Empirical Analysis of Stock Patterns in the Hong Kong Stock Market Based on Asset Pricing Models and Prospect Theory

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Abstract. COVID-19 impacts hundreds and thousands of people globally while increasing volatility in the Hong Kong stock market, Asia's financial hub. This paper aims to investigate whether prospect theory and COVID-19 can help illustrate variations in stock returns on the market based on asset pricing models. The empirical findings demonstrate that the pandemic triggers volatility in the Hong Kong stock market. The return of Portfolios is highly correlated to Hong Kong's broad stock market. Five factors of Fama French models help improve the model's performance by capturing cross-sectional anomalies such as firms' size, profitability, etc. Prospect theory reinforces the accuracy of the model's prediction, although explanatory power is minimal. Stocks with the highest previous monthly returns have higher returns in the current month. Momentum exists in the Hong Kong stock market, particularly stocks with large market capitalization. Value-weighted portfolios perform better than equal-weighted. Asset pricing models reach precise results because of R-square and are applicable to reflect stock returns' patterns in the Chinese stock market.

Keywords: Market Volatility; Asset Pricing; Prospect Theory; Hong Kong Stock Market.

1. Introduction

COVID-19 outbreak at the end of December 2019 after the first case of the virus was confirmed, and the virus has spread across all the countries within three months. Undoubtedly, the pandemic is the most severe disease in the past decade. Additionally, it negatively influences the global financial market, triggering large fluctuations in the market. For example, the standard deviation of stock returns in the U.S. was 1.36, compared with 1.47 in China, and the U.S. crude oil future market price experienced a sharp decline of 80% during the first four months. Hong Kong's stock market attracts many young investors to conduct investing activities and is recognized as the most active financial market in the world. The pandemic also has adverse effects on the market, and evidence illustrates that the Hang Seng Index has descended about 25% in March 2020. Prospect Theory is a risk factor that can help interpret variations in stock returns, and it describes how investors respond to 'gain' or 'loss' in investments depending on individual preferences, which is inconsistent with expected utility theory.

The paper will investigate how COVID-19 and Prospect Theory can affect stock returns based on asset pricing models in the Hong Kong Stock Market for the past decade. Section 2 is the literature review, section 3 is the research design, section 4 describes the model design, section 5 includes empirical results, and section 6 includes findings plus conclusions.

2. Literature Review

The capital asset pricing model measures the sensitivity of a portfolio's return to systematic risks, and it is widely used to price financial assets. However, the model cannot capture market anomalies and attach great importance to systematic risk in asset returns. To overcome the limitations of CAPM, the Fama French five-factor model is introduced, which incorporates firms' size, value, profitability, and investment styles into predicting the performance of stock returns. Mosoeu and Kodongo manifest that profitability has explanatory power for returns on stocks in emerging markets, which indicates that firms with robust profitability can have superior performance returns than those with impoverished performance [1]. Huang argued that the model has superior performance to other

traditional asset pricing models in China; besides, investment and profitability factors strengthen the model performance while extra factors have minor explanatory power for stock returns [2].

Hypothesis 1: Asset pricing models can help clarify variations of stock returns listed in the Hong Kong Stock Market.

COVID-19 has spread worldwide, enabling the global economy to pour into a downturn, and the pandemic has led to tremendous volatility in the global financial market. According to Zhang and Hamori, COVID-19 has generated a sequence of unpredictable risks, including changes in oil prices and damage to stock markets, bringing huge losses for investors [3]. Lo et al. reported that the S&P 500 experienced an acute decline of around 30% due to the pandemic, and the price of a barrel of crude oil on the US futures market reached -37.63 dollars on 21 March 2020 [4]. Besides, Owusu and Bentum found COVID-19 has a negative relationship with stock market performance in African Countries, and evidence depicted that Mauritius experienced around 20% decline in stock during COVID-19 [5]. In addition, Kusumahadi and Permana found that the number of deaths from COVID-19 has a negative impact on stock returns. In contrast, it is positively relevant to the volatility of stock price, which means that confirmed cases brought volatility to the stock market [6].

Hypothesis 2: COVID-19 has negative impacts on the Hong Kong Capital Market.

Prospect theory is the alternative model of expected utility theory, which provides investors with a convenient method to appraise decisions under uncertainty through a series of psychological criteria [7]. Prospect theory has four components: reference dependence, a value function, diminishing sensitivity, and probability weighting. Barberis et al. describe that the value curve is concave in the gain part and convex in the losses part, separated by a kink at its origin [8]. It represents that investors face greater sensitivities to losses than gains, known as 'loss aversion'. Besides, Kaustia commented that the disposition effect is related to the S-shape value function of prospect theory that indicates investors are likely to hold losing stocks.

In contrast, investors are prone to sell stocks instantly once the price exceeds the initial price [9]. In the long term, investors are associated with a lower tendency to sell their gains in that investors receive less utility from realizing gains due to the lock-in effect of capital gains tax. Besides, Zhong and Wang argued that the prospect theory could be quantified as prospect theory value which has predictive power in the bonds market, pointing out that attractive bonds have higher prospect theory value. Still, it brings little future returns [10].

Hypothesis 3: Prospect theory can interpret stock returns in the Hong Kong Stock Market.

3. Research Design

3.1. Data Description

To examine whether the risk factors will affect the Hong Kong securities market, listed companies were selected from the Hong Kong Stock Exchange. The time period of the sample is chosen between 2006 and 2021. The selected companies cover 80% of market capitalization in the Hong Kong Stock market and can provide at least 15 years of historical data. In addition, small-size firms will be excluded from the datasets. Thus, the total sample size is 158 listed firms.

The paper chooses EIKON and Yahoo Finance as databases. Monthly stock prices and market indexes are exported from the two platforms. Hang Seng Index is used as a proxy of the Hong Kong Stock Market for extorting a basis analysis of the 60-day rolling volatility in the stock market. Excel plays a crucial and useful role in calculating the rolling volatility and logarithmic HSSI returns daily. Firm-related factors include SMB, HML, CMA, and RMW. Monthly datasets of the factors are downloaded from Kenneth Online Data Library. The data library was created by Kenneth R. French, an expert on the behavior of security prices and investment strategies [11].

Besides, 158 companies are organized into four groups in the market capitalization criterion. The largest size group is labeled as 'Portfolio 1', and 'Portfolio 4' has the smallest size group. Portfolio returns are calculated in the format of value-weighted and equal-weighted. The paper will do a set of

regression analyses based on 2006:01 to 2021:01 in the course of the past 15 years, and it counts 29388 monthly observations in the total sample and four groups.

Table 1. Statistics sample and full sample

	Obs.	Mean	Std. Dev.	Min	Max	Exc.Kurtosis	Skewness
Full Sample	29388	0.0014	0.1712	-3.5621	2.5835	25.63	-0.2585
Portfolio 1	7812	0.0093	0.1314	-2.4143	2.1293	27.41	-0.4818
Portfolio 2	7440	0.0043	0.1302	-2.9957	2.5835	28.07	0.7722
Portfolio 3	7440	-0.0015	0.1306	-3.5621	1.5404	30.51	-1.0243
Portfolio 4	6696	-0.0078	0.1327	-2.9907	2.2798	22.10	-0.2343

Table1 displays statistics of each stock's monthly return in full sample and sub-sample. There are 29,388 monthly observations in sum and each sub-sample has around 7000 monthly returns. From Table 1, it can be found that average annualized stock returns in full sample are approximately 1.68% with a standard deviation of of 2.05. The maximum monthly return is around 258% and minimum monthly return is around -356% which appears Hong Kong stock market was volatile in the past years. Additionally, the sample's skewness is almost negative about -0.26 in the full sample and -1.02 in Portfolio 3, meaning that people who purchased shares in the market are more likely to experience losses during the period.

Table 2. Hang Seng Index monthly returns

	Obs.	Mean	Std. Dev	Min	Max	Skewness
Hang Seng Index Return	186	0.36%	0.11	-0.25	0.16	-0.67

Table 2 displays characteristics of Hang Seng Index monthly returns used as an explanatory variable. Compared with the four portfolios, it is clear that the Hang Seng Index's volatility is smaller and its standard deviation of 1.32. It indicates that the index is a well-diversified market portfolio because the index has the highest return given a certain of risks.

Table 3. Correlations of each variables

	R_m-R_f	SMB	HML	RMW	CMA
Rm-Rf	1				
SMB	0.22	1			
HML	0.12	0.36	1		
RMW	-0.25	-0.34	-0.04	1	
CMA	-0.17	0.09	0.49	0.05	1

Table 3 reports correlations of variables: excess market return, SMB, HML, RMW and CMA. The variable of excess market return is positively related to variables of SMB, HML and has negative impacts on RMW, CMA. Variable of RMW has a negative correlation with SMB and HML but CMA positively correlated with SMB, HML and RMW.

3.2. Modelling

For verification of the hypothesis, the paper has designed complex asset pricing models. Firstly, it conducts regression analysis of capital asset pricing models and considers the impact of board stock market in Hong Kong. Next, it analyzes datasets via Fama French three and five factors models, incorporating firms' size, value, profitability and investment patterns into asset pricing for capturing market anomalies in the market.

$$r_{it} - r_{i,f} = \alpha_{i,t} + \beta_{mkt}(r_m - r_f) + \beta_{SMB}r_{t,SMB} + \beta_{HML}r_{t,HML} + \beta_{RMW}r_{t,RMW} + \beta_{CMA}r_{t,CMA} + \varepsilon_t \quad (1)$$

Gregoriou and Healy stated that 'Peak end rule' is the proxy of prospect theory and two additional variables are generated as 'Peak' and 'End' [7]. In the section, it explores the relationship between

two variables and stock returns in the first step. Then, it intends to explore whether the prospect theory is able to impact stock returns based on capital asset pricing model and Fama French models via modified asset pricing models as shown below.

$$r_{it} - r_{i,f} = \alpha_{i,t} + \beta_{MaxPi_{t-1}} MaxPi_{t-1} + \beta_{i,Pi_{t-1}} Pi_{t-1} + \beta_{SMB} r_{t,SMB} + \beta_{HML} r_{t,HML} + \beta_{RMW} r_{t,RMW} + \beta_{CMA} r_{t,CMA} + \varepsilon_t \quad (2)$$

Additionally, the article plans to adopt 60 days rolling standard deviation to test impacts of COVID-19 on stocks listed in Hong Kong Stock Exchange.

3.3. Variable Descriptions

The section illustrates variable descriptions in the regression analysis and Table 4 shows the variables definitions and abbreviation. Foye stated that the market factor is calculated as value-weighted average returns of all stocks within the region minus the monthly returns on one-month U.S. Treasury Bills and the factor is labeled as Rm-Rf [12]. In the paper, market portfolio return is denoted as Rm. and Hang Seng Index is chosen as proxy of Hong Kong Stock Market. Risk free rate labeled as Rf is riskless assets' returns. It equals to the average deposit rates of the Chinese Commercial Banks including ICBC, CMB and CCB, thus the rate is 2.75%. Rm-Rf represent expected excess returns of market returns and is calculated by returns on market less return on risk free assets.

Fama and French (2015) illustrated that in a five-factor model size, value, profitability and investment patterns have been incorporated into the investigation of average stock return [13]. Thus, 'SMB' measures the size effect, 'HML' measures the value effect, 'RMW' represents profitability on company and 'CMA' outline investment styles of each company. In other words, the size factor, denoted as 'SMB' measures the difference among the returns on small-cap stocks and large-cap stocks. The value factor is labeled as 'HML and it measures returns on High B/M stocks minus returns on Low B/M stocks. The profitability factor computes differences in stock returns with robust and weak operating profitability and is presented by 'RMW'. Investment styles factor estimates the investment style of public companies which gauges changes in returns among stocks that invest aggressively and conservatively. The factor is called 'CWA'.

According to Gregoriou and Healy, it can be found that Daniel Kahneman who is an economist and Noble Price winner created 'Peak-End' rule for evaluating 'gains' or 'losses' comparing with the reference points and Max_{Pit-1} and Pi_{t-1} variable are the explicit representatives of 'Peak-End' rule [7]. In details, Max_{Pit-1} implies that highest excess daily return of $portfolio_i$ in the preceding month and Pit-1 is excess monthly return of $portfolio_i$ in the previous month.

Table 4. Variables descriptions

Variables	Description
R_f	Returns on risk free assets
R_m-R_f	Excess returns on board stock market
SMB	Firm size
HML	Firm fundamentals
CMA	Investment styles
RMW	Profitability factor
$MaxPi_{t-1}$	The previous highest excess daily return of $portfolio_i$
$Pi_{t-1.}$	The previous excess monthly returns of $portfolio_i$

4. Empirical Results

In the section, it outlines empirical results of the complex asset pricing model. The Table 5 describes CAPM regression results of the full sample and four individual groups. In the full sample, investors who hold the value-weighted full sample can earn abnormal returns in Hong Kong Stock Market as shown by the positive alpha about 0.021 and it has a positive relationship between excess

market return with the portfolio which indicates that 1% increase in the excess market return could cause the return on portfolio goes up around 1.52%. In addition, the coefficient of excess market return is significant at level of 1%, 5% and 10%.

Comparing with value-weighted portfolio, equal-weighted portfolio has the similar tendency but it has inferior performance than portfolio constructed by value-weighted formats. The differences between the portfolios are almost 0.023. Besides, coefficients of excess market returns in equal-weighted are positive and they are statistically significant at any level. R-squares of full sample and major portfolios are closed to 1, meaning that fitness of the model is good while whereas performance of group 4 is acceptable. Portfolios comprise of large companies have the ability of beating the board market in Hong Kong because the alpha is positive. It demonstrates that market efficiency hypothesis does not exist in the Hong Kong stock market.

Table 5. Capital asset pricing model

CAPM Regression Results	α	β_{MKT}	R-Square
Full Sample (EW)	-0.002	0.996	0.64
	(-0.64)	-18.27	
Full Sample (VW)	0.021	1.134	0.7
	-6.02	-20.85	
Portfolio 1 (EW)	0.009	1.12	0.81
	0	-28.03	
Portfolio 1 (VW)	0.022	1.137	0.7
	-6.1	-20.54	
Portfolio 2 (EW)	0.003	1.078	0.58
	-0.62	-16.06	
Portfolio 2 (VW)	0.003	1.06	0.6
	-0.64	-16.58	
Portfolio 3 (EW)	-0.008	0.896	0.49
	(-1.75)	-13.37	
Portfolio 3 (VW)	-0.006	0.915	0.51
	(-1.48)	-13.83	
Portfolio 4 (EW)	-0.038	0.869	0.4
	(-8.21)	-11.17	
Portfolio 4 (VW)	-0.038	0.859	0.4
	(-8.06)	-11.04	

Fama French three factors model's regression results are shown in Table 6. It illustrates that excess market returns positive related to portfolio's returns. It means that one percent of increase in excess market return causes that the portfolio's return goes up about certain amount of beta. The coefficient of variable is statistically significant at 1%, 5% and 10%. Large market size of portfolios and value-weighted portfolios can generate abnormal returns with positive alpha of 1% approximately and it violates market efficient hypothesis in Hong Kong Stock Market.

Beta of SMB is positive in sample except for Group4, indicating that one increase in returns of small firms brings higher returns in portfolios. In value-weighted full sample, there is more than 0.31 times growth in the portfolio's return accompanying with one unit increase in small firms' returns. Besides, the coefficient of firm-related size factor is statistically significant at 10% in value-weighted full sample and sub-sample portfolio1 to portfolio 3. And coefficients of HML are negative in the most sample but it appears positive in group 4. It indicates that portfolios are prone to contain growth stocks with lower book to market ratio because it has the potential ability to generate more returns than others. Nonetheless, the value factor is insignificant at any level and cannot illustrate the returns' variations significantly in Hong Kong Stock Market.

Table 6. Fama French three factors model

FF Three Factor Model	α	β_{MKT}	β_{SMB}	β_{HML}	R-Square
Full Sample (EW)	-0.003	0.978	0.2	-0.015	0.65
	(-0.83)	-17.47	-1.45	(-0.15)	
Full Sample (VW)	0.02	1.114	0.309	-0.157	0.71
	-5.71	-20.14	-2.27	(-1.34)	
Portfolio 1 (EW)	0.008	1.104	0.176	-0.002	0.81
	-3.12	-26.98	-1.75	(-0.03)	
Portfolio 1 (VW)	0.021	1.117	0.303	-0.149	0.7
	-5.78	-19.8	-2.18	(-1.26)	
Portfolio 2 (EW)	0.001	1.048	0.356	-0.062	0.59
	-0.33	-15.3	-2.11	(-0.43)	
Portfolio 2 (VW)	0.002	1.034	0.32	-0.083	0.61
	-0.37	-15.83	-1.99	(-0.60)	
Portfolio 3 (VW)	-0.007	0.886	0.321	-0.033	0.52
	(-1.73)	-13.1	-1.94	(-0.23)	
Portfolio 3 (EW)	-0.009	0.87	0.282	-0.031	0.5
	(-1.96)	-12.68	-1.67	(-0.22)	
Portfolio 4 (VW)	-0.037	0.865	-0.062	0.007	0.4
	(-7.97)	-10.77	(-0.31)	(-0.04)	
Portfolio 4 (EW)	-0.04	0.87	-0.032	0.04	0.4
	(-8.11)	-10.83	(-0.16)	-0.23	

Table 7 displays the Fama French five factor model's results. After adding two extra factors, some of five factors in the model become invalid but the board market is still robust to interpret the portfolio returns. In details, coefficients of CMA and RMW are statistically significant in the value-weighted full sample and value-weighted portfolio 1 at level 1%, 5% and 10%.

Table 7. Fama French five factor model

FF Five Factors Model	α	β_{MKT}	β_{SMB}	β_{HML}	β_{CMA}	β_{RMW}	R-Square
Full Sample (EW)	0	0.95	0.17	0.08	-0.35	-0.08	0.72
	-0.84	-16.22	-1.19	-0.6	(-1.38)	(-0.38)	
Full Sample (VW)	0.02	1.06	0.2	0	-0.5	-0.44	0.72
	-5.93	-18.6	-1.43	-0.04	(-2.10)	(-2.04)	
Portfolio 1 (EW)	0.01	1.09	0.18	0.09	-0.34	0.04	0.82
	-3	-25.37	-1.66	-0.9	(-1.87)	-0.27	
Portfolio 1 (VW)	0.02	1.06	0.2	0.01	-0.51	-0.43	0.72
	-6	-18.27	-1.37	-0.1	(-2.02)	(-2.04)	
Portfolio 2 (EW)	0	1.02	0.3	0.04	-0.34	-0.2	0.6
	-0.37	-14.13	-1.72	-0.24	(-1.09)	(-0.74)	
Portfolio 2 (VW)	0	1.02	0.26	0.03	-0.35	-0.25	0.61
	-0.43	-14.59	-1.52	-0.17	(-1.20)	(-0.99)	
Portfolio 3 (VW)	-0.01	0.86	0.3	0.1	-0.46	-0.04	0.52
	-1.76	-12.08	-1.72	-0.57	(-1.51)	(-0.16)	
Portfolio 3 (EW)	-0.01	0.85	0.27	0.08	-0.39	-0.03	0.51
	-1.98	-11.72	-1.49	-0.46	(-1.27)	(-0.11)	
Portfolio 4 (VW)	-0.04	0.83	-0.11	0.12	-0.38	-0.19	0.4
	-7.53	-9.86	-0.55	-0.62	(-1.06)	(-0.63)	
Portfolio 4 (EW)	-0.04	0.84	-0.07	0.14	-0.34	-0.14	0.41
	-7.71	-9.96	-0.35	-0.71	(-0.94)	(-0.46)	

Beta of RMW is negative, which explains that the level of firms' profitability has an adverse influence on the portfolios' returns. If companies have higher profitability about 1% than the previous years the portfolio could experience losses about 44% as shown in value-weighted full sample. Besides, CML measures firms' investment patterns and the results indicate that portfolio returns tend to stocks with conservative investing style. Provided that firms are less frequent for undertaking investing activities, they would afford more risks and cause 50% losses in returns. FF3 and FF5 model has superior performance because the models' R-square are greater than 0.5 in major models although R-square of portfolio 4 is 0.40.

Table 8 shows regression's results of capital asset pricing model additional with prospect theory. In the model 4, it presents that the market index and 'Peak End' factors have positive impact on the portfolio returns in the full equal-weighted and value-weighted portfolios. It indicates that the higher former monthly and daily returns can bring higher portfolios' returns. But the 'Peak' variable of the full samples is not significant at any level and its coefficient is negative in group 4 which means that growing stock returns in the previous month bring lower returns in the current month. In the model, alpha is positive about 1% particularly for portfolios consisting of large market capitalization.

Table 9 shows regression's results based on Fama French Three Factor Model. In the model 5, the 'Peak' variable has a positive relationship between the portfolios' returns. It means that the growing daily returns of portfolios in the previous month can predict the consecutive monthly return but it is inverted in the small-size portfolios. The range of 'End' variable is from 0.01 to 0.3 for the whole sample, indicating that the previous monthly return of portfolio goes up 1 percent then portfolios' returns increase about 2% and 30% level. As for firm-related factors, the beta of value effect is negative in the whole sample but it is not meaningful which can be seen as a redundant variable.

Based on Fama French Five Factors Model with 'peak-end' rule, firms-related risks and $MaxP_i$ are insignificant in the full sample and group 1 to group3 as shown in Table 10, but variable P_i has explanatory power in the entire trial. It points out that the higher monthly return in the previous month is, the higher portfolio return is in the current month. To be specific, the unit of one increase in monthly returns of former month brings more returns about 20.32% in the equal-weighted full portfolio meanwhile the beta of 'End' variable is statistically significant at 1%, 5% and 10%.

Table 8. Capital asset pricing model and 'peak-end' rule

CAPM+ 'Peak-End'	α	β_{MKT}	$\beta_{MaxPit-1}$	β_{Pit-1}	R-Square
Full Sample (EW)	0.0053	0.9799	0.2703	0.2079	0.68
	-1.23	-18.75	-1.2	-4.85	
Full Sample (VW)	0.0245	1.1233	0.1977	0.0834	0.71
	-5.47	-20.69	-0.84	-1.87	
Portfolio 1 (EW)	0.0096	1.1064	0.0564	0.0837	0.82
	-3.7	-28.01	-0.33	-2.64	
Portfolio 1 (VW)	0.0195	1.1276	0.2611	0.0355	0.7
	-5.11	-20.5	-1.31	-0.87	
Portfolio 2 (VW)	0.0091	1.0516	0.3853	0.1987	0.64
	-2.11	-17.04	-1.52	-4.46	
Portfolio 2 (EW)	0.0089	1.0688	0.2979	0.2042	0.63
	-1.97	-16.48	-1.19	-4.49	
Portfolio 3 (VW)	-0.0047	0.893	-0.2208	0.1458	0.53
	-0.89	-13.54	-0.77	-2.83	
Portfolio 3 (EW)	-0.0063	0.8674	-0.3053	0.16	0.52
	-1.19	-13.01	-1.13	-3.08	
Portfolio 4 (VW)	-0.0278	-0.003	-0.0894	0.013	0.03
	-28.68	-0.21	-2.02	-1.27	
Portfolio 4 (EW)	-0.0279	-0.0028	-0.0962	0.0155	0.04
	-28.07	-0.2	-2.17	-1.49	

Table 9. Fama French three factors model and 'peak-end' rule

	α	β_{MKT}	β_{SMB}	β_{HML}	$\beta_{MaxPit-1}$	β_{Pit-1}	R-Square
Full Sample (EW)	0.0048	0.9684	0.1505	-0.027	0.2793	0.2037	0.69
	-1.11	-18.09	-1.13	-0.24	-1.23	-4.72	
Full Sample (VW)	0.0236	1.1097	0.2598	-0.1535	0.2091	0.0782	0.72
	-5.28	-20.1	-1.9	-1.33	-0.9	-1.76	
Portfolio 1 (EW)	0.0092	1.0938	0.1368	0.0061	0.0644	0.0806	0.82
	-3.5	-27.06	-1.36	-0.07	-0.38	-2.53	
Portfolio 1 (VW)	0.0182	1.1104	0.2842	-0.1489	0.0307	0.3039	0.71
	-4.75	-19.83	-2.03	-1.26	-0.76	-1.52	
Portfolio 2 (EW)	0.0078	1.0474	0.2828	-0.0632	0.2951	0.1939	0.63
	-1.71	-15.81	-1.72	-0.46	-1.18	-4.24	
Portfolio 2 (VW)	0.0082	1.0333	0.2557	-0.0745	0.3848	0.1899	0.65
	-1.87	-16.38	-1.64	-0.57	-1.52	-4.24	
Portfolio 3 (VW)	-0.0057	0.8702	0.2909	-0.0531	-0.2119	0.1391	0.54
	-1.08	-12.93	-1.75	-0.38	-0.74	-2.69	
Portfolio 3 (EW)	-0.0074	0.8474	0.2536	-0.0528	-0.312	0.1533	0.53
	-1.38	-12.42	-1.51	-0.37	-1.16	-2.93	
Portfolio 4 (VW)	-0.0278	0.001	-0.0268	-0.025	-0.0867	0.0144	0.04
	-28.6	-0.07	-0.75	-0.83	-1.95	-1.39	
Portfolio 4 (EW)	-0.0279	0.0012	-0.029	-0.0231	-0.0944	0.0168	0.05
	-28.01	-0.08	-0.8	-0.75	-2.12	-1.6	

Table 10. Fama French five factors model and 'peak end' rule

	α	β_{MKT}	β_{SMB}	β_{HML}	β_{CMA}	β_{RMW}	$\beta_{MaxPit-1}$	β_{Pit-1}	R-Square
Full (EW)	0.0044	0.956	0.1588	0.047	-0.2838	0.0719	0.2726	0.2032	0.69
	-1.02	-17.01	-1.14	-0.36	-1.18	-0.35	-1.2	-4.63	
Full (VW)	0.0238	1.0633	0.1646	-0.0004	-0.4712	-0.4126	0.2256	0.059	0.73
	-5.4	-18.65	-1.16	0	-1.96	-1.93	-0.98	-1.33	
Port. 1 (EW)	0.0088	1.0823	0.1524	0.0835	-0.3071	0.109	0.0461	0.0813	0.82
	-3.35	-25.62	-1.45	-0.85	-1.69	-0.69	-0.27	-2.51	
Port. 1 (VW)	0.0185	1.0589	0.1766	0.0064	-0.4852	-0.4662	0.3484	0.014	0.72
	-4.89	-18.32	-1.22	-0.05	-1.95	-2.18	-1.77	-0.35	
Port. 2 (EW)	0.0077	1.0275	0.2632	0.0229	-0.3036	-0.062	0.3009	0.1907	0.64
	-1.68	-14.78	-1.52	-0.14	-1.02	-0.24	-1.19	-4.11	
Port. 2 (VW)	0.0084	1.0065	0.2153	0.0306	-0.357	-0.1558	0.4194	0.1847	0.65
	-1.9	-15.27	-1.31	-0.2	-1.27	-0.64	-1.65	-4.08	
Port. 3 (VW)	-0.0064	0.8519	0.3	0.0524	-0.3973	0.0867	-0.237	0.1349	0.55
	-1.2	-12.07	-1.72	-0.32	-1.31	-0.33	-0.82	-2.57	
Port. 3 (EW)	-0.0083	0.8332	0.2708	0.0342	-0.3357	0.1144	-0.35	0.1495	0.53
	-1.52	-11.59	-1.53	-0.2	-0.44	-1.09	-1.29	-2.8	
Port. 4 (VW)	-0.0283	0.0167	0.0113	-0.0704	0.1303	0.1668	-0.0891	0.0197	0.11
	-29.76	-1.13	-0.31	-2.06	-2.08	-3.09	-2.07	-1.94	
Port. 4 (EW)	-0.0284	0.0183	0.0118	-0.0737	0.1463	0.1774	-0.0952	0.0226	0.13
	-29.33	-1.23	-0.32	-2.13	-3.25	-2.31	-2.22	-2.2	

Overview of volatility in Hong Kong Stock Market has been shown in Figure 1. It can be clearly found that there are five main periods of fluctuation in the past 15 years: 2007-2008, 2011-2012, 2014-2015, 2017-2018 and 2019-2020.

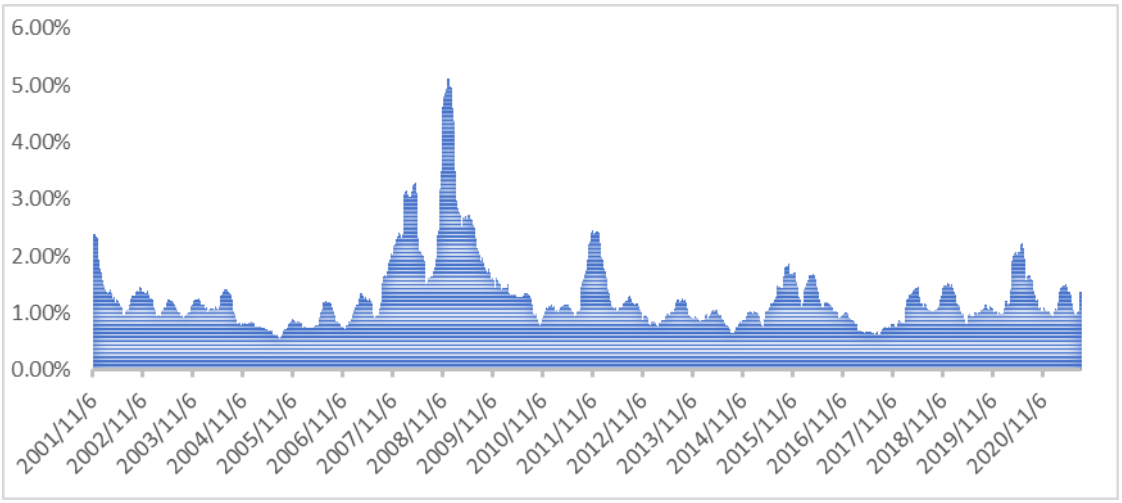

Fig 1. 60 day rolling standard deviation of Hong Kong stock market in the past decade (Photo/Picture credit: Original)

In the first period of fluctuation, the volatility of Hang Seng Index reached at the peak that the highest 60 rolling daily standard deviation is about 5.0%. Reasons for the volatility are subprime crisis and 2008 financial crisis in the US which has spread all over the world and gave rise to a sharp decline in financial products such as stocks, bonds and futures. In the 2011-2012, the stock market bear 2.5% daily standard deviation. This is contributed by China Securities Regulatory Commission, who conducts general elections to make efforts against inside trading and illegal behaviors of managers who work in brokerage companies. Besides, some environmental issues troubled the steel industry and intensive regulations distressed the corporations' financial conditions. In third period, the daily volatility of Hong Kong Stock Market has reached between 1% and 2%. According to the main index of Chinese stock market, it can be found that the indexes have climbed consecutively around 5% on a daily basis at the starting of 2015 and the market experienced reversal effect that it poured into the bear market in the following months that returns on the index have decreased around 6%. US-China trade war has triggered a large fluctuation in Hong Kong Stock Market bringing tremendous volatility about 1.5% of 60 rolling daily standard deviation on the announcement date of trade war. The last period of 2019-2020, the COVID-19 pandemic has an outbreak at the end of 2019. It triggered 2% of volatility in Hong Kong Stock Market and that means investors are likely to experience higher volatility in the stock market which makes the market more volatile.

Table 11. Data statistics of 60 days rolling volatility in Hong Kong Stock Market

	Obs.	Mean	Std. Dev	Min	Max	Skewness	Kurtosis
60 Days Rolling Volatility	4874	1.27%	0.63%	0.56%	5.12%	11.18	2.85

Table 11 shows that data statistics of the rolling 60 days volatility of Hong Kong stock market in the past twenty years. It describes that the maximum standard deviation is around 5.12% and 0.56% is the minimum daily volatility. Besides, the average rolling 60 days volatility is around 1.27 and median is around 1.09%.

Full sample is selected for conducting experiment of volatility and data statistics as shown in Table 12. The volatility is measured by standard deviation of the sample which excludes 2008 financial crisis factor and starts from 2010 to now. Evidence describes the annual returns on the equal-weighted full sample are lower than the value-weighted which is -3.41% and 25.62% separately, corresponding to standard deviation in the dataset of value-weighted full sample is 5.65 larger than the Equal-weighted Full sample. 'After COVID-19' sub-period has higher volatility about 6.61 than 'Before COVID-19' in the period dataset. When 2008 Financial Crisis is taken into account, the total observations counts for 3806 in full sample. Its annual standard deviation of Value-Weighted and

Equal-Weighted Portfolio are 6.78% and 4.21%, higher than the former dataset which excludes the risk factors.

Table 12. Volatility and data statistics in sub-period analysis

		Obs.	Mean	Std. Dev	Min	Max	Skewness	Kurtosis
Full Sample (Ex. 2008 Financial Crisis)	VW- Portfolio	2817	25.62%	5.65	-8.12%	8.54%	-0.2	2.13
	EW- Portfolio	2817	-3.41%	3.92	-11.01%	15.78%	-0.41	27.89
Prior to COVID-19	VW- Portfolio	2463	23.35%	5.5	-8.12%	8.54%	-0.19	2.34
	EW- Portfolio	2463	-5.11%	3.93	-11.01%	15.78%	-0.36	31.26
After COVID-19	VW- Portfolio	353	41.16%	6.61	-5.93%	6.47%	-0.24	1.06
	EW- Portfolio	353	8.19%	3.85	-4.04%	3.03%	-0.8	2.28
		Obs.	Mean	Std. Dev	Min	Max	Skewness	Kurtosis
Full Sample (In. 2008 Financial Crisis)	VW-Portfolio	3806	40.06%	6.78	-13.87%	11.24%	-0.05	3.79
	EW- Portfolio	3806	4.21%	4.3	-11.01%	15.78%	-0.66	17.42
Prior to COVID-19	VW- Portfolio	3452	39.93%	81.53	-13.87%	11.24%	-0.03	4.04
	EW- Portfolio	3452	3.78%	52.1	-11.01%	15.78%	-0.65	-0.65
After COVID-19	VW- Portfolio	354	41.41%	79.24	-5.93%	6.47%	-0.24	1.07
	EW- Portfolio	354	8.43%	46.19	-4.04%	3.03%	-0.8	2.29

5. Discussion

Empirical findings of sub-period analysis narrate that volatility of 'After COVID-19' period is higher than 'Before COVID-19' period in the datasets. Hong Kong Stock Market is volatile during the pandemic but it has compensated relatively higher returns for investors. Results of control group with factor of 2008 financial crisis illustrate that impacts of financial crisis is deeper than the COVID-19 pandemic and brought higher fluctuations in Hong Kong stock market as well.

After applying asset pricing models into the market, it finds that broad stock market has positive impacts on returns of portfolios and it is robust to explain variations of stock returns in the market. It means that one unit increase in returns of the board stock causes higher returns on the index. Size effect exists in portfolios that adding small size firms into the portfolios can carry higher returns in portfolios. Besides, HML is a redundant factor in asset pricing model applied in emerging market and it is insignificant to explain changes in stocks. Even though, the coefficient HML is negative which means that growth stocks is possible to outperform than value stocks in Hong Kong. But there is an occasional phenomenon that profitable companies cannot guarantee profits in the market and negative beta of RMW is weak to clarify returns on portfolios which may be attributed to market anomalies and systematic risks such as: pandemic, investors' behavior, etc. It indicates that companies with higher profitability are likely to suffer a small number of losses due to higher risks in long-term. Firms with aggressive investment patterns can grasp certain amount of returns and it is also attributed to the huge volatility of financial markets during the pandemic.

Prospect theory is added for enhancing performance of asset pricing models and it makes profitability effect appear in the market whereas it has minimal explanatory power in the Hong Kong Stock Market. 'Peak End' rule as explicit representation of prospect theory is widely used to pricing stocks. Investors are likely to realize gains and sell shares regardless of firms' financial performance, particularly in the pandemic. The higher previous monthly stock returns forecast higher returns in the current month which is known as momentum. The variable has a positive relationship with returns on portfolios which comprises of large market capitalization firms and the trend disappears in small size firms. Moreover, value-weighted portfolios can engender higher profits than portfolios constructed by equal-weighted method. Market efficiency does not exist in Hong Kong Stock Market and investors can beat the market because of positive alpha. The paper suggests professional investors can utilize volatility for securing profit, for instance they can adopt aggressive investment patterns through frequently taking short and long positions on stocks in the volatile market. Besides it advises that asset managers construct portfolios in format of value-weighted.

6. Conclusion

COVID-19 is a global pandemic and affects the entire financial market deeply covering Hong Kong Stock Market. Asset pricing models are widely used for detecting the risks factors in securities market and they are also applicable in Hong Kong stock market. Capital asset pricing model gauges about the sensitivity of returns on stocks to excess market returns, which solely emphasizes the market risk. But drawback of the model is that it cannot capture any market anomalies in financial market. Market anomalies are caused by traders' behavior such as disposition effect, etc. Thus, Fama French three and five factor models were introduced for absorbing these anomalies into the model including size effect and fundamental effect, etc. To enhance the performance of model, the prospect theory is an additional factor considered in asset pricing that can explain investors' decision-making under uncertainty and risks.

The paper has conducted a set of regression analysis for whether asset pricing models, COVID-19 and the prospect theory can clearly explain the trend of portfolios returns. Empirical findings reveal that firms-related risk factors can help explain variations of stock returns in Hong Kong as well as prospect theory whereas the factors have diverse explanatory power. In addition, it depicted that COVID-19 has caused a fluctuation to the financial market in Hong Kong and the market is volatile in the past decade. The limitation is that scope of the research is wide. And the future improvement is that it continues to highlight topics about asset pricing models and behaviour finance but it will discuss them in details and compare different asset pricing models meanwhile seeking out additional factors for improving model's performance.

References

[1] Mosoeu, S. and Kodongo, O. (2020). 'The Fama-French five-factor model and emerging market equity returns', The Quarterly Review of Economics and Finance, pp. 1-22.

[2] Huang, T.-L. (2019). Is the Fama and French five-factor model robust in the Chinese stock market? Asia Pacific Management Review, pp. 278-289.

[3] Zhang, W. & Hamori, S. (2021). 'Crude oil market and stock markets during the COVID-19 pandemic: Evidence from the US, Japan, and Germany', International Review of Financial Analysis, pp. 101702.

[4] Lo, G. D., Bassene, T., and Sene. B. (2021). 'COVID-19 And the African Financial Markets: Less infection, less economic impact?', Finance Research Letters, pp. 102148.

[5] Owusu Takyi, P. and Bentum-Ennin, I. (2020). 'The impact of COVID-19 on stock market performance in Africa: A Bayesian structural time series approach', Journal of Economics and Business, pp. 105968.

[6] Kusumahadi, T. A. and Permana, F. C. (2021). 'Impact of COVID-19 on Global Stock Market Volatility', Journal of Economic Integration, pp. 20-45.

[7] Gregoriou, A., Healy, J. V. and Le, H. (2019). 'Prospect theory and stock returns: A seven factor pricing model', Journal of Business Research, pp. 315-322.

[8] Barberis, N. C., Wang, B. and Jin, L. J., (2021). Prospect Theory and Stock Market Anomalies. NBER Working Paper Series, pp.27155.

[9] Kaustia, M. (2010). 'Prospect Theory and the Disposition Effect', The Journal of Financial and Quantitative Analysis, pp. 791-812.

[10] Zhong, X. and Wang, J. (2018). 'Prospect Theory and Corporate Bond Returns: An Empirical Study.' Journal of Empirical Finance, pp. 25-48.

[11] French, K. R. (2021). Kenneth R. French - Data Library. Available at: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html.(Accessed 19 July 2021).

[12] Foye, J. (2018). A comprehensive test of the Fama-French five-factor model in emerging markets. Emerging Markets Review, pp. 199-222.

[13] Fama, E. F., & French, K. R. (2015). A five-factor asset pricing model. Journal of Financial Economics, pp. 1-22.