Research on the Impact of Pandemic on U.S. Wholesale and Retail Industries Based on Fama-French Five Factor Model

Mengqi Qiao(✉)

Faculty of Science, University of Melbourne, Melbourne, Australia
mengqiq@student.unimelb.edu.au

Abstract. The COVID-19 pandemic is wreaking havoc on the global economy and people's lives, especially in the wholesale and retail sectors, which are closely related to people's basic needs. This paper will discuss the impact and changes of COVID-19 on wholesale and retail industry based on the Fama-French five-factor model. The founders of the Fama-French model built Kenneth R. French's Web database based on data obtained from the relevant information of the U.S. stock market, which is the source of the experimental data in this paper. By extracting the data of 49 industry portfolios collected daily, the wholesale and retail industry data from 2018.01.25 to 2022.03.31 were obtained, and the average data of "Pre-epidemic" and "In-epidemic" groups were compared. Through multiple linear regression coefficients are obtained. The results show that the COVID-19 outbreak did have a negative impact on the wholesale and retail sectors but not overwhelmingly. HML and SMB are redundancy factors in wholesale and retail industries respectively, while CMA has changed from an effective factor to a redundancy factor.

Keywords: Fama-French Model · Covid-19 · Wholesale Industry · Retail Industry · U.S. Stock Market

1 Introduction

Because of the prolonged lockdown and economic depression caused by COVID-19, industries and people's lives have been widely affected. In mid-October 2021, D. Tighe conducted a survey of small businesses engaged in wholesale trade in the United States and found that fewer than 25% were significantly negatively affected by the COVID-19 pandemic [1]. At the same time, about the same number of enterprise businesses are almost not affected by the pandemic. Overall, the coronavirus pandemic has not had much of an impact on the US wholesale industry.

By contrast, the retail industry has been put to a severe test by the COVID-19 pandemic. Under the general lockdown around the world, different sectors of the industry have diverged, with some stores experiencing an unprecedented surge in demand while others have closed entirely. Obvious differences exist in the physical stores and online stores, large and small retailers. Through the FF5F model, the purpose of this paper is

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to explore the impact of the COVID-19 pandemic on the wholesale and retail industry respectively.

The purpose of this paper is to apply the results of Fama and French (2015) to the current US wholesale and retail stock markets [2]. To see whether Fama and French's (2015) five-factor model can explain the impacts and changes caused by COVID-19 on these two industries, and to find out the redundant factors in the FF5F model for these two industries [2]. When similar situations occur again in the future, the research results of this paper can help the government and research institutions more accurately predict the market changes in the wholesale and retail industries, so as to formulate relevant policies in advance. Not only that, businesses and people can also take precautions in advance.

2 Literature Review

One of the most important topics in finance is asset pricing. The CAPM model proposed by William Sharp (1964) and John Lintner (1965) is the first theory to describe how systemic risk affects the expected return on investment [3][4]. CAPM is a single-index model used to help investors and researchers quantify the risk of an investment and examine estimates of expected returns by explaining the return changes of a security through correlations with other securities [5].

Despite its widespread use, it is often criticized for ignoring specific characteristics of the company. To capture every motive behind changes in returns, researchers try to build more accurate models by taking into account a wide range of variables, such as market value, B/M value ratios, price-earnings ratios and leverage. Reinganum (1981) explained the CAPM misstatement in terms of earnings-to-price ratio and described a statistically significant improvement. On the other hand, size seems to be more effective than p/E ratios when firms' scale effects are controlled for [6]. Rosenberg, Reid, and Lanstein (1985) control size and equity ratio by inserting B/M ratios into the model. Furthermore, a positive correlation is found between a high B/M ratio and an average monthly return [7].

Fama and French (1992) found that market beta alone could not accurately reflect the actual situation [8]. By combining market beta, size, equity-to-price, leverage, and B/M ratios to observe the interaction of average market returns, size and B/M, individually or in combination, give more accurate results. Therefore, Fama and French proposed a three-factor model in 1993, in which the three factors were market return, M and B/M value [9]. Vernon et al. found by using the Fama-French three-factor model that costs often exceed initial estimates as drug development progresses [10].

Based on the previous three-factor model, Fama and French came up with a new five-factor model in 2015 by adding two more factors - profitability and investment. They tested the five-factor model in the US market using data from July 1963 to December 2013. Their results show that the three-factor model is inferior to the five-factor model in assessing the cross-sectional risk of stock returns when considering more financial factors [2][11].

However, Diallo, B. et al. put forward an opposing view in August 2019 [12]. They used Bayesian optimized support vector regression (BSVR) to predict portfolio returns

and analyzed the fitting degree of the Fama-French three-factor model and the Fama-French five-factor model for the US industry from July 1926 to January 2019, respectively. This study found that the correlation coefficient of the FF3F model is greater than 90%, and that of the FF5F model is distributed between 48% and 89%, implying that the FF5F model does not perform as well as the FF3F model in the practical application of the U.S. stock market.

In fact, the FF5F model has been validated in markets other than the U.S. market. Chiah, M. et al. compared and evaluated the FF5F model and other models with the Australian stock market in 2016 as the data source [13]. The results show that the FF5F model can explain more asset pricing anomalies than other models because of the profitability and investment. In addition, Cakici, N. (2015) explained the effectiveness of Fama-French five-factor model in 23 developed stock markets by analyzing company-level data from July 1992 to December 2014 [14]. The results not only support the point made by Fama and French in 2015, but the results of the FF5F model in the North American, European, and global markets are analogous to those in America [2].

However, the five-factor model is not perfect. For example, it cannot capture the low average return of small stocks with high investment and low profitability. Fama and French (2015) also show that the value factor (HML) becomes redundant in the US stock market due to the addition of two additional factors [2]. However, in sharp contrast, Cakici, N (2015) believes that the difference in returns between high-cap and low-cap companies (HML) is not redundant in any region, The Conservative Minus Aggressive (CMA) is only important in Europe, while Global becomes redundant in all other regions. The Small Minus Big (SMB) is redundant in all regions and Robust Minus Weak (RMW) is important in all regions [14].

3 Method

The traditional asset pricing model, CAPM, uses a variable to describe the specific return of a portfolio or stock relative to the return of the overall market. Its equation is: $R_i - R_F = \beta_M(R_M - R_F)$. In this equation, R_F represents risk-free rate of return; R_M stands for market regression; R_i is the expected return rate of the portfolio, and $R_M - R_F$ represents the market risk premium.

3.1 Fama-French Three-Factor Model (FF3F)

The Fama-French three-factor model is composed of market factor, scale factor and value factor. The representation of this model is:

$$R_i - R_F = \beta_M(R_M - R_F) + \beta_{SMB}SMB + \beta_{HML}HML \quad (1)$$

The size factor refers to the difference between the earnings of small and large firms, known as the market premium, which is the Small Minus Big (SMB). Companies with smaller assets and market capitalization typically have higher risk and generous returns. Large companies, by contrast, are characterized by low risk and low returns.

The development opportunity premium of an enterprise is represented by the value factor, namely, High Minus Low (HML), the profit difference between a companies

with high and low BM (book to market) values. A company with a high BM has poor fundamental performance, a relatively weak financial position, higher risk and income. By contrast, a company with a low BM is a growth stock, with more space for evolution, lower risks and returns.

3.2 Fama-French Five-Factor Model (FF5F)

The five-factor model is evolved by adding profitability and investment style factors to the three-factor model, which was proposed by Eugene F. Fama and Kenneth R. French in 2015. Therefore, the expected return rate of the stock portfolio in the cross section can be better represented. The five-factor model can be represented by the following formula:

$$R_i - R_F = \beta_M(R_M - R_F) + \beta_{SMB}SMB + \beta_{HML}HML + \beta_{RMW}RMW + \beta_{CMA}CMA + \varepsilon \quad (2)$$

The profitability factor is Robust Minus Weak (RMW), which is the difference between the returns of the portfolio of stocks with high and low operating profit margin, which reflects the premium of the portfolio of stocks with high operating profit margin relative to the portfolio of stocks with low operating profit margin. Higher profitability means higher risk in the industry.

The investment style factor is Conservative Minus Aggressive (CMA), which is the difference in returns between conservative and aggressive stock portfolios. Companies with low investment rates are perceived as riskier and investors demand higher rates of return. In contrast, companies with high investment rate are less risky, and investors do not have strict demand for return rate for these companies [1].

4 Results

The founders of the Fama-French model built Kenneth R. French's Web database based on data obtained from the relevant information of the U.S. stock market, which is the source of the experimental data in this paper. The data of the wholesale and retail industries from 2018.01.25 to 2022.03.31 is selected from 49 Industry Portfolios [Daily].

Table 1 (Wholesale) and Table 2 (Retail) are consist of coefficients calculated by multiple linear regression for the industry before (2018.01.25-2020.02.28) and during (2020.03.02-2022.03.31) the COVID-19 Pandemic by student's t-test.

At wholesale, $R_M - R_F$, SMB and RMW factors always showed strong significance. With the outbreak of the pandemic, the coefficient of $R_M - R_F$ increased to 0.975, the coefficient of RMW increased to 0.376, and the coefficient of SMB decreased from 0.451 to 0.377(a decrease of about 16%). On the other hand, the CMA factor decreased significantly in the second stage, becoming an inefficient factor in the COVID-19 pandemic. Moreover, the market has never used HML as an influential factor in gauging returns in the wholesale sector.

In retail, before the pandemic, $R_M - R_F$, RMW and CMA factors were all significant under the T-statistical test. The coefficients of all five factors decreased with the outbreak of COVID-19. HML became significant during the COVID-19 outbreak, whereas CMA was not significant during the second stage, becoming a redundant factor. Whether before or during the COVID-19 pandemic, SMB is a redundant factor.

Table 1. Wholesale

Industry	Item	Period	$R_M - R_F$	SMB	HML	RMW	CMA
Wholesale	Coefficients	Before	0.937	0.451	0.014	0.300	0.417
		During	0.975	0.377	0.147	0.376	0.046
	Standard Error	Before	0.020	0.037	0.039	0.054	0.071
		During	0.015	0.030	0.026	0.042	0.054
	t-Stat	Before	46.875	12.277	0.371	5.523	5.903
		During	65.027	12.385	5.738	9.043	0.853

Table 2. Retail

Industry	Item	Period	$R_M - R_F$	SMB	HML	RMW	CMA
Retail	Coefficients	Before	0.977	0.015	-0.140	0.363	-0.374
		During	0.832	-0.024	-0.326	0.287	-0.040
	Standard Error	Before	0.025	0.046	0.048	0.068	0.088
		During	0.019	0.039	0.033	0.054	0.070
	t-Stat	Before	39.244	0.318	-2.910	5.354	-4.249
		During	42.936	-0.604	-9.872	5.329	-0.570

5 Discussion

As a result of the pandemic, lockdowns have become common in many countries and cities and people's consumption patterns have changed. This study conducted a multiple linear regression analysis of wholesale and retail industry data before and during the pandemic. The impact of COVID-19 on the wholesale and retail sectors in the US was analyzed by evaluating the significance level and correlation coefficient changes of each factor in the Fama-French 5 factor model. After that, it studies the deep reason for the change, and gives the corresponding investment decision thinking.

5.1 MKT

The MKT factor $R_M - R_F$ represents the market risk premium. Since both wholesale and retail industries are cyclical industries, the coefficient of $R_M - R_F$ does not change significantly, which means that the positive correlation between wholesale and retail industries and the market remains unchanged. Consumer demand has not changed much, despite the severe lockdown caused by COVID-19. Retailers with brick-and-mortar stores as their main business and e-commerce as a supplement are transforming one after another, and a large number of traditional brick-and-mortar shopping is temporarily shifting to online shopping. As the outbreak eases, consumer-related markets have become more active among investors.

5.2 SMB

The SMB factor provides strong support for explaining changes in wholesale stocks during the pandemic, but it is a redundant factor in retail. Statistical test results show that the SMB factor is significant and always greater than 0 in the earnings forecast of the wholesale industry. The higher SMB coefficient value means the higher return for small-cap stocks. Before the global pandemic, investors tended to buy small-cap companies for good returns, driven by their strong growth potential. Compared to other large companies in the industry, small companies are more flexible, able to quickly change their marketing strategies to adapt to new market conditions when the market changes and require fewer processes for their major products with less loss of productivity. During the global pandemic, SMB coefficient values decreased slightly due to a large number of order cancellations and postponements, which greatly increased the financial and operational pressure on wholesalers. This is because leading companies will have stronger cash flow and bargaining power than smaller companies and will be better able to withstand sudden risks. In the early days of the pandemic, stock market circuit breakers led to severe declines in overall share prices, but wholesale-related commodities can be seen as a necessity, which will spur the development of these stocks. Investors buy undervalued stocks because they tend to earn excess returns. To be sure, the cheaper a stock is, the more space it has to rise. Affected by the pandemic, the growth potential and yield gap between large-cap and small-cap stocks have narrowed. In contrast, the SMB factor was not significant enough in the retail industry either before or during the pandemic, suggesting that the retailer's size had no effect on its earnings.

5.3 HML

The difference in returns between high-cap and low-cap companies is expressed by HML.. Referring to HML data, prior to the pandemic (2018.01.25-2020.02.28), HML data for the wholesale and retail sectors were not significant. HML is too small, although they show a positive or negative relationship between portfolio and value premium. Therefore, when a pandemic emerges, the relationship between portfolio and value premium becomes close. However, there was a general increase in the absolute value of HML during the pandemic and HML becomes more important but still does not account for significant investor preference.

5.4 RMW

Prior to the pandemic explosion and during the COVID-19 pandemic, RMW factors in the wholesale and retail sectors underwent completely opposite changes. During a pandemic, the wholesale business tends to favor companies with higher margins, which means better management and lower risk. Profitability is particularly important during the COVID-19 pandemic, as the wholesale industry is characterized by high capital expenditure and high demand for cash flow. The retail sector, on the other hand, has seen a decline in preference for companies with high margins, as it faces a severe test due to the COVID-19 pandemic. This is reflected differently in different parts of the industry, with some stores experiencing unprecedented spikes in demand in the face of lockdowns

around the world, while others are shutting down altogether. The differences between physical and online stores, and between large and small retailers, are particularly stark. Some stores deemed "unimportant", such as specialty shops, have been forced to close, leaving their prospects bleak and struggling to absorb existing stock through online sales. Flower shops are a particularly bleak example: unsold plants are wilting and rotting on their shelves. Others, especially those such as supermarkets and pharmacies, are busier than ever. But the surge in demand does not mean these retailers are immune to supply chain challenges. Empty shelves on local news channels and social media are the best proof of this. In general, the retail industry is affected by the epidemic, and the overall profitability of the retail industry declines. The entire market is in recession, and investors begin to rely on factors other than the profitability of the company to follow the market changes to make investment decisions.

5.5 CMA

The yield gap between conservative and aggressive investment style firms is represented by CMA. The results showed that CMA factors were significantly effective in both wholesale and retail sectors prior to the outbreak. It also suggests that investors in both wholesale and retail industries are not hungry for returns. Since the coefficient is positive, the return is mainly dependent on the conservative investment style of the wholesale industry. That could indicate a lack of optimism about the wholesale market and are more willing to take a more conservative approach to lower returns. Since the coefficient is negative, the return is mainly dependent on the aggressive investment style of the retail sector. This could indicate optimism about the retail market and a willingness to be more aggressive in getting higher returns. During the pandemic, although CMA remained positive and negative for both industries, it was no longer significantly effective and became a redundant factor. This shows that conservative or aggressive investment strategies are not the focus of investors anymore and no longer have an impact on the stock valuations of the two industries.

6 Conclusion

In this paper, multiple linear regression was used to process the sample data, and the impact and changes were explained by Fama-French five-factor model in the wholesale and retail industries caused by COVID-19. The study found that, for the wholesale industry, HML is always a redundant factor. SMB is always a redundancy factor for the retail industry. The common impact of COVID-19 on both sectors was CMA, with investors willing to take a more conservative approach to lower returns in the wholesale sector and a more aggressive approach to higher returns in the retail sector, respectively, prior to the pandemic. However, conservative or aggressive investment strategies are no longer the focus of investors during the pandemic, as CMA in the wholesale and retail sectors have changed from 0.417 and -0.374 to 0.046 and -0.040, respectively, making them redundant. Overall, the COVID-19 pandemic did have some negative impact on both sectors, with fluctuations in the other four factors, but not significantly, as the demand was always there. Things will get better soon after the global pandemic is over.

Because the COVID-19 pandemic has not yet completely ended, we compare changes in wholesale and retail markets before and during the pandemic based only on currently available data. When the epidemic is completely over, researchers can compare the three sets of data before, during, and after the epidemic by using the same data processing method. In this way, they will have a more intuitive understanding of the changes and impacts of the epidemic on the wholesale and retail markets, as well as the recovery of the market.

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