

Application of Fama-French five factor model in US clothing industry during COVID-19

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Abstract. During the COVID crisis, the US clothing industry has suffered a great plunge due to vast store closures and business discontinuation. People must understand in what aspects this crisis impacted on the clothing industry. This paper aims to analyze the impact of COVID-19 on US clothing industry return and risk. We used data in a one-year span before and during COVID-19, respectively, from the Kenneth French Data Library. This study applies the Fama & French 5-factor asset pricing model and adopts the multiple linear regression method for analysis. We tried to identify which factors in the model explained the COVID returns and how their explanatory power changes before and during COVID. It is interesting to evaluate that size, value, and investment factors were all insignificant before the crisis, but all turned significant during COVID-19. Also, discovering that growth stocks outperformed value stocks during the crisis was not the case before the crisis. It could be attributed to investors' speculation intent becoming stronger amid the distressing environment of the pandemic. Firms in clothing industries were investing conservatively due to a shortage in cash flows in extreme uncertainty. Small stocks performed better than big stocks during the crisis. It speculates that bigger-size firms were shattered more as they occupied greater market share and thus undertook more loss than smaller-size firms. In short, during the COVID period, small stocks, growth stocks, and conservative stocks performed more strongly and were thus more favourable to investors.

Keywords: COVID, Fama-French five-factor model; US market; clothing industry; multiple linear regression.

1. Introduction

The spread of COVID-19 brought panic to the investors and triggered the stock market's circuit breaker mechanism four times in March 2020 [1]. Dow Jones Index decreased about 2000 points, and the SPX was below 2300 points. Under such a harsh market environment, a great number of industries suffered. Many investors experienced loss during this period. In this circumstance, assessing the price of the asset becomes extremely essential. The first model used for pricing an asset is the CAPM which was developed in 1964 [2]. The Capital Asset Pricing Model was built based on the portfolio theory and capital market theory. It mainly studies the relationship between the expected return rate and systematic risk for the asset. The CAPM theory is the base of the modern finance market and is widely used in finance for pricing risky securities. CAPM theory aims to examine whether a stock is fairly valued by comparing the risk and the expected return. Then in 1993, the Fama-French three-factors model was developed [3]. Fama and French added size risk and value risk factors into the original CAPM model. However, after a while, they found that the three-factor model's value factor becomes superfluous. They then introduced two more factors to weaken the impact of HML on the stock return. Hence, the five-factors model was proposed [4]. The newly developed five-factor model aims to capture stock in wilder aspects like profitability and investment patterns. What is more, the five-factor

model performed much better than the three-factor model. This essay uses data analysis based on Fama-French five-factor model to study COVID-19's impact on the clothes industry.

Some researchers have applied the five-factor model in many fields. Ülkü investigated empirical evidence of the RMW profitability factor. He used the day-of-the-week-dummy model to capture the properties of daily returns. He found that the RMW factor contributes to the overwhelming majority of the RMW premium on Monday through the modeling. HML, however, lost its significance among the value-type strategies. He also proposed that the mispricing of the "early-in-the-week" is caused by noise trading during the week and the "sound mind" during the weekend [5]. Lin tested the Fama-French 5-factor model in China using two-dimensional sorting that is also used by Fama & French and another 2*2 sorts by size and B/M, size and OP, size and Inv. She then ran descriptive statistics and the GRS test. Results concluded that SMB, HML, and RMW factors are also crucial in describing average return among these factors. Mkt factor, on the other hand, is less crucial, while the CMA factor is redundant according to CMA regressions, as CMA return is fully captured by value and profitability factors. Lin proposed two possible explanations for the redundancy. First is that China is a bank-oriented market. Secondly, Investors in developing countries like China are more likely to overinvest, and ownership concentration is more severe. Thus, past investment is much less a predictive factor. Besides, Lin also found that the five-factor model always outperforms the three-factor model in China [6]. Fama and French tested their five-factor model internationally. They constructed similar portfolios as Lin did and also constructed other 5*5 sorts following the same rule and 2*4*4 sorts on size and pairs of B/M, OP, and Inv. They performed regression for North America, Europe, and Asian Pacific. Ultimately, the factor spanning tests show that all five factors are significant in North America, while the CMA factor is redundant for Europe and Japan. They also found that small stocks isolated by Size-OP-Inv sort in the test tend to invest a lot, despite low profitability and low average return. It contradicts the prediction of the five-factor model. Such a problem is rather severe in Asian Pacific and Europe [7]. Sundqvist studied average return in the Nordic markets. He compared the Fama-French five-factor model's performance and the CAPM's performance by using data statistics. While these models mentioned in the essay faced a problem explaining the portfolio's average return based on the size and profitability, the five-factor model cannot promote the intercepts made in regression in the three-factor model. What is more, this essay also found that small-value stocks actually contain lower beta than stocks with big value in the Nordic market [8].

Moreover, Foye investigated in his paper whether the Fama-French 5-factor model could provide a better explanation of average returns than the three-factor model in emerging markets, specifically, Eastern Europe, Asia Pacific, and Latin America. He finds that, except in Asia, the HML factor is the only one that can absorb the average return in all regions above. In contrast, the RMW factor only works in Eastern Europe, Latin America. The CMA and SMB factors are redundant in all regions. In general, the five-factor model worked well in Eastern Europe and Latin America as it successfully absorbs the remaining alpha. Still, it failed in Asia as it yielded no better results than the three-factor model [9]. López-García et al. based their research on the Fama-French five-factor model and proposed the long-term memory factor in addition to the existing factors. The proposed memory factor is calculated using the fractal dimension algorithm and is based on the Hurst exponent. Using the sample data of 1500 largest U.S. companies across numerous sectors, they found that the new factor is as relevant as the existing factors and even more relevant than the momentum factor proposed in other literature. They also discovered that using an equally weighted portfolio, the model becomes very significant while using a capitalization-weighted portfolio, the model becomes very close to irrelevant [10]. Diallo et al. give new estimations about the Fama-French five-factor models by using the machine learning approach. They used Bayesian optimization-support vector regression (BSVR) approach to collect data of portfolio returns. This research successfully applied machine learning to the Fama-French three- and five-factor models. More significantly, it combines Bayesian optimization and SVR (BSVR) to gain portfolio predictions in the training sample [11]. Leite et al. explored more profoundly the relation of macro variables and interest rates with Fama-French's five-

factor model. They built their research on existing literature on the explanatory power of aggregate dividend yield, term spread, default spread, and one-month T-bill rate on HML and SMB factors in three-factor models. Unfortunately, it fails to explain RMW in the five-factor model. The researchers used an approach similar to Fama-French five-factor model but instead included inflation in the form of CPI, which relates to operational profitability as RMW. They found that RMW lost its explanatory power in the presence of CPI. When the researchers combined CPI with term structure's slope and excess market returns, they discovered that it explains the cross-section of average returns better than the Fama-French five-factor model [12]. Mosoeu and Kodongo made a test about Fama-French five-factor model on average stock returns. They used GMM regression on 313 weekly data from January 2010 to December 2015. They found that the five factors asset pricing model did not perform as people expected in some country-specific portfolios and geographically diversified portfolios by using the GRS tests. Furthermore, a surprising result was also found that the average return of big enterprises outweighs that of small companies. Similarly, the average return of low b/m stock is more than that of high b/m stock [13].

This paper mainly focuses on the impact of COVID-19 on the clothing industry. We use the Fama-French five-factor model to do data analysis on the clothing industry before the pandemic and after the COVID-19. The essay also recorded some related researches done by many famous scholars helping to better understand and apply the five-factor model to the clothing industry. We analyzed all five factors to assess whether COVID-19 exerted an enormous impact on the clothing industry and discussed the performance of the clothing industry during the period of COVID-19.

2. Method

The history of asset pricing models starts from the CAPM model brought forward by Lintner, Sharpe, and Mossin. They first proposed that an asset expected return depends upon market systematic risk premium [2]. However, people gradually found that the CAPM was too general in terms of explaining risk factors. The market has many other specific factors that could affect returns. Later, Fama and French(1996) proposed their famous three-factor model, which added two firm-specific characteristics-firm size and book-to-market ratio, to the market factor [3]. Although the three-factor model has achieved great success in explaining asset return, some further empirical tests found that the remaining alphas were still significantly large. In 2006, Fama and French demonstrated that book-to-market ratio and profitability factor are positively related to the expected return [14]. In the same year, Robert Novy-Marx found that the profitability factor has about the same predictive power on expected return as the B/M factor [15]. Subsequently, in 2015, Fama and French proposed to add two more factors, profitability and investment, to the three-factor model. The updated five-factor model is as follows [4]:

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_iSMB_t + h_iHML_t + r_iRMW_t + c_iCMA_t + e_{it}. \quad (1)$$

The five factors are Mkt, SMB (small minus big), HML (high minus low), RMW (robust minus weak), CMA (conservative minus aggressive) [4]. Except for the Mkt factor, the other four factors are all represented by the difference of two portfolios that contain stocks on the two ends, respectively. For example, the SMB factor is constructed by picking one portfolio consisting of the 30% stocks with the highest B/M ratio and another portfolio consisting of the 30% stocks with the least B/M ratio, subtracting the latter from the former. In order to control for each factor, Fama and French sorted the factors in 2*2 (e.g., size & B/M, size & OP, size & Inv), and 2*2*2*2. They estimated the model to explain between 71% to 94% of the average return [4].

3. Result

This paper collected data from Kenneth R. French's data library. It investigated daily data from March 1, 2019, to February 28, 2020 (251 data points recorded), one year before the COVID pandemic started significantly impact the United States (hereafter pre-COVID), and corresponding data from March 2, 2020, to February 26, 2021 (252 data points recorded), one year since COVID's initial impact (hereafter post-COVID). We performed multilinear regressions for both pre-covid and post-covid periods for each of the Fama-French five-factor. The results are as follows:

Table 1. Regression results before COVID-19

	Coeff	SE	t-stat	p-value
Mkt-RF	1.09	0.06	19.24	0.00
SMB	0.17	0.10	1.72	0.09
HML	0.10	0.10	1.00	0.32
RMW	0.63	0.16	3.89	0.00
CMA	-0.01	0.20	-0.04	0.97

Table 2. Regression results during COVID-19

	Coeff	SE	t-stat	p-value
Mkt-RF	0.92	0.07	13.65	0.00
SMB	0.66	0.12	5.52	0.00
HML	-0.31	0.12	-2.61	0.01
RMW	-0.25	0.19	-1.33	0.18
CMA	0.92	0.24	3.79	0.00

The t-statistics on each factor were examined at a 95% confidence level. Table 1 and Table 2 found that SMB became more significant and positive, meaning investors are investing more heavily in small firms. We also discovered that investors are investing more heavily in growth stocks during the pandemic as HML became significant and negative. Investors also tend to invest more conservatively as CMA had gone from insignificant to significant. RMW, on the other hand, has gone from significant to insignificant, meaning that the pandemic has decreased the importance of the Robustness of stock in asset valuing. We then also examined the sensitivity of excess market return, where it found that the clothes industry went from more sensitive than the market to less sensitive to the market.

4. Discussion

4.1 Market

The factor Mkt-RF of the clothes industry changed from 1.09 to 0.92. It became relatively less sensitive to the market. During the whole pandemic, the COVID-19 has a dramatically negative impact on the clothes industry. A great number of governments around the world require clothing firms to close their offline stores to avoid public gatherings, and it caused an extremely negative consequence, where the turnover of the clothing firms decreased substantially. Governments called on people to stay at home for those countries that did not shut down clothes stores. According to a report by McKinsey & Co, the turnover of offline clothes stores decreased by 30% to 40%, and it reached 80% in areas that had serious COVID-19 situation [16]. During this period, the stock prices of many clothing companies have depreciated at a significant level. For example, at the beginning of February 2020, the stock price of Nike was at \$103 per share, but after Nike experienced 4 times US stock fusing, its stock price declined to \$82 per share. Similarly, the stock price of Levi's decreased from \$18 per share to \$12 per share from February 2020 to March 2020 [1]. During March 2020, the value of the whole clothing section continued decreasing. However, in April, due to the increase of the main stock index in the US, the clothing section rapidly recovered the position it lost in March [1].

4.2 SMB

The SMB factor became significant after the pandemic, as its t-score increased from 1.717 to 5.521. This proves that investors prefer to invest in firms with small market value because, before the pandemic, those clothing firms with huge market share had a stable cash flow and increasing profit. Still, the COVID-19 has a great impact on major enterprises like Nike or Levi's. However, many firms with relatively small market share rose rapidly, although under the effect of the pandemic. Because major companies have already taken a huge market share, the impact of COVID-19 on small firms would not be as serious as that of the major companies. The COVID-19 took away the market share of major companies. This gave companies with low net assets a chance to develop and occupy the market. For instance, a company called the Children's Place Retail Store has less than 100 offline stores in the US, and its major business is to sell children's wear. The net profit of this company was not affected by the pandemic too much, earning \$70million net profit. Though its stock value has decreased to \$9 per share in March 2020, which could be attributed to the 4 times fusing of the American stock market, the company's stock rapidly reached \$41 per share in April and May [1].

4.3 HML

According to the t-statistics in the tables, the book-to-market (HML) ratio factor has shifted from insignificant to significant, showing a greater explanatory power of the value factor to the average return. At the same time, the coefficient moves from positive to negative, meaning low B/M stocks outperformed high B/M stocks, which are rarely found. Given the wide collapse stock market during the pandemic, it is normal that investors would pursue growth stocks, which are perceived to have the potential to shine in the future. Investors' skewness-seeking tendency could explain such a phenomenon. During the pandemic, the book value of stocks is much more likely to be measured lower than its true value or market value due to increasing uncertainty in future performance and cash flows. Thus, investors would perceive more downside risk, driving the return distribution to be positively skewed in compensation for that risk. According to Zhang (2013), growth stocks exhibit significant positive skewness on their return distributions [17].

The shift from positive to negative coefficient can also be explained by investor sentiment. It can be expected that during the COVID pandemic, the average investor sentiment level was low. Investment sentiment could motivate speculation (Baker & Wurgler, 2006), while growth stocks are the kind of stocks that are easily subject to speculation due to their 'young age', 'non-dividend-paying', 'potential growth' characteristics, making the valuation of these stocks very subjective [18].

4.4 RMW

In terms of the profitability (RMW) factor, it had turned insignificant while significant before the COVID-19. Its coefficient has shifted from positive to negative as well. It is the case that during the pandemic, the entire clothing industry in the US has suffered a great profit plunge [19]. In the grievous months of March, April, May 2020, the Clothing and accessories industry monthly retail sales have suffered a slump, reducing by 51%, 89%, 62% each month, respectively [19]. Profitability would make no difference among firms and thus would not carry explanatory power in returns.

4.5 CMA

The CMA factor emerged to be a significant factor after the COVID pandemic hit North America. As the demand for the apparel industry plunged, aggressive investment among clothing companies became undesirable to investors. Several potential reasons can explain this. First, due to the drop in demand, cash flow became a problem for essentially everyone in the clothing industry. According to McKinsey & Co. (2021), "Consumer's intent to shop for apparel, footwear, accessories and jewelry in September 2020 was still down by 27 to 35 percent in the US," which corresponded with a 17% - 35% drop in sales in the US in 2020 [20]. The situation was unlikely to recover until at least the third quarter of 2022, which means the clothing industry will continue to suffer from a shortage in cash flow for another year. An aggressive investment policy will most certainly disrupt cash flow and increase the risk of bankruptcy. Even during the pre-pandemic era, around 34% of all listed fashion companies were already under the stress of loss-making sales and unhealthy debt generation [20]. The pandemic would likely be the last straw that brought an end to those struggling companies. In the meantime, companies with a more conservative investment strategy during the pandemic with larger cash positions can benefit from the future bankruptcies of struggling competitors through M&A. This constitutes the second explanation as to why conservative investment is more attractive during the pandemic. The third and last potential explanation is the uncertainty that lies ahead. As countries roll back and forth on vaccination and reopening, the future remains unforeseeable. In general, in times of uncertainty, it is good to swap fixed costs to variable costs. According to Deloitte (2020), Switching fixed costs to variable costs involves selling assets [21]. This action raises cash to sustain the crisis but also shows as a conservative strategy. For investors in the clothing industry, it is more important that their investments survive rather than perish.

5. Conclusion

This paper examined the impact of COVID-19 on the clothing industry through the Fama-French five-factor Model. Using data collected from Professor French's database, the authors performed multilinear regression and examined each factor's coefficient and significance. From the result, this paper concludes that COVID-19 has a significant impact on the clothing industry. Investors are more inclined to invest in smaller companies (SMB) and growth companies (HML) due to the substantial shrink in offline retailing. The overall decline in demand for clothing also contributes to the decrease in revenue industry-wide, leaving firms with low to negative profitability, which diminished the explanatory power of the profitability (RMW) factor. The drop in revenue also caused cash flow problems for the industry, forcing investors to focus on the companies with more conservative investment policies, which the CMA factor can reflect. The market sensitivity also diminished correspondingly due to the overall decrease in performance and reactivity of the industry. In short, the impact of COVID-19 can be observed from all five of the Fama-French factors.

References

- [1] Tiger Brokers Ltd. 2021. Tiger Trade (version 7.0.1.1). [Mobile app]. [Accessed 27 April 2021].
- [2] Sharpe, W. 1970. Portfolio theory and capital markets. McGraw-Hill.

- [3] Fama, E. and French, K. 1993. Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*. 33(1), pp.3–56.
- [4] Fama, E. and French, K. 2015. A five-factor asset pricing model. *Journal of Financial Economics*. 116(1), pp.1–22.
- [5] Ülkü, N. 2017. Monday effect in Fama–French's RMW factor. *Economics Letters*. 150, pp.44–47.
- [6] Lin, Q. 2017. Noisy prices and the Fama–French five-factor asset pricing model in China. *Emerging Markets Review*. 31, pp.141–163.
- [7] Fama, E. and French, K. 2017. International tests of a five-factor asset pricing model. *Journal of Financial Economics*. 123(3), pp.441–463.
- [8] Sundqvist, T. 2017. Tests of a Fama-French Five-factor asset pricing model in the Nordic stock markets. *Hanken School of Economics*.
- [9] Foye, J. 2018. A comprehensive test of the Fama-French five-factor model in emerging markets. *Emerging Markets Review*. 37, pp.199–222.
- [10] López-García, M., Trinidad-Segovia, J., Sánchez-Granero, M. and Pouchkarev, I. 2021. Extending the Fama and French model with a long-term memory factor. *European Journal of Operational Research*. 291(2), pp.421–426.
- [11] Diallo, B., Bagudu, A. and Zhang Q. 2019. A machine learning approach to the Fama-French three-and five-factor models. *ResearchGate*. [Online]. [Accessed 27 April 2021]. Available from: https://www.researchgate.net/publication/335277192_A_MACHINE_LEARNING_APPROACH_TO_THE_FAMA-FRENCH_THREE-AND_FIVE-FACTOR_MODELS
- [12] Leite, A., Klotzle, M., Pinto, A., & da Silveira Barbedo, C. 2020. The Fama-French's five-factor model relation with interest rates and macro variables. *The North American Journal of Economics and Finance*. 53, pp.1-13.
- [13] Mosoeu, S and Kodongo, O. The Fama-French five-factor model and emerging market equity returns. *The Quarterly Review of Economics and Finance*., in press.
- [14] Fama, E. and French, K. 2006. Profitability, investment and average returns. *Journal of Financial Economics*. 82(3), pp.491–518.
- [15] Novy-Marx, R. 2013. The other side of value: The gross profitability premium. *Journal of Financial Economics*. 108(1), pp.1–28.
- [16] <http://www.jccief.org.cn/v-1-15608.aspx>
- [17] Zhang, X. 2013. Book-to-Market Ratio and Skewness of Stock Returns. *The Accounting Review*. 88(6), pp.2213–2240.
- [18] Baker, M. and Wurgler, J. 2006. Investor Sentiment and the Cross-Section of Stock Returns. *The Journal of Finance (New York)*. 61(4), pp.1645–1680.
- [19] Ricchetti, M. and Palma, R. 2020. Will COVID-19 accelerate the transition to a sustainable fashion industry? [Online]. [Accessed 27 April 2021]. Available from: <http://www.unido.org/>
- [20] McKinsey. 2021. The State of fashion. [Online]. [Accessed 28 April 2021]. Available from: <https://www.mckinsey.com/~media/McKinsey/Industries/Retail/Our%20Insights/State%20of%20fashion/2021/The-State-of-Fashion-2021-vF.pdf>
- [21] Deloitte. 2020. COVID-19: managing cash flows during a period of crisis. [Online]. [Accessed 28 April 2021]. Available from: <https://www2.deloitte.com/content/dam/Deloitte/global/Documents/About-Deloitte/gx-COVID-19-managing-cash-flow-in-crisis.pdf>