January 2015

Using The Fama-French Five-Factor Model To Predict Industry Market Returns

Dustin Barvels

USING THE FAMA-FRENCH FIVE-FACTOR MODEL TO PREDICT INDUSTRY MARKET RETURNS

By

Dustin Wayne Barvels

Bachelor of Arts, University of North Dakota, 2014

A Thesis

Submitted to the

Graduate Faculty

For the

University of North Dakota

In Partial Fulfillment of

the Requirements for the Degree of

Master of Science in Applied Economics

Grand Forks, North Dakota

December

2015

This thesis, submitted by Dustin Barvels in partial fulfillment of the requirement for the Degree of Master of Science in Applied Economics from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

Dr. Daniel Biederman, Chairperson

Dr. Pradosh Simlai

Dr. David Flynn

This thesis is being submitted by the appointed advisory committee as having met all the requirements of the School of Graduate Studies at the University of North Dakota and is hereby approved.

Wayne Swisher

Dean, School of Graduate Studies

December 4, 2015

Date

PERMISSION

Title: Using the Fama - French Five-Factor Model to Predict Industry Market Returns

Department: Applied Economics

Degree: Master of Science in Applied Economics

In presenting this thesis in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the library of this University shall make it freely available for inspection. I further agree that permission for extensive copying for scholarly purposes may be granted by the professor who supervised my thesis work or, in their absence, by the chairperson of the department or the dean of the School of Graduate Studies. It is understood that any copying or publication or other use of this dissertation or part thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of North Dakota in any scholarly use which may be made of any material in my thesis.

Dustin Barvels

December 1th, 2015

TABLE OF CONTENTS

LIST OF TABLES

Table Page

ACKNOWLEDGEMENTS

I would like to express my appreciation for the members of my advisory committee for their insight support during my time in the master’s program at the University of North Dakota. I would especially like to thank Dr. Cullen Goenner, who introduced me to the program and encouraged me in taking a step in further developing my skills and knowledge in the field of economics. Finally, I would like to thank my friends and family. Your continuous support made it possible for me to be where I am today and for that I am grateful.

ABSTRACT

I examine industry sector returns using the Fama-French five-factor model between January 1966 and July 2015. This paper contributes to the literature by examining the Fama-French five-factor model on industry returns, where as previous literatures apply the model to the whole market or specific portfolios. My results suggest that although the Fama-French five-factor model is not a significant improvement to that of the three-factor model it is the best model of choice when examining industry returns between the CAPM and the three-factor model.

CHAPTER I

INTRODUCTION

The Fama and French three-factor model has been widely used by professionals in predicting the returns of securities. It was a vast improvement from the single-factor Capital Asset Pricing Model (CAPM), which was explanatory for 75-94% of a portfolio's return, as compared to the model developed by Fama and French, which explained 89-96% (Bhatnagar and Ramlogan (2012)). They included two factors relating to firm size, Small minus Big (SMB), and book-to-market ratio (BE/ME), High minus Low (HML). Regression results of these two factors along with excess market return captured significant explanatory power in the variation of average stock returns when compared to the CAPM. With this model, Fama and French (1992) found that low market equity firms and high market equity firms were more likely to have: low stock prices with higher average stock returns with large BE/ME and high stock prices with lower average stock returns with small BE/ME, respectively. The SMB factor is calculated using the average monthly return difference between small stock portfolios and big stock portfolios. Similar to the calculation of SMB, HML is calculated using the average monthly return difference between value stocks (high BE/ME) and growth stocks (low BE/ME).

However, major statistical anomalies were still unexplained with this three-factor model, such as: better t-statistics for High-Low portfolios vs. individual ones, expected returns directly related to a firm's B/M, variable selection driving other ones out of significance, etc. An improvement was made to it by Mark Carhart in 1997, which included a fourth factor, momentum (Carhart (1997)). This factor was to account for the tendency of a stock price to continue to rise or decrease month after month. This four-factor model was the predominant model used, until recently an alternative method, the Q-factor model (Hue, Xue, Zhang (2015)), was developed. The Q-factor model was suggested to be the workhorse for research and predicting the excess return of an asset by using a model based on a market factor, size factor, an investment factor and a profitability (return on equity, ROE) factor. Results from the Q-factor model perform very similar to the Carhart model, but underperforms in certain aspects, particularly in pricing total accrual deciles (Hou, Xue, Zhang (2015)).

With several alternative methods and issues concerning major anomalies, Fama and French developed a new model that was an improvement to their three-factor model with relevance to a CMA (Conservative Minus Aggressive) factor and a RMW (Robust Minus Weak) factor (Fama and French (2015)). The addition of these factors is used to capture investment and profitability, similar to the characteristics captured by the Q-factor model. Taking the average monthly return difference between conservative and aggressive stock portfolios calculates the CMA factor and taking the average monthly return difference between the robust operating profitability portfolio and the weak operating profitability portfolio calculates the RMW factor.

While numerous studies have tested the three-factor and five-factor model on a variety of markets, none have examined the five-factor model and its' use in predicting industry costs of equity (CE) within the United States. The main objective of this paper is to examine the estimating capabilities that the Fama-French five-factor model has in industry sector returns. We examine these industry sector returns in the full market, as well as in sub-periods from 1966-2015.

Our results show that the HML is not redundant in the Fama-French five-factor model and the incorporation of the CMA and RMW factors appear to be irrelevant when examining industry returns.

CHAPTER II

LITERATURE REVIEW

No research has been provided on the significance that the five-factor model has in explaining industry returns, while a vast amount of studies have examined the three-factor model. A study done by Varun Kapur (2007), suggests that the three-factor model is successful in explaining the excess returns, but the SMB and HML factors fluctuate in their significance, due mostly in part of the firm's capitalization and book-to-market equity. Fama and French (1996) compare the three-factor model to the traditional CAPM in predicting expected returns by industries from 1963-1994 by examining CE. They used several methods including: 3,4&5-year rolling CAPM and three-factor regressions as well as a 1-month, 1, 2, 3, 4 & 5-year forecasts. Results showed that the estimates are imprecise, due to standard errors, and there is no clear model that should be used between the two when examining industry market returns.

While the three-factor model may not be an improvement to the CAPM in industry CE estimation, others have suggested it to be an improvement in other various settings (Bhatnagar and Romlogan (2012) and Bundoo (2008)). Homsud et al. (2009) examined the three-factor model on the Stock Exchange of Thailand and found that it performed better in four (SH, BH, BM, SL) out of the six groups (i.e. SH is a portfolio in the small size group with a high BE/ME). Schink and Bower (1994) examined the three-factor model on the CE for New York electric utilities. They focused on the returns for the utilities and compared them to those recorded by the New York Public Service Commission. The results from their analysis supported the use of the Fama-French three-factor model in calculating a generic CE for utilities.

The article written by Hou, Xue and Zhang (2015) is probably one of the most influential papers written an alternative model and its comparative ability at pricing portfolios. They proposed the Q-factor Model, which takes into account the market factor, size factor, an investment factor as well as a return-on-equity factor (ROE). Results showed that the Q-factor model performed fairly well in summarizing the cross-section of returns, one of the primary concerns with the three-factor model, but didn't outperform the Carhart four-factor model in pricing total accrual deciles.

With several studies examining the benefits of the Fama-French three-factor model, it would be necessary to look at research on the five-factor model as well. Racicot and Theoret (2015) study how well the five-factor model performs on a variety of hedge fund strategies returns through testing redundancy of the HML factor with the addition of the CMA factor as well as the RMW separately. Their results showed that for most instances HML is quite redundant, but in several cases significant while CMA and RMW are present. CMA and RMW are suggested to absorb a portion of the impact HML has in the three-factor model. Fama and French (2015) suggested that if the primary interest is abnormal returns (regression intercepts), a model with the exclusion of HML performs just as well. However, if the interest lays in a portfolio's relationship with size, value, profitability and investment premiums, than the five-factor model is the model of choice. With dispute as to which pricing model is best, Fama and French (2015) make note that Hou, Xue and Zhang (2015) examine their pricing model only to the CAPM, three-factor model and Carhart's four-factor model, and focus on value-weighted portfolios from univariate sorts. Fama and French stress the importance of this due to value-weighted portfolios from univariate sorts on variables other than size are largely made up of big stocks and the main message that Fama and French (1993, 2012, 2015) state is the concern for pricing models is not within big stocks, but rather small stocks.

CHAPTER III

DATA AND METHODOLOGY

The data used in this analysis was acquired from the Center for Research in Security Prices (CRSP). There are a total fifteen variables observed within this study. Our dependent variables are the industry returns separated into ten groups: consumer nondurables (nodur), consumer durables (durbl), business equipment (hitec), manufacturing (manuf), energy (enrgy), telephone and television transmission (telcm), shops (shops), healthcare (hlth), utilities (utils) and other (other). We observe these variables from January 1966 – July 2015 (2015M7). In Table 1, provides a summary of the industry groups, their description and their respective SIC codes. Our independent variables are the five Fama-French factors: Small Minus Big (SMB), High Minus Low (HML), Robust Minus Weak (RMW), Conservative Minus Aggressive (CMA), and the excess market return (MKTRF); CRSP's value-weighted index comprising of NYSE, AMEX and NASDAQ stocks. Using the dependent variables as well as our excess market return factor, we will perform a CAPM regression represented by equation (1)

$$I_{i,\,t} = \alpha + \beta_1 * (mktrf_{i,\,t}) + \varepsilon_t \qquad (1)$$

Table 1. Summary of Industry Groups, Description and SIC Codes

INDUSTRY GROUP	DESCRIPTION	SIC CODES
nodur	Food, Tobacco, Textiles, Apparel, Leather, Toys	0100-0999|2000-2399|2700-2749|2770-2799|3100-3199|3940-3989
durbl	Cars, TV's, Furniture, Household Appliances	2500-2519|2590-2599|3630-3659|3710-3711|3714-3714|3716-3716|3750-3751|3792-3792|3900-3939|3990-3999
manuf	Machinery, Trucks, Planes, Chemicals, Off Furn, Paper, Com Printing	2520-2589|2600-2699|2750-2769|2800-2829|2840-2899|3000-3099|3200-3569|3580-3621|3623-3629|3700-3709|3712-3713|3715-3715|3717-3749|3752-3791|3793-3799|3860-3899
enrgy	Oil, Gas, and Coal Extraction and Products	1200-1399|2900-2999
hitec	Business Equipment - Computers, Software, and Electrical Equipment	3570-3579|3622-3622|3660-3692|3694-3699|7370-7379|7391-7391|8730-8734
telcm	Telephone and Television Transmission	4800-4899
shops	Wholesale, Retail, and Some Services (Laundries, Repair Shops)	5000-5999|7200-7299|7600-7699
utils	Utilities	4900-4949
hlth	Healthcare, Medical Equipment, and Drugs	2830-2839|3693-3693|3840-3859|8000-8099
other	Mines, Construction, BldMt, Transportation, Hotels, Bus Services, Entertainment, Finance	-

$I_{i,t}$ is our dependent variable, industry return by group; α represent our constant; β_i represents the coefficient of excess market return (mktrf) from the regression with respect to industry group i at time t, and our error term is represented by ε_t. This will be used as a baseline for our analysis and compare our results to the three-factor model and five-factor model to these. Considering that the Fama-French models are augmented versions of the CAPM this would provide a reliable comparison. Next, to construct our Fama-French three-factor model we will use an augmented version of the CAPM and add the SMB and HML factors represented by equation (2).

$$I_{i,t} = \alpha + \beta_1 * (mktrf_{i,t}) + \beta_2 * (SMB_{i,t}) + \beta_3 * (HML_{i,t}) + \varepsilon_t \qquad (2)$$

β_2 and β_3 represent our coefficients for SMB and HML respectively, by industry group, i, and at time t. We would expect our results to be reflective of the those found by Fama and French (1996), however, we anticipate to find that HML and SMB will have a larger role in explaining industry returns than their analysis, mostly due to their observation of 48 U.S. industries compared to our observation of 10, thus, allowing for mean reversion to occur within our analysis. Lastly we will construct our Fama-French five-factor model, represented by equation (3), where β_4 and β_5 represent the coefficients for CMA and RMW, respectively, by industry group, i, and at time t.

$$I_{i,t} = \alpha + \beta_1 * (X_{i,t}) + \beta_2 * (SMB_{i,t}) + \beta_3 * (HML_{i,t}) + \beta_4 * (CMA_{i,t}) + \beta_5 * (RMW_{i,t}) + \varepsilon_t \qquad (3)$$

With consideration on market volatility and differences in shocks to certain sectors within that markets, I have divided the time frame into three sub-periods (1966-1980, 1981-1998, 1999-2015) and will be comparing results from the CAPM and the five-factor model. This method is used to separate the possible extreme differences in market volatility and shocks occurred during certain time periods, such as the time period of 1973-1982 (Jain and Rosett (2001)) that may alter our full market results.

Another method we will be using to test the redundancy of the HML factor is using an augmented four-factor model, excluding the HML factor from the five-factor, this is represented by equation (4). The purpose of this four-factor model is to examine whether or not the CMA and RMW factors have a statistical significance increase with the exclusion of HML and if the explanatory power, adjusted R-squared, will increase or decrease when compared to the five-factor model.

$$I_{i,\,t} = \alpha + \beta_1 * (X_{i,\,t}) + \beta_2 * (SMB_{i,\,t}) + \beta_3 * (CMA_{i,\,t}) + B_4 * (RMW_{i,\,t}) + \varepsilon_t \quad (4)$$

In Table 2, I have provided summary statistics on the dependent and independent variables in the full market. As you can see our dependent variables, hitec, hlth and telcm have the highest average returns as well as the highest standard deviations, with the exclusion of enrgy and max returns. On the other hand, when we look at the market as a whole, mktrf, the returns on average are quite smaller compared to industry sector returns, but the standard deviation is almost 1.0 above the lowest in our dependent variables, utils, suggesting that there is a large variation in industry specific returns. Our risk-free rate, not shown, had an average return of .408; standard deviation of .265; and min and max of 0 and 1.35 respectively.

Table 2. Summary Statistics on Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent Variables					
nodur	595	1.08842	5.492851	-27.93	28.75
durbl	595	0.9843866	6.922464	-31.56	38.31
manuf	595	1.175244	6.038336	-29.91	27.81
enrgy	595	1.181412	7.927718	-32.66	28.34
hitec	595	1.364941	8.531243	-31.62	46.62
telcm	595	1.330739	7.508631	-27.39	52.8
shops	595	1.127983	6.296402	-29.65	34.84
hlth	595	1.480555	7.257788	-32.67	43
utils	595	1.009395	3.644559	-13.07	22.76
other	595	1.158118	5.468386	-24.85	29.01
Independent Variables					
mktrf	595	0.4859496	4.528669	-23.24	16.1
smb	595	0.2552437	3.119561	-15.36	19.18
hml	595	0.3274622	2.92027	-13.11	13.91
rmw	595	0.2595126	2.168822	-17.57	12.19
cma	595	0.3167227	2.050045	-6.81	9.51

Next, a correlation test would be necessary to find if any variables have a particular relationship with one another. The results, not shown, were identical to prior results by Fama and French (2015).

CHAPTER IV

RESULTS

We will start off with CAPM estimation using, equation (1) for the full market and observing each industry sector separately. Our results, shown in Table 3, supports the notion that the CAPM is an obsolete analysis on industry returns with very little explanatory power represented by our R-squared values ranging from 38% - 72%. We see that the excess market return is significant at the 1%, there are still anomalies unexplained by this model; which is why we will compare them to the Fama-French three-factor model shown in Table 4. These results show a vast improvement in explaining industry returns; noted from the increase in the adjusted R-squared values ranging from 44.3% to 91.1% along with the significance of all the variables, except SMB for utils in column 9 and the constants for each industry except for nondurbl and hlth in columns 2 and 8 respectively. The interpretation of this constant is used in evaluating the fund managers. If the constant is zero, the fund manager has captured the factor exposures perfectly. Taking the insignificance of the constants for the industries into consideration suggests that the performance of the managers in these industries can't be claimed for the excess returns. Also, with the SMB factor being insignificant for utils tells us the small market factor does not play a statistically significant role in the returns for utils. In regards to the effects that these factors have on industry returns, we see that mktrf is slightly less when compared to the CAPM model effects.

Table 3. CAPM Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Nodur	Durbl	Hitec	Manuf	Enrgy	Telcm	Shops	Hlth	Utils	Other
mktrf	0.982***	1.228***	1.472***	1.133***	1.081***	1.309***	1.117***	1.226***	0.527***	0.992***
	(0.0428)	(0.0544)	(0.0547)	(0.0399)	(0.0672)	(0.0499)	(0.0471)	(0.0420)	(0.0322)	(0.0376)
Constant	0.203	-0.0201	0.242	0.217*	0.248	0.287	0.177	0.477**	0.345***	0.268**
	(0.131)	(0.166)	(0.214)	(0.130)	(0.257)	(0.185)	(0.151)	(0.192)	(0.114)	(0.128)
Observations	595	595	595	595	595	595	595	595	595	595
Adj. R-squared	0.650	0.640	0.607	0.716	0.379	0.621	0.640	0.582	0.428	0.669

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4. Fama-French Three-Factor Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Nodur	Durbl	Hitec	Manuf	Enrgy	Telcm	Shops	Hlth	Utils	Other
mktrf	0.906***	1.119***	1.126***	1.040***	1.064***	1.123***	0.988***	0.945***	0.616***	0.918***
	(0.0273)	(0.0395)	(0.0414)	(0.0259)	(0.0727)	(0.0438)	(0.0357)	(0.0406)	(0.0289)	(0.0235)
smb	0.781***	1.002***	1.331***	0.842***	0.563***	0.787***	0.940***	1.060***	0.00882	0.782***
	(0.0533)	(0.0665)	(0.0758)	(0.0500)	(0.104)	(0.0705)	(0.0737)	(0.0765)	(0.0382)	(0.0540)
hml	0.385***	0.433***	-0.456***	0.358***	0.469***	-0.175*	0.270***	-0.388***	0.466***	0.398***
	(0.0533)	(0.0710)	(0.0793)	(0.0491)	(0.106)	(0.0913)	(0.0753)	(0.0701)	(0.0500)	(0.0492)
Constant	-0.0855	-0.365***	0.220	-0.0700	-0.0409	0.234	-0.0885	0.470***	0.147	-0.0258
	(0.0863)	(0.110)	(0.136)	(0.0775)	(0.251)	(0.162)	(0.104)	(0.136)	(0.103)	(0.0789)
Observations	595	595	595	595	595	595	595	595	595	595
Adj. R-squared	0.862	0.851	0.852	0.911	0.447	0.724	0.848	0.799	0.553	0.885

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

This is assumed due the addition of the SMB and HML factors. Looking more closely to the coefficients of the factors, we also see that SMB has values very close to that of the mktrf factor, except in the case of hlth where it surpasses the estimated coefficient and is drastically smaller for utils and slightly under half for enrgy and telcm; HML on the other hand has values resembling half that of SMB as well as negative values. These negative coefficients resemble that within the sectors of hitec, telcm and hlth, growth portfolios were the primary purchase.

Next, we examine the industries using the Fama-French five-factor model in the full market shown in Table 5. A slight increase in the R-squared value for all industries is observed. Telcm, column 6, being the largest movement. Another movement we see when we add the CMA and RMW factors is the significance of the factors among the industries. We observe that several variables that are insignificant: SMB for utils, HML for Telcm, RMW for enrgy and utils, and CMA for nodur, manuf, enrgy and hlth. These insignificant values suggest that the addition of CMA and RMW absorb some of the explanatory power that HML contained in the three-factor model as well as the significance for these factors seem to be diminishing. While the additions of these factors seem to pose insignificant for several of the industries, we cannot conclude that the HML factor is redundant. There is slight increase movement within the adjusted R-squared values as well as the HML factor seems to remain significant for all, but one industry, telcm, while RMW is insignificant for four of the industries and CMA for six of the industries at the 5% level.

Table 5. Fama-French Five-Factor Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Nodur	Durbl	Hitec	Manuf	Enrgy	Telcm	Shops	Hlth	Utils	Other
mktrf	0.915***	1.112***	1.055***	1.036***	1.046***	1.039***	0.986***	0.935***	0.630***	0.911***
	(0.0208)	(0.0276)	(0.0316)	(0.0187)	(0.0613)	(0.0378)	(0.0251)	(0.0325)	(0.0252)	(0.0189)
smb	0.831***	1.028***	1.189***	0.860***	0.537***	0.612***	0.986***	0.961***	0.00685	0.816***
	(0.0291)	(0.0387)	(0.0443)	(0.0261)	(0.0858)	(0.0529)	(0.0352)	(0.0455)	(0.0353)	(0.0264)
hml	0.397***	0.496***	-0.263***	0.396***	0.530***	0.0437	0.329***	-0.446***	0.397***	0.468***
	(0.0408)	(0.0541)	(0.0620)	(0.0366)	(0.120)	(0.0741)	(0.0492)	(0.0637)	(0.0494)	(0.0370)
rmw	0.211***	0.108*	-0.642***	0.0729*	-0.118	-0.790***	0.191***	-0.423***	0.000562	0.139***
	(0.0428)	(0.0568)	(0.0650)	(0.0383)	(0.126)	(0.0777)	(0.0516)	(0.0668)	(0.0518)	(0.0388)
cma	-0.0326	-0.142*	-0.406***	-0.0859	-0.129	-0.458***	-0.135*	0.139	0.150**	-0.158***
	(0.0613)	(0.0814)	(0.0931)	(0.0549)	(0.181)	(0.111)	(0.0739)	(0.0957)	(0.0743)	(0.0555)
Constant	-0.150*	-0.372***	0.522***	-0.0768	0.0261	0.597***	-0.125	0.584***	0.116	-0.0400
	(0.0866)	(0.115)	(0.132)	(0.0776)	(0.255)	(0.157)	(0.104)	(0.135)	(0.105)	(0.0785)
Observations	595	595	595	595	595	595	595	595	595	595
Adj. R-squared	0.868	0.853	0.873	0.912	0.446	0.765	0.853	0.814	0.555	0.890

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6. Alternative Four-Factor Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Nodur	Durbl	Hitec	Manuf	Enrgy	Telcm	Shops	Hlth	Utils	Other
mktrf	0.917***	1.115***	1.053***	1.038***	1.049***	1.040***	0.988***	0.933***	0.632***	0.914***
	(0.0224)	(0.0295)	(0.0321)	(0.0204)	(0.0622)	(0.0378)	(0.0260)	(0.0338)	(0.0265)	(0.0212)
smb	0.837***	1.037***	1.185***	0.866***	0.546***	0.613***	0.991***	0.954***	0.0135	0.824***
	(0.0314)	(0.0413)	(0.0449)	(0.0286)	(0.0871)	(0.0529)	(0.0364)	(0.0473)	(0.0372)	(0.0298)
rmw	0.297***	0.215***	-0.698***	0.158***	-0.0039	-0.781***	0.262***	-0.519***	0.0862	0.240***
	(0.0450)	(0.0593)	(0.0645)	(0.0410)	(0.125)	(0.0760)	(0.0523)	(0.0680)	(0.0534)	(0.0427)
cma	0.378***	0.371***	-0.678***	0.323***	0.418***	-0.413***	0.205***	-0.322***	0.561***	0.325***
	(0.0479)	(0.0631)	(0.0686)	(0.0436)	(0.133)	(0.0808)	(0.0556)	(0.0723)	(0.0568)	(0.0454)
Constant	-0.175*	-0.403***	0.539***	-0.102	-0.0073	0.595***	-0.146	0.612***	0.0907	-0.0694
	(0.0932)	(0.123)	(0.133)	(0.0849)	(0.259)	(0.157)	(0.108)	(0.141)	(0.110)	(0.0884)
Observations	595	595	595	595	595	595	595	595	595	595
Adj. R-squared	0.847	0.832	0.869	0.895	0.429	0.765	0.843	0.799	0.507	0.861

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Again, noting the coefficients from the five-factor model, HML is negative for hitec and hlth, but not telcm. If you look you will see that the coefficients for CMA and RMW in telcm are negative; suggesting that majority of that industry is comprised of weak and aggressive purchases. CMA has negative values for all industries except for hlth and utils. RMW has negative values in hitec, enrgy, telcm, and hlth. It is interesting to see that HML is positive in the telcm industry, while the CMA and RMW factors are negative.

To further investigate this we use an alternative four-factor model, excluding the HML, factor from the five-factor model to see if the significance of RMW and CMA increases. This is done by using equation (4); results are shown in Table 6. As predicted, our four-factor model does shed light on the redundancy issue concerning the HML factor, with the hitec, enrgy, telcm and hlth containing negative RMW coefficients and hitec, telcm and hlth containing negative CMA coefficients. SMB is still insignificant for utils, however, RMW is only insignificant for enrgy and utils. With the changes in the adjusted R-squared values and the significance of the factors, it appears that the HML factor is not redundant. While taking the change in explanatory power and the changes in the coefficients we cannot dismiss that HML adds no insight in explaining industry returns.

Lastly, we observe the five-factor model over sub-periods. We do this by observing three separate time frames (1966-1980, 1981-1998, 1999-2015) as described earlier. Table 7, Table 8 and Table 9 depict our results from these sub-period regressions. The decision on choosing these time periods as opposed to alternative periods is the concern on balancing the number of observations for each sub-period as well as our concern with shocks to the market.

The primary outcome we derive from these results is that as time progresses, the explanatory capabilities of the five-factor model diminish for all industries, with the exception of enrgy, whose R-squared values increase from the second sub-period to the third. In Table 7, the five-factor model accounts for 67.4% - 98% of industry returns; Table 8 shows it accounts for 39.7% - 92.3%; and in Table 9 it accounts for 42.6% - 86.8%. While the five-factor model in certain sub-periods provides exceptional results, it does not provide explanation for all of the anomalies. However, we do note that during certain sub-periods market shocks occurred such as: Black Friday, dotcom bubble, oil and natural gas bubble, etc. These are not controlled for during these sub-periods, however the purpose of this analysis is to see the estimation capabilities the Fama-French five-factor model have over time.

Perhaps the most interesting point made from the these results is that although the Fama-French three-factor model is a vast improvement to the CAPM, the addition of CMA and RMW seem to dilute the significance that HML has in explaining returns. Although the factors, CMA and RMW are significant without the HML factor, we cannot exclude it when we observe industry returns since CMA and RMW are insignificant for half or more of industries in every sub-period.

Table 7. Five-Factor Model: Sub-Period 1966-1980

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Nodur	Durbl	Hitec	Manuf	Enrgy	Telcm	Shops	Hlth	Utils	Other
mktrf	0.896***	1.062***	1.030***	0.951***	1.012***	1.051***	0.946***	1.031***	0.755***	0.902***
	(0.0302)	(0.0372)	(0.0419)	(0.0188)	(0.0712)	(0.0490)	(0.0341)	(0.0417)	(0.0477)	(0.0262)
smb	1.055***	1.228***	1.464***	0.987***	0.470***	0.694***	1.178***	0.745***	-0.0473	1.024***
	(0.0397)	(0.0490)	(0.0551)	(0.0248)	(0.0937)	(0.0645)	(0.0449)	(0.0549)	(0.0628)	(0.0345)
hml	0.197***	0.340***	0.143	0.205***	-0.464***	0.220*	0.0219	-0.352***	0.366***	0.166***
	(0.0725)	(0.0893)	(0.100)	(0.0452)	(0.171)	(0.118)	(0.0818)	(0.100)	(0.114)	(0.0630)
rmw	0.136	0.286**	-0.0285	0.0228	-1.305***	0.216	0.195*	0.0779	-0.291*	-0.279***
	(0.102)	(0.126)	(0.142)	(0.0638)	(0.241)	(0.166)	(0.115)	(0.141)	(0.161)	(0.0888)
cma	0.196**	0.0895	-0.536***	0.0273	-0.0828	-0.0190	0.257**	0.137	0.0408	-0.179**
	(0.0987)	(0.122)	(0.137)	(0.0616)	(0.233)	(0.160)	(0.111)	(0.136)	(0.156)	(0.0857)
Constant	-0.296**	-0.405***	0.128	0.0211	1.511***	0.342*	-0.181	0.363**	-0.0807	0.0679
	(0.123)	(0.152)	(0.171)	(0.0768)	(0.290)	(0.200)	(0.139)	(0.170)	(0.194)	(0.107)
Observations	168	168	168	168	168	168	168	168	168	168
Adj. R-squared	0.949	0.944	0.946	0.980	0.747	0.867	0.944	0.905	0.674	0.963

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8. Five-Factor Model: Sub-Period 1981-1998

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Nodur	Durbl	Hitec	Manuf	Enrgy	Telcm	Shops	Hlth	Utils	Other
mktrf	0.872***	0.976***	1.012***	0.957***	0.911***	0.960***	0.918***	0.971***	0.574***	0.942***
	(0.0264)	(0.0382)	(0.0443)	(0.0263)	(0.0991)	(0.0553)	(0.0344)	(0.0538)	(0.0356)	(0.0303)
smb	0.916***	1.146***	1.321***	0.958***	0.643***	0.868***	1.089***	1.275***	-0.123**	0.885***
	(0.0417)	(0.0604)	(0.0700)	(0.0416)	(0.157)	(0.0874)	(0.0543)	(0.0850)	(0.0562)	(0.0478)
hml	0.154**	0.117	-0.456***	0.0577	-0.393*	-0.125	0.0889	-0.511***	0.489***	0.380***
	(0.0628)	(0.0909)	(0.105)	(0.0625)	(0.236)	(0.131)	(0.0817)	(0.128)	(0.0845)	(0.0719)
rmw	0.0978	-0.0832	-0.468***	-0.0606	-0.347	-0.438***	-0.0459	-0.475***	-0.277***	-0.0874
	(0.0772)	(0.112)	(0.129)	(0.0768)	(0.290)	(0.161)	(0.100)	(0.157)	(0.104)	(0.0884)
cma	0.263***	0.276**	0.106	0.267***	0.938***	0.0406	0.107	0.326*	-0.284**	0.0393
	(0.0894)	(0.129)	(0.150)	(0.0890)	(0.336)	(0.187)	(0.116)	(0.182)	(0.120)	(0.102)
Constant	-0.168	-0.163	0.443**	-0.0990	-0.759*	0.660***	-0.0835	0.535**	0.325**	0.0254
	(0.111)	(0.161)	(0.186)	(0.111)	(0.417)	(0.233)	(0.145)	(0.226)	(0.150)	(0.127)
Observations	228	228	228	228	228	228	228	228	228	228
Adj. R-squared	0.904	0.864	0.884	0.923	0.397	0.756	0.881	0.823	0.581	0.886

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9. Five-Factor Model: Sub-Period 1999-2015M7

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Nodur	Durbl	Hitec	Manuf	Enrgy	Telcm	Shops	Hlth	Utils	Other
mktrf	0.911***	1.259***	1.097***	1.134***	1.037***	1.129***	1.067***	0.732***	0.544***	0.807***
	(0.0500)	(0.0671)	(0.0753)	(0.0464)	(0.142)	(0.0924)	(0.0618)	(0.0719)	(0.0547)	(0.0360)
smb	0.538***	0.784***	0.768***	0.688***	0.468**	0.442***	0.780***	0.830***	0.0286	0.507***
	(0.0644)	(0.0865)	(0.0970)	(0.0598)	(0.183)	(0.119)	(0.0796)	(0.0927)	(0.0705)	(0.0463)
hml	0.491***	0.574***	-0.355***	0.538***	1.263***	0.182	0.414***	-0.0704	0.337***	0.521***
	(0.0833)	(0.112)	(0.126)	(0.0774)	(0.237)	(0.154)	(0.103)	(0.120)	(0.0913)	(0.0600)
rmw	0.0699	0.0825	-0.878***	0.0208	-0.344	-1.009***	0.194	-0.924***	0.00855	-0.0349
	(0.0953)	(0.128)	(0.144)	(0.0885)	(0.271)	(0.176)	(0.118)	(0.137)	(0.104)	(0.0686)
cma	-0.160	-0.230	-0.291*	-0.181*	-0.723**	-0.680***	-0.297**	-0.00842	0.324***	-0.167**
	(0.111)	(0.150)	(0.168)	(0.103)	(0.317)	(0.206)	(0.138)	(0.160)	(0.122)	(0.0801)
Constant	0.210	-0.373	0.771***	0.0487	0.420	0.489	0.0949	1.140***	0.364*	0.0951
	(0.189)	(0.254)	(0.285)	(0.176)	(0.538)	(0.350)	(0.234)	(0.272)	(0.207)	(0.136)
Observations	200	200	200	200	200	200	200	200	200	200
Adj. R-squared	0.779	0.792	0.843	0.868	0.426	0.754	0.767	0.792	0.474	0.856

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

CHAPTER V

CONCLUSION

With this paper I have shown that the five-factor model may not be the best model to use when looking at industry returns, but when compared to the CAPM and the three-factor model it does provide the most insight and explanatory power for industry returns. The main concern is due to the diminishing effect it has in explaining returns in recent years as compared to prior periods along with the insignificance of the CMA and RMW factors. We have used monthly return data on 10 separate industries spanning from 1966 – 2015M7. The insight that this paper has provided can be used to assist fund managers and future research on industry returns. While the CAPM provides solid foundation, it is obsolete when examining returns and the Fama-French three-factor model has shown that time and time again. Although Fama and French have augmented their three-factor model and included the CMA and RMW factors, our results suggest that the five-factor model provides the most insight on industry returns with concern being focused on the CMA and RMW factors.

REFERENCES

Bhatnagar, Chandra S., and Riad Ramlogan, The Capital Asset Pricing Model Versus The Three Factor Model, 2012, A United Kingdom Perspective, *International Journal of Business 2.1: 51-65*

Bundoo, Sunil K., 2008, An Augmented Fama and French Three-Factor Model: New Evidence from an Emerging Stock Market, *Applied Economics Letters 15:15, 1213-1218*

Carhart, Mark M., 1997, On Persistence in Mutual Fund Performance, *Journal of Finance 52:1, 57-82*

Fama, Eugene F., and Kenneth R. French, 1993, Common risk factors in the returns on stocks and bonds, *The Journal of Finance 33, 3-56*

Fama, Eugene F., and Kenneth R. French, 1996, Industry costs of equity, *Journal of Financial Economics 43, 153-193*

Fama, Eugene F., and Kenneth R. French, 2012, Size, Value and Momemtum in International Stock Returns, *Journal of Financial Economics 105:3, 457-472*

Fama, Eugene F., and Kenneth R. French, 2015, A five-factor asset pricing model, *Journal of Financial Economics 116:1, 1-22*

Gibbons, Michael R., Stephen Ross, and Jay Shanken, 1989, A Test of the Efficiency of a Given Portfolio, *Econometrica 57, 1121-1152*

Hou, K.ewei, Xue, Chen, and Lu Zhang, 2015, Digesting Anomalies: An Investment Approach, *The Review of Financial Studies* 28:3, 650-705

Homsud, Nopbhanon et. al., 2009, A Study of Fama and French Three Factors Model and Capital Asset Pricing Model in the Stock Exchange of Thailand, *International Research Journal of Finance and Economics 25, 31-40*

Jain, Prenn, and Rosett, Joshua, 2006, Macroeconomic variables and the E/P ratio, *Review of Quantitative Finance and Accounting 27:1, 5-26*

Kapur, Varun, 2007, Is the Fama and French model a good indicator of market sectoral performance?, *Honors Thesis at NYU*

Racicot, Francois-Eric, and Raymond Theoret, 2015, The q-factor model and the redundancy of the value factor: An application to hedge funds, Working Paper

Schink, George R., and Richard s. Bower, 1994, Application of the Fama-French Model to Utility Stocks, *Financial Markets, Institutions and Instruments* 3:3, 74-96