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Jumps in Equity Return Volatilities of Chinese Stock Markets in Pre and Post Covid-19

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Abstract
In this study we examine economic and financial conditions drive volatility jumps in pre and post crisis (Covid-19). Using monthly returns of Chinese equity stocks, monthly realized volatility jumps in returns are identified for SZSE index over the period 2010M07 to 2023M08. The whole sample divides into two sections as pre and post Covid-19. Jumps in volatility detect both continuous and discontinuous jumps through median variance approach of Andersen (2012). We employ stepwise regression analysis to determine the key drivers of volatility-jumps in returns. Results uncovers economic factors (gross domestic product, industrial production, oil prices and exchange rate) negatively while financial conditions (stock prices, policy uncertainty and sentiment index) directly cause jumps in volatility. From pre to post crisis, shift in economic-financial conditions is observed. The results provide significance to policy makers and investors to hedge against turbulent periods.

Keywords: Jumps, Pre and Post Crisis, Equity stock markets, Economic Policy Uncertainty

Introduction

Since 2010, China is the second largest economy in the world and according to capitalization, it is ranked second, 2016 onwards (Hu et al., 2018). Meanwhile, Chinese stock markets got popularity in the globe with deep liberalization (Huang, 2019 & Xu et al., 2019). 75.1% individual investments lie in Chinese equity market (SSE, 2018). Chinese stock markets are likely affected by global factors as happened in financial crisis-2008, stock market crash-2015 and COVID-19. Economic output decreased to 6.8% in the first quarter 2020. Stock market bear negative shocks to economic indicators and monetary policy. Due to high volatility, the SSE index dropped to 13.4% in Q1 (February to March) 2020. Covid-19 and oil price shocks were the root cause of stock market crash (Horowitz, 2020; Partington and Wearden, 2020). This drop in stock prices induced high volatility in stock returns. This impact of epidemic (Covid-19) on market volatility or returns are studied by (Al-Awadhi et al., 2020; Ashraf, 2020; Baker et al., 2020; Phan and Narayan, 2020; Sharif et al., 2020; Kartal et al., 2020; Zhang et al., 2020a). Rise in market volatility plunged global equities (Liu and Huynh, 2021). After the pandemic, the intensity of stock market-crash risks were higher than normal. In first quarter 2020, more than 2% a single day crash arises in six days. This behaviour of stock market crashes increased returns volatility attract the attention of researchers. Mazur et al (2020) analyzed stock market crash and pandemic lead to extreme volatility and stock returns.

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Volatility is an unobservable indicator and a measure of risk. That is why asset return volatility is an important phenomenon in asset pricing and portfolio management. Due to large economic scale activities, market capitalization and increased integration, it is interesting to examine global factors of volatility jumps in Chinese stock markets. According to financial theory, asset prices reveal future expectations of forecast cash flows, subject to macroeconomic changes (Lee et al., 2019 and 2022a; Narayan, 2019 and 2022). Stock price fluctuations are caused by monetary shocks (Adediran and Akpa, 2022; Gangopadhyay, 2008; Fama and Schwert, 1977). Macroeconomic factors less track volatility whereas financial conditions play an important role in volatility (Bevilacqua et al., 2019).

There are studies empathized on jumps, jumps size in volatilities and asset pricing (Bollerslev et al., 2008; Ait Sahalia and Jacod, 2012; Jiang et al., 2013). Andersen (2007) determine jump magnitude and dynamics in high frequency data. Gkillas (2018) investigate a linkage between volatility jumps and geopolitical risk for DIJA stock index. Previous studies (Caporin., 2015) consider financial conditions can derive volatility jumps but left to consider economic factors. Economic factors can derive volatility in long term (Schwert, 1977). This study extends the analysis to identify the economic and financial drivers of volatility jumps considering the most recent crisis of Covid-19. Using Anderson (2012) method for testing jumps in realized volatility, particularly continuous and discontinuous jumps in daily series adds significance in our study. This study address to answer whether economic factors derive volatility jumps in the whole sample, pre and post crisis in a similar way. Whether financial conditions derive volatility jumps in the whole sample, pre and post crisis in a similar way.

Literature Review

Financial markets are adversely affected by financial crisis-2008, terrorists attacks-2011 (Wang and Young, 2020), stock market crashes-2015 and pandemic-2019 (Gao et al., 2020). Investors preference vary with uncertainty and sentiments (He, 2020; He et al., 2019; Dai et al., 2021; Liu et al., 2022, 2020b; Zhang et al., 2020b). Partial disruptions in specific regions were observed with previous disasters however, Covid-19 disturbed the whole world with respect to import-export and industrial production. In March 2020, government restrictions and policy uncertainty triggered financial markets (Mazur et al, 2020). This prompt behaviour provoke volatility-jumps in global financial markets. John and Li (2021) analyze Jumps in VIX increases with Covid-19 index and market index increases jumps of realized volatility of S&P 500 index and Banks index. Whereas lockdown and bank index decreases volatility jumps in both S&P-500 indices. On the basis of asset pricing model, uncertain sentiments cause high stock market volatility during Covid-19 evident by (Cox et al., 2020). Gkillas (2018) analyze the relationship between volatility jumps and geopolitical risk in quantile regression method. Megaritis (2021) determines increase in macroeconomic uncertainty (M-U) increases USA equity stock volatility and stock price jumps. Caporin (2023) examine the significance of jumps in forecasting-modelling realized volatility, using intraday data. Findings suggests adding jumps can add significance and better fit volatility models (Gkillas, 2018; Todorov and Tauchen, 2011; Broadie et al., 2007). Caporin et al. (2015) addressed model volatility jumps and explain volatility jumps are caused by financial

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conditions. In a similar way (Baker et al., 2018 and Boudoukh et al., 2015) examine stock jumps are related to news announcements. The objective of this study is twofold. First with respect to financial conditions and second whether economic factors can derive volatility jumps in realized volatility of Chinese equity stocks in three selected periods in a similar way.

Data and Methodology

This study employs daily returns of Chinese equity stock index. Stock returns are calculated by taking log, first difference of daily stock prices. Jumps are identified through variance from daily median value (Andersen et al., 2012). Monthly economic conditions (consumer confidence index of China, oil prices, GDP, gold prices, industrial production, inflation, effective exchange rate of China and financial conditions (stock price index, credit spread, economic policy uncertainty and market sentiments) are collected from FRED and Thomson reutter. The market sentiment index is computed by the University of Michigan. Our analysis depends on monthly data from 2010M07 to 2023M08 for the whole sample, 2010M07 to 2019M11 for pre-crisis and 2020M04 to 2023M08 for post crisis. We develop a stepwise regression analysis (backward) on monthly basis to analyze the relationship between realized volatility jumps, economic and financial factors in the whole sample period and in pre and post crisis of COVID-19 to provide intuitive explanation of outcomes. We find continuous and stochastic jumps for our three distinct periods (whole period, pre and post crisis).

$$\Delta RVJ_t = \alpha + \sum_{j=1}^{n} \beta_j (\Delta V_{Economic,Financial)_{t,j}} + \sum_{j=1}^{n-1} \gamma_j (\Delta V_{Economic,Fianancial)_{t-1,j}} + \phi_t \text{ .. (1)}$$

RVJ is realized volatility jumps, V is matrix of independent variables (economic and financial) with j vary from 1 to 11.

$$\Delta RVJ_t = \alpha + \sum_{j=1}^{n} \beta_j (\Delta V_{CIC,OIL,GD,GP,IN,CP,EX,SP,CS,EP,SN)_{t,j}} +$$
$$\sum_{j=1}^{n-1} \gamma_j (\Delta V_{CIC,OIL,GD,GP,IN,CP,EX,SP,CS,EP,SN)_{t-1,j}} + \phi_t \text{ ..... (2)}$$

Where, RVJ is realized volatility jumps, CIC is consumer confidence index of China, OIL is oil prices, GD is gross domestic product, GP is gold prices, IN is industrial production, SP is stock price index, CS is credit spread, EP is global economic policy uncertainty, SN is sentiment index computed by university of Michigan). All the variables are used at monthly frequency to avoid model issues and spurious regression.

Results

Table 1 Descriptive Statistics

	Mean	Median	Max	Min	S. D	Skewness	Kurtosis	J-Bera
RVJ	-0.0061	0.0032	0.0106	-0.015	0.029	-0.6662	8.8292	219.0
CIC	108.55	105.80	127.00	85.500	10.821	-0.079	2.1559	4.516
OIL	72.082	71.550	114.59	18.247	22.767	-0.077	1.8290	8.545
GD	6.609	6.900	15.233	-3.566	2.575	-0.625	5.9910	64.378
GOL	102.96	101.80	122.92	82.780	9.191	0.1981	2.2398	4.501
IN	107.55	106.50	135.10	86.500	4.524	1.126	14.230	803.64
CP	0.1462	0.100	1.600	-1.20	0.486	0.2447	3.4884	2.929
EX	95.679	97.250	106.39	78.830	7.102	-0.801	2.763	16.095

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SP	2932.13	3045.41	4578.4	2009.1	488.03	-0.112	2.987	0.3097
CS	1.3587	0.800	2.930	0.800	0.691	0.688	1.916	18.818
EP	188.397	169.04	428.10	86.283	72.860	0.767	2.879	14.516
SN	65.843	66.740	78.830	51.600	6.457	-0.259	2.236	5.223

Table 1 presents descriptive statistics of dependent and explanatory variables. Confidence index of China, OIL, stock price index-SZSE and global economic policy shows high standard deviation. RVJ, GD, IN depict excess kurtosis whereas Jerque Bera rejects the hypothesis of normality in some cases (CP and SP).

Table 2 Correlation Matrix

	RVJ	CIC	OIL	GD	GP	IN	CP	EX	SP	CS	EP	SN
RVJ	1.00	-0.03	0.09	0.02	0.05	0.03	-0.05	-0.09	-0.13	0.03	0.02	0.01
CIC	-0.03	1.00	-0.52	0.06	0.14	-0.01	0.00	0.29	0.28	-0.41	0.19	0.40
OIL	0.09	-0.52	1.00	0.11	-0.25	0.32	0.11	-0.53	-0.62	0.62	-0.32	-0.47
GD	0.02	0.06	0.11	1.00	-0.03	0.79	0.17	-0.46	-0.27	0.51	-0.53	-0.40
GP	0.05	0.14	-0.25	-0.03	1.00	0.08	0.07	-0.33	0.25	-0.10	0.46	-0.01
IN	0.03	-0.01	0.32	0.79	0.08	1.00	0.15	-0.55	-0.33	0.58	-0.42	-0.47
CP	-0.05	0.00	0.11	0.17	0.07	0.15	1.00	-0.18	-0.03	0.14	-0.20	-0.09
EX	-0.09	0.29	-0.53	-0.46	-0.33	-0.55	-0.18	1.00	0.57	-0.74	0.36	0.66
SP	-0.13	0.28	-0.62	-0.27	0.25	-0.33	-0.03	0.57	1.00	-0.66	0.40	0.63
CS	0.03	-0.41	0.62	0.51	-0.10	0.58	0.14	-0.74	-0.66	1.00	-0.60	-0.85
EP	0.02	0.19	-0.32	-0.53	0.46	-0.42	-0.20	0.36	0.40	-0.60	1.00	0.54
SN	0.01	0.40	-0.47	-0.40	-0.01	-0.47	-0.09	0.66	0.63	-0.85	0.54	1.00

Table 3 Unit Root Test

	Augmented Dickey-Fuller test		Phillips-Perron test	
	Level	1st Difference	Level	1st Difference
CIC	-1.65061	-12.315	-1.69104	-12.315
OIL	-2.08925	-9.84103	-1.87814	-9.61927
GD	-3.90669		-2.87376	
GP	-2.17787	-10.9969	-2.36286	-10.9969
IN	-9.69476		-8.62736	
CP	-8.37304		-9.80672	
EX	-2.42267	-8.48312	-2.12759	
SP	-2.72652		-2.35176	-8.99786

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CS	-3.79069		-1.24215	-4.61085
EP	-2.56027	-10.354	-2.89779	
SN	-1.49442	-14.4298	-3.18184	

Table 2 presents a correlation matrix between realized volatility jumps and economic-financial conditions. Table 3 shows that all the variables are tested to check stationarity at level and at 1st difference through Augmented Dickey fuller and Phillips Perron test. According to ADF test GD, IN, CP, SP and CS are stationary at level whereas CIC, OIL, GP, EX, EP and SN are stationary at first difference. With respect to PP test, GD, IN, CP, EX, EP and SN are stationary at level while CIC, OIL, GP, SP, CS are stationary at first difference. All the variables considered are stationary at first difference.

Table 4 Stepwise Regression between Realized Volatility Jumps and economic-Financial Variables

	Whole Sample		Pre-Crisis		Post-Crisis	
	RVJ					
	t	t-1	t	t-1	t	t-1
CIC			-0.01**	-0.01**	-0.003	0.004
OIL				0.003	-0.007*	-0.06***
GD		-0.014*		-0.013*	-0.002	
GP			0.018*	-0.009	-0.008**	-0.019**
IN	-0.053***		-0.038*	-0.024		-0.172*
CP	-0.001	0.02*	-0.001	0.02*	0.007	0.001
EX		-0.053**		-0.052**		
SP	-0.008	0.023*	-0.028*	0.021*		0.109*
CS	0.002	-0.001				-0.755*
EP			-0.001***		0.039**	0.005
SN	0.057*		0.059*		0.002*	
R^2	0.19	0.25	0.29	0.23	0.29	0.38

Note: Significance levels 1%, 5%, 10% *, **, ***

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Table 4 represents the results of stepwise regression between realized volatility jumps and consumer confidence index of China, oil prices, Gross domestic product, gold prices, industrial production index of China, consumer price index, effective exchange rate, stock prices, credit spread, global economic policy uncertainty, sentiment index for three distinct periods. In the whole sample realized volatility jumps are caused by Gross domestic product, consumer price index, effective exchange rate, stock prices, market sentiment index. Increase in gross domestic product is the symbol of industrial production, inversely react to volatility jumps in Chinese equity stocks. Stock prices and market sentiments directly explain realized volatility jumps at t and t-1.

We see a shift in the behaviour of macroeconomic and financial conditions in pre and post crisis period. Consumer confidence index of China influence jumps in pre-crisis (Covid-19) however in post-crisis we find CIC cannot influence jumps. After crisis China tends to recovery. Increase in oil prices and volatility jumps are negatively linked in post crisis. During Covid-19, lock down restrictions shutdown industries and exports, lead to decrease in oil prices. This was an unexpected decrease in oil prices, first time happened which Shaked the whole economy. Before crisis GDP of China negatively cause jumps at its lag term. While no evidence is found for post crisis. Geopolitical risk is more pronounced in pre-crisis as compared to post crisis period. The behaviour of geopolitical risk differs in pre and post crisis with realized volatility jumps. Industrial production explains a negative link with volatility jumps in all periods. Consumer price index (CP) positively influence realized volatility jumps in pre-crisis. However, reverse for effective exchange rate (EX) is found. We find stock prices changes at t to t-1, highlight leverage effect in pre-crisis period. Whereas positively explain jumps in the whole sample and in post-crisis at its lag terms. Credit spread is a measure of liquidity, inversely linked to post crisis realized volatility jumps at its lag terms. A clear shift in the behaviour of economic policy uncertainty is found in pre- and post-crisis. Market sentiment index positively influence jumps in all periods at t. Market sentiments can affect returns of equity stock markets of China.

Conclusion

This study extends previous analysis, which consider financial factors can derive jumps in volatility and left economic variables which is addressed here considering the most recent crisis and its pre and post periods. Daily equity stock index of Shenzhen stock market is considered to compute log returns from 1st January 2010 to 31st August 2023. Jumps in returns volatility are determined through difference in realized median of each month. All the monthly explanatory variables (economic and financial) are regressed with dependent variable (realized volatility jump) which uncovers economic factors are negatively associated to jumps in volatility and positively to financial conditions. The intensity and behaviour of economic-financial conditions shifts in pre and post crisis periods. We can interpret that business cycle fluctuations can cause jumps in returns volatility but in a negative manner. Whereas short term uncertainty in financial markets directly influence jumps in equity stock markets of China in pre and post crisis (Covid-19). Short-term investment decisions can be made on the basis of financial conditions and long-term decisions on economic conditions.

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