stationary then the regression model may be spurious. Therefore, for taking difference of the series (Δy_t and Δx_t) ensures stationarity of variables, so that $\Delta y_t \sim I(0)$ and $\Delta x_t \sim I(0)$ and the regression model will be:

$$\Delta y_t = a + b\Delta x_t + \Delta e_t$$

3. DATA ANALYSIS AND DISCUSSION

Weekly closing returns of fourteen markets data; KSE-100(Pakistan) ,NIKKIE (Japan), S &P 500, NASDAQ and DJI (USA), KLSE (Malaysia), BSESN (India), HIS (Hong Kong), JKSE (Indonesi) SSE(China), KS11(Korea), TWII (Tiwan), CSE(Sri Lanka) and TASI (Saudi Arabia) markets are selected. The graphs of data from 1st January, 2001 to 24thMarch, 2019 are given in below.

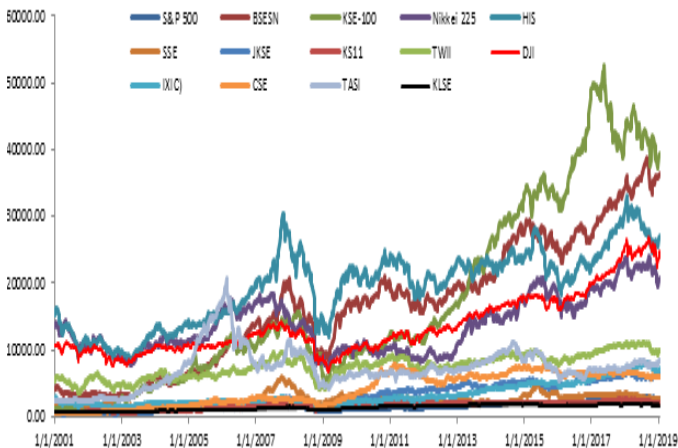


Figure 1: Daily closing returns of Asian and USA stock markets

Table 1, shows the descriptive of the weekly returns over the period 1st January, 2001 to 24th March, 2019. KSE-100 has highest average returns while TWII has lowest average returns. KLSE has less volatile among the considered markets due to minimum standard deviation. This indicates KLSE has more attractive for investors on the basis of risk-return trade-off. All returns have negative skewness shows extensive negative returns except CSE. The returns have excess of kurtosis and Jarque-Bera test also reject the null hypothesis of normality.

Table 1: Descriptive statistics of returns

	Mean	Max	Min	S.Dev	Ske	Kurt	J-Bera	Probability
BSESN	0	0.13	-0.17	0.03	-0.5	6.38	486.973	0
CSE	0	0.18	-0.11	0.03	0.79	9.53	1770.363	0
DJI	0	0.11	-0.2	0.02	-1.07	11.9	3303.779	0
HIS	0	0.12	-0.18	0.03	-0.26	5.78	313.484	0
NASDAQ	0	0.13	-0.18	0.03	-0.56	6.45	515.459	0
JKSE	0	0.12	-0.23	0.03	-0.95	9.21	1654.738	0
KLSE	0	0.07	-0.11	0.02	-0.77	7.94	1048.966	0
KS11	0	0.17	-0.23	0.03	-0.7	9.11	1540.763	0
KSE-100	0	0.11	-0.2	0.03	-1.16	8.39	1348.776	0
NIKKEI225	0	0.11	-0.28	0.03	-1.09	11.2	2824.341	0
S&P500	0	0.11	-0.2	0.02	-0.92	10.7	2480.944	0
SSE	0	0.14	-0.16	0.03	-0.29	5.81	321.887	0
TASI	0	0.14	-0.24	0.03	-1.4	11	2787.907	0
TWII	0	0.18	-0.13	0.03	-0.2	6.88	596.65	0

Correlation matrix among the considered stock markets is calculated see Table 2. All markets are positively correlated as the coefficients of correlations positive. The pair wise correlation of SSE and considered markets are low. Furthermore, the pair of SSE-HIS i.e. 0.36 is high among all pairs. On the other hand, KSE-100 and remaining markets correlation is also very low. However, none of the pair of KSE-100 and considered markets are significantly considerable. Correlation matrix provides the insight

information about the co-movements of the stock returns. Despite these the correlation does not explain the cointegration between the returns series.

Table 2: Correlation coefficient of the returns.

	BSESN	CSE	DJI	HIS	NASDAQ	JKSE	KLSE	KS11	KSE-100	NIKKEI225	S&P500	SSE	TASI	TWII
BSESN	1													
CSE	0.19	1												
DJI	0.48	0.13	1											
HIS	0.59	0.16	0.56	1										
NASDAQ	0.47	0.16	0.84	0.58	1									
JKSE	0.44	0.13	0.32	0.48	0.3	1								
KLSE	0.42	0.16	0.31	0.53	0.32	0.52	1							
KS11	0.53	0.11	0.5	0.65	0.54	0.45	0.5	1						
KSE-100	0.16	0.04	0.13	0.16	0.11	0.12	0.1	0.2	1					
NIKKEI225	0.49	0.16	0.58	0.63	0.58	0.4	0.4	0.6	0.12	1				
S&P500	0.49	0.15	0.97	0.59	0.91	0.34	0.3	0.5	0.11	0.6	1			
SSE	0.16	0.06	0.15	0.36	0.15	0.22	0.2	0.2	0.09	0.22	0.15	1		
TASI	0.13	0.1	0.13	0.14	0.13	0.15	0.2	0.1	0.13	0.2	0.14	0.11	1	
TWII	0.46	0.13	0.42	0.62	0.48	0.42	0.5	0.7	0.19	0.51	0.45	0.23	0.12	1

One of the constraints with cointegration is that all time series must be stationary with same order. As the considered series are not stationary so they were made stationary at first difference using Fisher-Augmented Dickey-Fuller and Fisher-Phillips-Perron tests (ADF and PP combined with Fisher 1932). The Johansen cointegration test is applied on stationary series.

The main focus of the study is to explore and investigate co integration between KSE-100, SSE with other selected stock markets. To develop more insight about the linkages, pairwise cointegration is tested between the countries under the following hypotheses.

1. There exists Pair wise Cointegration between KSE-100 (Pakistan) and the selected series.
2. There exists Pair wise Cointegration between SSE (China) and the selected series.
3. There exists Pair wise Cointegration between S&P 500 (USA) and the selected series.

The pairwise Johansen cointegration tests are computed and presented in Appendix. The results based on trace and maximum test statistics are used to drawn conclusion about cointegration relationship. KSE-100 has maximum one order cointegration with BSESN, DJI, NASDAQ, KLSE, JKSE,KS11, S&P 500, SSE, Nikkie225,TASI and TWII. This indicates the existence of weak linkage between KSE-100 and these countries (Table 1(a), Appendix). However no co integration is found among KSE, CSE and HIS stock markets that shows KSE-100 is not linked with these market. Similarly, SSE has maximum one order co integration with BSESN, DJI, HIS, NASDAQ,JKSE, KLSE, KS11, KSE-100, Nikkie225, S&P500, and TWII. However, SSE has no cointgration with CSE and TASI. Similarly, S&P 500 has also cointegration with all selected Asian stock

markets except CSE. Over all, it may be concluded that CSE stock market moves independently, Table 1(b) and 1(c), Appendix.

4. CONCLUSION:

CPEC is a great project and its aim is twofold the first is to transform Pakistan's economy by modernizing its roads, rail, air, and energy transportation systems and the second is to provide an opportunity to China to access the central Asia and European market via Pakistan. If all the projects that were decided between Pakistan and China are executed, Pakistan economy will definitely boost up and strengthened. CPEC is also expected to provide a better solution of unemployment in Pakistan. CPEC will play a vital role in boosting the economic activities by improving and increasing the means of communication within Pakistan for better trade with China and will also integrate and attract the other countries of the region. According to our findings except CSE and HIS all stock market returns are cointegrated with KSE-100. On the other hand for the case of SSE, TASI and CSE have no co integration with Chain's

stock markets. Moreover, CSE has no long-run relationship with SSE, KSE-100 and S&P500. Moreover, TASI and HIS have no long-run linkage with SSE and KSE-100 respectively. Both SSE and KSE-100 have weak correlation with all returns. However, CSE has correlations 0.04 and 0.06 with KSE-100 and SSE respectively which are the lowest correlation among all the correlation coefficients.

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Appendix A:

Table1(a): Cintegration output of SSE and the selected countries

Series: SSE -DJI					Series: SSE -DJI				
Hypothesized		Trace	0.05		Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.003541	3.323630	15.49471	0.9503	None	0.003541	3.323486	14.2646	0.9229
At most 1	1.54E-07	0.000144	3.841466	0.9919	At most 1	1.54E-07	0.000144	3.841466	0.9919
Series: SSE -HSI					Series: SSE -HSI				
None	0.005963	7.184499	15.49471	0.5563	None	0.005963	5.603886	14.2646	0.6644
At most 1	0.001685	1.580613	3.841466	0.2087	At most 1	0.001685	1.580613	3.841466	0.2087
Series: SSE -NASDAQ					Series: SSE -NASDAQ				
None	0.003746	3.523286	15.49471	0.9382	None	0.003746	3.516371	14.2646	0.9065
At most 1	7.38E-06	0.006915	3.841466	0.9332	At most 1	7.38E-06	0.006915	3.841466	0.9332
Series: SSE -JKSE					Series: SSE -JKSE				
None	0.005529	6.859583	15.49471	0.5940	None	0.005529	5.195265	14.2646	0.717
At most 1	0.001775	1.664318	3.841466	0.1970	At most 1	0.001775	1.664318	3.841466	0.197
Series: SSE -KLSE					Series: SSE -KLSE				
None	0.005458	6.568469	15.49471	0.6283	None	0.005458	5.127955	14.2646	0.7256
At most 1	0.001536	1.440514	3.841466	0.2301	At most 1	0.001536	1.440514	3.841466	0.2301
Series: SSE -KS11					Series: SSE -KS11				
None	0.007752	10.16295	15.49471	0.2684	None	0.007752	7.292164	14.2646	0.4552
At most 1	0.003059	2.870787	3.841466	0.0902	At most 1	0.003059	2.870787	3.841466	0.0902
Series: SSE -KSE-100					Series: SSE -KSE-100				
None	0.006523	9.429827	15.49471	0.3271	None	0.006523	6.132465	14.2646	0.5963
At most 1	0.003513	3.297362	3.841466	0.0694	At most 1	0.003513	3.297362	3.841466	0.0694
Series: SSE -Nikkie225					Series: SSE -Nikkie225				
None	0.004847	6.595772	15.49471	0.6251	None	0.004847	4.552994	14.2646	0.7969
At most 1	0.002178	2.042778	3.841466	0.1529	At most 1	0.002178	2.042778	3.841466	0.1529
Series: SSE -TASI					Series: SSE -TASI				
None	0.006368	10.04284	15.49471	0.2774	None	0.006368	5.985425	14.2646	0.6151
At most 1 *	0.004321	4.057418	3.841466	0.0440	At most 1 *	0.004321	4.057418	3.841466	0.044
Series: SSE -TWII					Series: SSE -TWII				
None	0.008755	10.66712	15.49471	0.2328	None	0.008755	8.239565	14.2646	0.3549
At most 1	0.002587	2.427558	3.841466	0.1192	At most 1	0.002587	2.427558	3.841466	0.1192
Series: SSE -S&P500					Series: SSE -S&P500				
None	0.003580	3.368254	15.49471	0.9477	None	0.00358	3.360161	14.2646	0.9199
At most 1	8.64E-06	0.008093	3.841466	0.9279	At most 1	8.64E-06	0.008093	3.841466	0.9279

Table1(b): Cintegration output of KSE-100 and the selected countries

Series: KSE-100 - BSESN					Series: KSE-100 - BSESN				
Hypothesized		Trace	0.05		Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.010804	13.07647	15.49471	0.1120	None	0.0108	10.18	14.26	0.20
At most 1	0.003088	2.897670	3.841466	0.0887	At most 1	0.00309	2.90	3.84	0.09
Series:KSE-100-CSE					Series:KSE-100-CSE				
None	0.008415	12.54069	15.49471	0.1328	None	0.00842	7.91818	14.2646	0.3871
At most 1 *	0.004921	4.622512	3.841466	0.0315	At most 1 *	0.00492	4.62251	3.84147	0.0315
Series:KSE-100-DJI					Series:KSE-100-DJI				

None	0.010281	11.25306	15.49471	0.1964	None	0.01028	9.68333	14.2646	0.2336
At most 1	0.001674	1.569733	3.841466	0.2102	At most 1	0.00167	1.56973	3.84147	0.2102
Series: KSE-100- NASDAQ					Series: KSE-100- NASDAQ				
None *	0.018309	18.68478	15.49471	0.0160	None *	0.01831	17.3148	14.2646	0.016
At most 1	0.001461	1.370007	3.841466	0.2418	At most 1	0.00146	1.37001	3.84147	0.2418
Series: KSE-100-KLSE					Series: KSE-100-KLSE				
None	0.008721	10.17265	15.49471	0.2677	None	0.00872	8.20776	14.2646	0.358
At most 1	0.002095	1.964892	3.841466	0.1610	At most 1	0.0021	1.96489	3.84147	0.161
Series: KSE-100-KS11					Series: KSE-100-KS11				
None	0.006551	8.947531	15.49471	0.3703	None	0.00655	6.15861	14.2646	0.5929
At most 1	0.002972	2.788920	3.841466	0.0949	At most 1	0.00297	2.78892	3.84147	0.0949
Series: KSE-100- S&P500					Series: KSE-100- S&P500				
None	0.013955	14.82467	15.49471	0.0629	None	0.01396	13.1683	14.2646	0.0739
At most 1	0.001766	1.656406	3.841466	0.1981	At most 1	0.00177	1.65641	3.84147	0.1981
Series: KSE-100- SSE					Series: KSE-100- SSE				
None	0.006523	9.429827	15.49471	0.3271	None	0.00652	6.13247	14.2646	0.5963
At most 1	0.003513	3.297362	3.841466	0.0694	At most 1	0.00351	3.29736	3.84147	0.0694
Series: KSE-100- TWII					Series: KSE-100- TWII				
None *	0.019738	21.77659	15.49471	0.0049	None *	0.01974	18.6791	14.2646	0.0094
At most 1	0.003300	3.097524	3.841466	0.0784	At most 1	0.0033	3.09752	3.84147	0.0784
Series: KSE-100-JKSE					Series: KSE-100-JKSE				
None	0.005723	7.751891	15.49471	0.4923	None	0.00572	5.37742	14.2646	0.6936
At most 1	0.002531	2.374476	3.841466	0.1233	At most 1	0.00253	2.37448	3.84147	0.1233
Series: KSE-100-TASI					Series: KSE-100-TASI				
None	0.005764	7.708054	15.49471	0.4971	None	0.00576	5.41672	14.2646	0.6886
At most 1	0.002442	2.291338	3.841466	0.1301	At most 1	0.00244	2.29134	3.84147	0.1301

Table1(c): Cintegration output of S&P500 and the selected Asian countries

Series: BSES N S_P_500									
Hypothesized		Trace	0.05		Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.006191	7.024533	15.49471	0.5748	None	0.006191	5.819222	14.2646	0.6365
At most 1	0.001286	1.205312	3.841466	0.2723	At most 1	0.001286	1.205312	3.841466	0.2723
Series: CSE S_P_500									
None *	0.014536	18.144	15.49471	0.0195	None*	0.014536	13.72055	14.2646	0.0608
At most 1 *	0.00471	4.423449	3.841466	0.0354	At most 1 *	0.00471	4.423449	3.841466	0.0354
Series: HIS S_P_500									
None	0.004146	3.91063	15.49471	0.9106	None	0.004146	3.892449	14.2646	0.8705
At most 1	1.94E-05	0.01818	3.841466	0.8926	At most 1	1.94E-05	0.01818	3.841466	0.8926
Series: JKSE S_P_500									
None	0.00903	11.02369	15.49471	0.21	None	0.00903	8.499938	14.2646	0.3301
At most 1	0.00269	2.523749	3.841466	0.1121	At most 1	0.00269	2.523749	3.841466	0.1121
Series: KLSE S_P_500									
None	0.0069	8.468432	15.49471	0.4167	None	0.0069	6.487582	14.2646	0.5515
At most 1	0.002112	1.98085	3.841466	0.1593	At most 1	0.002112	1.98085	3.841466	0.1593
Series: KS11 S_P_500									
None	0.014241	14.20984	15.49471	0.0774	None	0.014241	13.43938	14.2646	0.0672
At most 1	0.000822	0.770456	3.841466	0.3801	At most 1	0.000822	0.770456	3.841466	0.3801
Series: KSE S_P_500									
None	0.013955	14.82467	15.49471	0.0629	None	0.013955	13.16827	14.2646	0.0739
At most 1	0.001766	1.656406	3.841466	0.1981	At most 1	0.001766	1.656406	3.841466	0.1981
Series: S_P_500 Nikkie									
None	0.006376	6.071452	15.49471	0.6871	None	0.006376	5.993589	14.2646	0.614
At most 1	8.31E-05	0.077863	3.841466	0.7802	At most 1	8.31E-05	0.077863	3.841466	0.7802
Series: S_P_500 SSE									
None	0.00358	3.368254	15.49471	0.9477	None	0.00358	3.360161	14.2646	0.9199
At most 1	8.64E-06	0.008093	3.841466	0.9279	At most 1	8.64E-06	0.008093	3.841466	0.9279
Series: S_P_500 TASI									
None	0.008653	8.342907	15.49471	0.4295	None	0.008653	8.143104	14.2646	0.3644
At most 1	0.000213	0.199803	3.841466	0.6549	At most 1	0.000213	0.199803	3.841466	0.6549

Series: S_P_500 TWII									
None	0.014196	13.68097	15.49471	0.0921	None	0.014196	13.39738	14.2646	0.0682
At most 1	0.000303	0.283591	3.841466	0.5944	At most 1	0.000303	0.283591	3.841466	0.5944

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