Fama and French Three Factor Model's Performance in the COVID-19 Pandemic: A Case Study for Technology, Healthcare and Finance Sectors

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Abstract—This paper examines the empirical performance of Fama and French Three Factor (FFTF) Model in the event of COVID-19 pandemic. The model estimation was implemented across different industries of technology, healthcare and finance. I find that the abnormal growth of different sectors can be well predicted by the FFTF Model. Within the potential factors, industry specific features are not the main source of reducing the forecasting capability of the model. In addition, the excess return on the market is the factor that dominates during the pandemic. This could be explained by the fear of the virus spreading and worsening the economy. It suggests that the performance of the market regarding to the risk-free rate should be taken as the key factor to predict the return. This research also indicates the degree of precision of the FFTF model which can help investors compare it with other asset pricing models.

Index Terms—Asset pricing, fama and French, three factor model.

I. INTRODUCTION

As the COVID-19 pandemic has spread globally, it creates the health crisis which causes detrimental effect on the financial market reducing a large part in the value of stocks for most of the industries. And as a result, the stock markets all around the world have been suffered the significant loss of trillion US dollars in one week (the week ending of February 28) which is the worst week of finance industry since the shock of financial crisis occurred in 2008-2010 (Nogi, 2020) [1]. Therefore, it is considered that the health crisis is not a good period to invest in.

However, this statement is still in the contest. To explain, many people believe that if the change in return can be predicted using the asset pricing model such as Fama and French Three Factors Model, we can leverage the acquired information to capture possible profit. However, the main question here is: Does the Fama and French three factors model perform well in the crisis period? Any strong economic models will have to overcome the anomalies which is the difference between the actual result and the result that are forecasted using the models. Fama and French use machine learning method to match their sample data with their regression phenomenally well [2]. The machine learning will use the underlying process that match each point of the

explanatory variable with the dependent variable in their sample data. Then most of the point in sample can be explained by the regression of three factors model. But it may not be efficient to fit the regression out of sample in the Corona pandemic as the impact of three factors are not identical as they used to be in the Fama & French sample and the previous underlying process is not accurate anymore. In practice, when the model is applied to forecast return with different sample, the degree of accuracy will not be the same. Because each data sample will imply unique characteristic of the economy and hence there will not be one size fit all approach to achieve in this case.

In addition, the Fama and French model introduced that value stocks, which is the stock with high ratio of book-to-market, earn higher return than growth stock- the stocks with low book-to-market ratio [2]. This is one of the three factors in the model: Value Premium. But in fact, according to (Bailliegiford, 2020) the growth stocks have generally outperformed value stocks helping the Scottish Mortgage Investment Trust during market falls of COVID-19 pandemic [3]. In addition, due to the impact of COVID-19 on stock market, the rate of growth stock, which relatively outperformed, has increased significantly in 2020 (Bickford, 2020) [4]. This has proven my previous point that the forecasting ability of the model will not be the same out of sample- in the COVID-19. Therefore, the model needs to be tested and compared for its performance in the COVID-19's recession. Because this is a popular and widely applied model to predict return, any significant change in the capability of prediction of the model may cause detrimental or beneficial impact to the investors.

Finally, according to (Roach, 2020), there are some certain industries such as Technology and Health care that benefit immensely from the COVID-19 while other sectors have fallen into the recession [5]. In addition, big tech companies such as Amazon, Google and Facebook have reported strong increase in sales and profit due to the increasing reliance of people on Technology service (Mattioli, 2020) [6]. For this reason, I will conduct the model estimation by sectors to clear the noise in the stocks coming from different industries and inducing industry specific information. The idea is to only capture the effect of three factors on return and reduce effect of other factors that are not included in the Fama and French model. It also helps me to clarify if the abnormal increase/ decrease in value of different sectors can be explained well by the model or not. So in this research, I will examine the predicting power of Fama and French model in the COVID-19 pandemic by three main industries which have the

different growth in the COVID-19 pandemic period: Technology, Healthcare and Finance to determine whether the model can work well in the recession.

II. LITERATURE REVIEW

There are some theories and literatures that need to be applied here to clarify and support my research proposal. Firstly, this research will use the results from the study of Jinjarak and Zheng (2010) to show that in the tranquil period, the flow of return is determined by the combination of price pressure and information while the information effect is proven to dominate in the financial panic [7]. It suggests that in the crisis of 2007-2009, the panic may make investors to be more sensitive to the 'bad' information which is theoretically supposed to induce further decrease in the return and increase the impact of market risk. Therefore, I expect that the return will be more sensitive with risk in the crisis of COVID-19. This research has given me the idea to test the impact of the Excess Return On Market- one of the factor in Fama and French model in the COVID-19 pandemic.

Secondly, the paper of Sarafrazi *et al.* (2014) found that in the financial crisis period, the portfolio which is diversified in the commodities' sector, especially gold is the one that achieve the best performances [8]. It can be explained as the crisis has reduced most of the assets' value except commodities. These commodities such as gold, silver and oil sometimes considered as more valuable than others' factors in the crisis. This result indicates that the industries with specific growth in the crisis can significantly increase the performance of all the stocks in these industries. After exploring this study about the crisis and industry specific, I think that my paper should take into account the impact of stock growth on the overall performance. However, different from financial crisis, there are still some industries that has excessive growth and benefit from the COVID-19 pandemic such as Healthcare, Information Technology industry. Therefore, the effect of these industries' growth on the sector performance in my research may be different with the result in Sarafrazi *et al*. research (2014) [8].

Finally, to prove the capability of prediction, the strong model is supposed to capture and go through negative shock from crisis which affect the functionality of the whole market. To support for this view, the research of Buelens (2012) indicated that the financial crisis has induced significant forecasting error to the three group of inflation model [9]. This paper is useful for me to realize that the model may not work well in the crisis due to the noise that occurred during this period. Therefore, the Fama and French three factors model should be tested for its predictive ability through the most recent issue: COVID-19 pandemic.

III. METHODOLOGY

Now I will focus on the method that is conducted and also display the hypothesis that will be tested in this paper.

A. Method

In this paper, I will use the log return of the sector as the dependent variable. To be clear, some of the stocks' return will fit the model measurement exceptionally well while other will be poorly explained by the Fama & French model. To increase the reliability of the model regression, I will integrate all of the stocks' return in the same industry and present them as the sector's return. With the sector's return, the variable estimation will be less dependent on a single stock return's variation and hence expected to have a more significant and precise outcome when running regression.

$$\text{Industry's market value of equity} = \sum_{i=1}^{i=K} \text{Stock's market value of equity}_i$$

$$\text{Sector return}_t = \sum_{i=1}^{i=K} \left(\frac{\text{Stock's market value of equity}_i}{\text{Industry's market value of equity}} \right) * \text{Stock return}_i$$

Firstly, instead of using the price which is available in the data base, I will measure the log return of the stocks based on its price to be the indicator of firms' performance. To be clear, the average price of stocks across industries will be noticeably different and hence induce the industry-specific information in it. The log return is the percentage change in log price of two different period. This is to make the dependent variable: firms' performance more meaningful and comparable across periods, industries.

$$\text{Return}_t = \text{Ln}(\text{price}_t) - \text{Ln}(\text{price}_{t-1})$$

Then based on the estimated variables that are presented above, I will apply the existing model: Fama & French model (1992) into the most recent crisis period: the COVID-19 pandemic to evaluate the how the performance of the sectors (dependent variable) is affected by the three factors: Excess return on the market, Size Premium and Value Premium (independent variables).

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1 * (R_{Mt} - R_{ft}) + \beta_2 * SMB_t + \beta_3 * HML_t + e_{it}$$

where $R_{it} - R_{ft}$ is the expected return, $R_{Mt} - R_{ft}$ is the Excess Return On The Market and SMB_t is the Size Premium and HML_t is the Value Premium and $\beta_1, \beta_2, \beta_3$ are the coefficient of the three factors.

The Fama and French model stated that the value stocks outperform growth stocks, stocks with small caps company or high book-to-market value stock will generate higher return [2]. However, the COVID-19 pandemic is a new issue which will generate a new data sample and included the noise in it making the result of this paper different from that of Fama and French.

For the same period of time, the result that is generated from regressions will be compared across industries. By doing this, we can see how well the return of each sector can be explain by the independent variables and examine whether the difference in the growth of these industries is a considerable issue that will decrease the accuracy of the model. Then I will compare between 2 period: before and during the COVID-19 pandemic. It can help me to expose the impact of the pandemic on the capability of the model to forecast the return and suggest what factor is more likely to drive the sector performance in this crisis period.

B. Testable Hypothesis

In this research, I will test the hypothesis whether the performance of the sectors can be significantly affected by

the three factors: Excess Return On Market, Size Premium and Value Premium. In contrast, the null hypothesis is that these three factors are no longer reliable to predict future return in crisis of Corona pandemic. The low p-values of each coefficient that is generated from the model means that the independent variables are statistically significant to explain the variation in sectors' outcome and vice versa. The significant result will verify the underlying economic mechanism implied in the model and prove that it still works well even in the crisis period.

C. Data and Sample Selection

Our paper will collect the data of Fama- French factors in Wharton Research Data Services (WRDS) since it has been well known as one of the broadest public source for stock market. Each of the factor will be acquired as the daily data. Each of the stock will have 2 main category of data which are market value and price. These variables will be taken from Refinitiv which is a global provider of financial market data. This is supposed to be downloaded as panel data which has multi dimension and is measured over time. For each sector, I will firstly take the daily data from the top 10 stocks which have the largest market value of equity and exclude all other stocks. To be clear, my initial goal is to get all the stocks from the same sector and then weighted average them to represent for that industry. However, after conducting research on the Refinitiv, there are many stocks in the industry that has been unlisted or relisted on the exchange market. Therefore, it is almost impossible to take all of the stocks' price and capital market in the same industry with the daily data type since we have to deal and measure with big data. For that reason, I will choose to pick only the top 10 stocks with highest market capitalization since the companies with higher market value of equity are supposed to have more impact in their industry's value. Then based on these three variables, I will compute the sector price as specified in the Method part. There are two data period that will be estimated distinctly in this paper: the whole data sample and the data sample for Corona pandemic. This is to merely capture and isolate the impact from the external shock of COVID-19 on the industry performance and show how well the three factors model works out of sample.

IV. RESULTS

Firstly, I use the daily return of each sector which is measured by the weighted average return of each stocks in the same industry and the Fama and French three factors including Excess return on the market, Size premium and Value premium from 2000 to 2020 to replicate the Fama and French model. Based on the estimated result, we can see that Fama and French is not a good model to predict the return in this period.

TABLE I: OLS REGRESSION RESULTS OF TECHNOLOGY SECTOR FROM 2000 TO 2020

R-squared: 0.012		Adjusted R-squared: 0.012	
	Coef	Std err	t	P-value
Intercept	0.0003	0.000	1.024	0.306
Mktrf	0.1699	0.023	7.251	0.000
Smb	0.0390	0.048	0.813	0.416
Hml	0.1030	0.043	2.412	0.016

TABLE II: OLS REGRESSION RESULTS OF HEALTHCARE SECTOR FROM 2000 TO 2020

R-squared: 0.014		Adjusted R-squared: 0.014	
	Coef	Std err	t	P-value
Intercept	0.0005	0.000	2.120	0.034
Mktrf	0.1500	0.019	7.939	0.000
Smb	0.0151	0.039	0.391	0.696
Hml	0.0780	0.034	2.265	0.024

TABLE III: OLS REGRESSION RESULTS OF FINANCE SECTOR FROM 2000 TO 2020

R-squared: 0.045		Adjusted R-squared: 0.045	
	Coef	Std err	t	P-value
Intercept	0.0002	0.000	0.859	0.390
Mktrf	0.2028	0.015	13.763	0.000
Smb	-0.0352	0.030	-1.167	0.243
Hml	0.1553	0.027	5.781	0.000

As we can see from the tables above, the return in three sectors: Technology, Healthcare and Finance are not explained well by Fama & French model with the low R-squared return. To be clear, Technology can be considered as the worst measurement with the value of 0.012. It means that only 1.2% of the change in return in the period of 2000 to 2020 is explained by the model. Healthcare obtained a slightly higher R-squared with 0.014 and Finance is the sector that fit model the most with 0.045 in the value of R-squared. Although three of the tables achieved significant result on the coefficient of Excess return on market and Value premium at 5% level, the unexpectedly small value of R-squared made the model unreliable to predict the future return in this period.

In the second steps, I will focus on analyzing the efficiency of the Fama and French Model in the period of COVID-19. The data now will be narrowed down and only from 1st January 2020 to 29th May 2020. The acquired results indicated that performance of stock can be explained well by the Three Factor models in the Corona pandemic's period.

TABLE IV: OLS REGRESSION RESULTS OF TECHNOLOGY SECTOR IN COVID-19 PANDEMIC

R-squared: 0.404		Adjusted R-squared: 0.386	
	Coef	Std err	t	P-value
Intercept	0.0005	0.003	0.167	0.868
Mktrf	0.7008	0.106	6.603	0.000
Smb	-0.6328	0.279	-2.267	0.026
Hml	0.2220	0.200	1.108	0.271

TABLE V: OLS REGRESSION RESULTS OF HEALTHCARE SECTOR IN COVID-19 PANDEMIC

R-squared: 0.359		Adjusted R-squared: 0.339	
	Coef	Std err	t	P-value
Intercept	-0.0013	0.003	-0.425	0.671
Mktrf	0.7767	0.112	6.922	0.000
Smb	0.4727	0.295	1.602	0.112
Hml	-0.2381	0.212	-1.124	0.264

TABLE VI: OLS REGRESSION RESULTS OF FINANCE SECTOR IN COVID-19 PANDEMIC

R-squared: 0.405		Adjusted R-squared: 0.387	
	Coef	Std err	t	P-value
Intercept	-0.0019	0.003	-0.670	0.504
Mktrf	0.6773	0.099	6.837	0.000
Smb	-0.3572	0.261	-1.371	0.173
Hml	0.1804	0.187	0.964	0.337

It can be seen from the three tables above that all of the R-squared have been significantly increased as the models are executed in the period of COVID-19. The model for Technology sector had a rapid jump by 39.2% in the goodness-of-fit with 40.4% of the return's variance can be explained by the three factors. In addition, the R-squared of Healthcare and Finance are also high with respectively 35.9% and 40.5%. However, one of the main problem with the R-squared is that it will stay the same or keep increasing if we add more variables into the model. Then I will also take into account the Adjusted R-squared which penalizes the additional variables that do not help to improve the model. After considering the impact of additional independent variables which tend to overestimate the result of R-squared measurement, Adjusted R-squared in three of the sectors still achieved consistent result with 0.386, 0.339 and 0.387 for respectively Technology, Healthcare and Finance industry. It suggested that the gap between the fitted return from regression and the actual return was shifted closer and Fama & French model can be a reliable model to forecast the firm performance in this period.
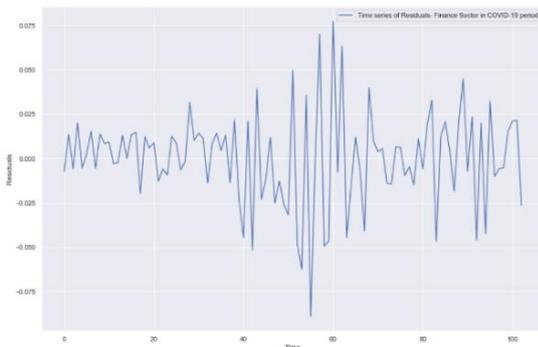
V. DISCUSSION

Fig. 1. – Residual plots for Finance sector during COVID-19 period.
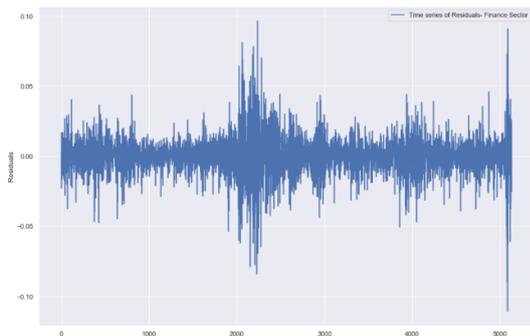

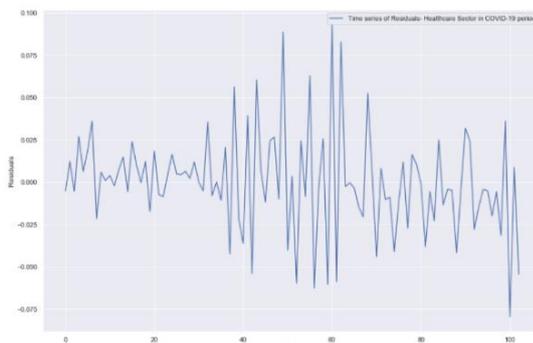Fig. 2. – Residual plots for Finance sector from 2000 to 2020.

Fig. 3. – Residual plots for Healthcare sector during COVID-19 period.
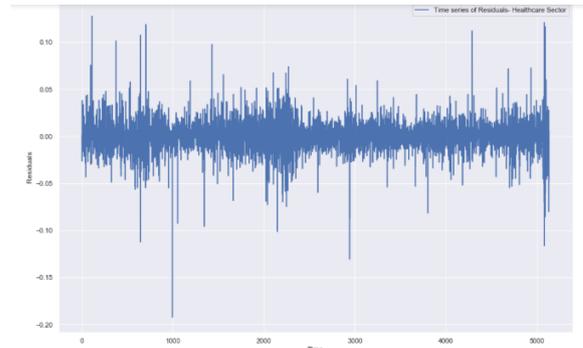

Fig. 4. – Residual plots for Healthcare sector from 2000 to 2020.
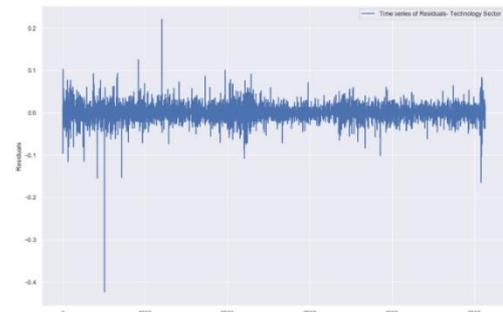

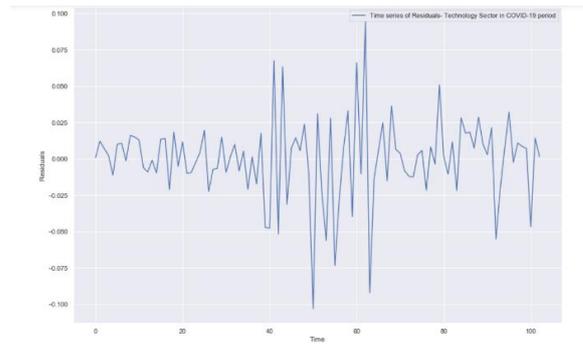Fig. 5. – Residual plots for Technology sector during COVID-19 period.

Fig. 6. – Residual plots for Technology sector from 2000 to 2020.

These graphs below display the time series of residuals which is the difference between the actual value and the value predicted by the model. It can be seen from these graphs that the gap between actual and predicted value in three of the sectors have been minimized as the model's period shifted from whole data sample to the COVID-19 period. It means that the model forecast the return change with less error in the COVID-19 crisis and investors can use this model to predict the stock/sector performance.

This result is quite surprised as the noise from crisis was supposed to tremendously affect all the industries performance in the market and hence result in the lower accuracy of three factors to predict the return. However, my measurement of the model turned out to be the other way around. If we deepen the relationship between return and the three factors, there might be a feasible explanation for this phenomenon. The excess return on the market was the only factor that obtained the significant result at 5% and 1% level in three of the sectors. Furthermore, this factor also had the highest coefficients in three tables with respectively 0.7008, 0.7767 and 0.6773. It suggested that Excess Return On Market is factor with the most significant and highest impact on the return of each sector. The result now seems to make more sense. According to (Malito, 2020), in February S&P

500 index has dropped more than 6% on only 2 days due to the fear of Corona pandemic spreading all over the world which is the biggest 2-day loss since 2015 [10]. They also suggested that the impact of fearing corona pandemic will continue to decrease the stock markets' price as it used to happen in the other pandemic period in the history such as SARS and Ebola. In the Fama & French three factors model, the 'mktrf' is a risk premium market factor which express how much return that the market can excess the risk free rate [2]. So with the fear that the Corona pandemic will negatively affect the market, investors will be discouraged to invest in the market that has low return compared to the risk free rate. The lower demand of investment will decrease the stock return to attract the investors and vice versa. Therefore, the Excess return on market factor had the highly positive coefficients on three of the sectors with 0.7008 for Technology, 0.7767 for Healthcare and 0.6773 for Finance which represent its direction with the return.

This finding is quite identical with the result of Jinjarak and Zheng study (2010) [7]. In contrast, the other 2 factors: Size Premium and Value Premium seems to be insignificant to forecast the sectors' performance with most of p values higher than 0.05 (5% significance level). These 2 factors tend to be less considered in the pandemic since the Excess Return On The Market risk is the top priority of investors.

Finally, despite taking the sectors that have different growth in the period of Corona pandemic, the return's measurement of these sectors in Fama model were not much different. So we can state that the industry's abnormal growth/recession in the Corona pandemic period is not the key factor to drive the accuracy in the prediction of return. This matched my expectation in the literature review as the industry's specific change in Financial crisis and Corona pandemic will not have the same impact on the industry performance.

VI. CONCLUSION

There are many studies that analyze the forecasting power of Fama and French, but their data does not mainly focus on the COVID-19 period in 2020. This is the first paper in the COVID-19 pandemic to incorporate the Market Value Of Equity of the stocks into industry and then compared the model estimation across industries. Based on the collected result, I can conclude that the abnormal growth/ recession of different sectors in the COVID-19 pandemic can be predicted by the Fama and French model and Industry Specific growth/recession is not the main factor to reduce the forecasting capability of the model. In addition, the Excess Return On The Market is the factor that dominates in the COVID-19 crisis. This result tends to make sense with the fear of the virus spreading and worsening the economy. It suggests that the Performance of the market regarding to the Risk Free Rate should be taken as the key factor to predict the return. Furthermore, with the improved R-Squared up to about 40%, it means that the three factors model of Fama and French is still applicable in the recession period. Based on the results from my research, investors can be aware of the importance of 'Excess Return On The Market' factor in forecasting return and hence develop the most suitable strategy to invest. Finally, this research also clearly indicates the accuracy degree of three factors model estimation which can help the investors/traders to compare it with other asset pricing models.

CONFLICT OF INTEREST

The author declares no conflict of interest.

AUTHOR CONTRIBUTIONS

Luu Gia Huy Vo carried out all parts of this study from conducting research, analyzing data to writing the paper. The author read and approved the final manuscript.

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