TESTS OF THE CAPM AND FAMA AND FRENCH THREE-FACTOR MODEL

by

Nima Billou
Honours BA, Business Administration, 1998
Richard Ivey School of Business, University of Western Ontario

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Name: Nima Billou

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Examining Committee:

____

Dr. Robert R. Grauer
Senior Supervisor
Endowed Professor, Faculty of Business Administration

____

Dr. Peter Klein
Supervisor
Associate Professor, Faculty of Business Administration

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ABSTRACT

This project compares and tests the effectiveness of two asset-pricing models: the Sharpe (1964)-Lintner (1965) capital asset pricing model (CAPM) and Fama and French (1993) three-factor model. Effectiveness is measured by focusing on the models' alphas and includes the mean absolute value of alphas (MAVA) and the Gibbons, Ross and Shanken (1989), or GRS F-Test. Fama and French (1996) claim their model outperforms the CAPM because their MAVA is smaller than that of the CAPM in a universe of twenty-five portfolios sorted by size and book-to-market equity. This paper examines these twenty-five portfolios over longer time periods. The three-factor model outperforms the CAPM according to the MAVA. However, both models are rejected by the GRS test. A dataset composed of twelve industries is also employed, where the MAVA of the CAPM is smaller than that of the three-factor model and the CAPM is not rejected by the GRS F-test.

DEDICATION

To my mother Mariam, without whom none of this would have been possible. Your support will forever be appreciated and will take many lifetimes to return in kind. To my better half Kira, a patient and understanding person whose words of encouragement from Toronto were of great comfort a few time zones away. Finally, I would like to thank Farhan Adam Hamidani, a fellow classmate and good friend. Farhan, your support has been a great help and contributed to my success in this program and more importantly your friendship has made the time pass by a lot quicker.

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1. INTRODUCTION

The purpose of this project is to compare and test the effectiveness of two premier asset-pricing models, the single factor Sharpe(1964)-Lintner(1965) capital asset pricing model, or CAPM, and the Fama and French (1993,1996) three-factor model. The appeal of these two asset-pricing models lies in their structural simplicity and ease of interpretation. Both are based on linear regression models which link the excess return on stocks to either a single factor or group of factors.

The CAPM relates the expected return on a portfolio or stock to a single factor β or the excess return on a market portfolio. The three-factor model expands on the CAPM with the introduction of two additional factors, SMB (small minus big) and HML (high book-to market equity less low book-to-market equity), which incorporate size and book to market equity.

Of course, the question that needs answering is, "Which is the more effective asset-pricing model?" Fama and French (1993, 1996) contend that their model is superior to that of the CAPM because of its ability to capture returns due to anomalies such as size and book-to-market equity that are not captured by the CAPM. From an empirical perspective the more specific question would be, "How do we statistically test to assess whether an asset-pricing model does a better job of explaining the variation in returns?"

Using evidence based on the results from the regressions of 25 portfolios sorted by size and book-to-market that showed a lower mean absolute value for the intercepts, Fama and French (1993, 1996) claim that their three-factor model is superior in explaining the variability in returns. I will first extend their study by examining two different time periods on the same grouping of 25 portfolios to see if the superior effectiveness of their model still holds. Finally, in order to see whether the effectiveness of a model is sample specific, I will compare the three-factor model and the CAPM using a different portfolio grouping based on 12 industries.

Fama and French (1996) have tested their three-factor model and the CAPM using the 1963:07 to 1993:12 time period. From the results of this regression they have concluded that their three-factor model is superior to the CAPM due to the values of the intercepts which were close to zero. I will first update their study by extending the time period with more recent data beginning in 1963:07 but now stretching to 2003:12 to see whether the superiority of their model is maintained. I will then look at a longer time period beginning in 1926:07 and ending in 2003:12 to see if the results are affected by the number of observations. In going as far back as 1926:07 I am hoping to build on the foundation of comparison that was established by Fama and French.

Testing the two models using the second grouping of industry portfolios will allow me to examine whether the effectiveness of an asset-pricing model is sample specific. In theory, the effectiveness of an asset-pricing model should not be dictated by how you group the data. For the industry portfolios, I will provide depth to this analysis by employing three separate time periods from 1926:07 to 2003:12, from 1963:07 to 1993:12 and from 1963:07 to 2003:12. By varying the time periods, I will have a broader perspective from which to compare the effectiveness of these asset-pricing models.

In addition to the large body of literature on comparing the effectiveness of these two models, there are innumerable articles on the correct testing measures to employ. In keeping with the nature of simplicity, I am going to compare the CAPM and Fama and French models by using two measures. Both tests will focus on the value of the intercepts generated by the time series regressions on the two sets of portfolios, both industry, and size and book-to-market. Fama and French (2004, Working Paper) stated simply that if asset-pricing theory holds either in the case of the CAPM (pp 10), or the Fama and French three-factor model (pp21), then the value of these intercepts or α's should be zero. Empirically, this demonstrates that the asset-pricing model, and its factor or factors, explain the variation in the returns of a portfolio. The larger the value of the intercepts, the poorer the job a model does of explaining the variation in returns.

For my first test, I will simply look at the mean absolute value of the alphas (MAVA). The model with the smallest MAVA will be judged the more effective model. This will be done simultaneously by looking at the t-statistics for the alphas in order to comment on statistical significance. For my second test, I will employ the Gibbons, Ross and Shanken (1989) or GRS F-statistic that tests the null H_o:$\alpha_i = 0$ for all of i. These tests, the data and methodology will be described in further detail in Section 3.

This rest of this paper is organized as follows. Section 2 will introduce the two asset-pricing models, probe some of the existing literature, and describe various tests using different portfolio groupings for these two asset-pricing models. Section 3 will describe the methodology, Section 4 will describe the data, and Section 5 will describe the results for the two tests of the CAPM and Fama and French three-factor model. Finally, Section 6 contains a discussion of the general results and my conclusion.

2. LITERATURE REVIEW

One of the fundamental concepts in the arena of financial economics is that of risk versus reward. Within the context of asset-pricing the capital asset pricing model or CAPM helped formed the foundation for empirical models that addressed the risk/reward concept. The CAPM was first introduced by Sharpe(1964)-Litner(1965). The reason that this model was so readily embraced when it was first introduced was that it addressed the difficult problem of asset-pricing in a simple, straightforward manner that used data that seemed to be readily available.

The equation for the CAPM model which describes the expected return on portfolio or stock i follows as:

$$\mathbf{E(R_i) = R_f + \beta_i[E(R_m)\text{-}R_f]\ (1),}$$

where R_f is the risk-free interest rate, $E(R_m)$ is the expected return on the value-weight market portfolio, and β_i, the CAPM risk of stock *i*, is the slope in the regression of its excess return on the market's excess return. The equation for the time series regression can be seen in (2) with the excess return on portfolio *i* as the dependent variable and the excess return on the market as the independent variable:

$$\mathbf{R_i\text{-}R_f = \alpha_i + \beta_i[R_m\text{-}R_f] + \varepsilon_i\ (2)}$$

In the CAPM model β or Beta is the sole factor when it comes to pricing risk. We can intuitively see why people initially embraced this model, and it was due to its simplicity.

The CAPM was formed on the basis of several key assumptions: 1) there are no taxes or transactions costs, 2) all investors have identical investment horizons, 3) all investors have identical perceptions regarding the expected returns, volatilities and correlations of available risky assets.[1] As mentioned, the attraction of the CAPM as an asset-pricing model lay in its simplicity in describing the relationship between expected return and risk. In the context of the CAPM, an investor is only rewarded for systematic or non-diversifiable risk which is represented by β. The excess premium that is afforded to portfolio or stock i is solely a function of its volatility to the expected market risk premium, or the β factor, multiplied by the expected market risk premium. The advantages of this model were that given historical returns on the portfolio, and the selection of another variable such as the S&P 500 as a proxy for the market, that it is very simple to calculate β from a time series regression. Despite the simplicity in its calculation, there were numerous criticisms of the CAPM in the years that followed. These criticisms emerged as people began to empirically test this breakthrough model.

Since the introduction of the CAPM model in 1964, empiricists began testing its implications almost immediately. Both Javed (2000) and Fama and French (2004) comment on many of the early tests which included: Black, Jensen and Scholes (1972); Blume and Friend(1973); Fama and Macbeth (1973); Basu (1977); Reinganum (1981); Banz (1981); Gibbons (1982); Stambaugh (1982) and Shanken (1985). Both papers came to the same conclusion that these early tests shared one central theme; that of offering very little evidence in support of the CAPM model.

Fama and French (2004, pp 8) noted that if one were to regress a cross-section of average portfolio returns on estimates of portfolio betas, the Sharpe-Lintner CAPM model would predict that the intercept in these regressions would be equal to the risk

[1] http://www.riskglossary.com/articles/capital_asset_pricing_model.htm

free rate or R_f. The model goes on to predict that the coefficient on beta is equal to $E(R_m) - R_f$. After having run numerous cross sectional regressions, Black Jensen Scholes (1972), Blume and Friend (1973) , Fama and Macbeth (1973), and Fama and French (1992) regularly find that the intercept exceeds the average risk free rate which is represented by the return on a one month T-bill.[2]

The results employing time series regressions were no better, with Friend and Blume (1970), Black Jensen and Scholes (1972) and Stambaugh (1982) finding evidence that the relation between beta and average return is too flat.[3] These time series tests owed their significance to Jensen (1968), who first discovered that the Sharpe-Lintner model and the relationship between expected return and beta necessitated a time series regression test.[4] If this relationship was to hold and beta accounted for the full explanation of an asset's expected return then Jensen's alpha, or the intercept term, would have to be zero.

Fama and French (2004) observed that the CAPM "undershot" or underestimated the expected returns with respect to companies with low betas and "overshot "or overestimated the expected returns for companies with high betas. This is consistent with their reasoning in earlier papers to include other factors to explain returns such as the difference between High BE/ME less low BE/ME stocks. The authors also cite a litany of evidence demonstrating the failure of the CAPM to incorporate many ratios which involve stock prices that contain information regarding expected returns which are missed by the sole beta variable.[5] They begin with Basu (1977) where the CAPM underestimates the future returns on high earnings to price stocks. They also cite Banz

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[2] Fama and French (2004), pg 11.
[3] Fama and French (2004), pg 11.
[4] Fama and French (2004), pg 10.
[5] Fama and French (2004), pg 16.

(1981) where there was an appearance of the size effect that demonstrated the inability of the CAPM to capture returns of small stocks. As well, Statman (1980) showed that that "value" stocks or stocks with high book-to-market equity ratios had returns that were not captured by market betas.

For a period of close to 30 years, the CAPM dominated the academic literature when it came to asset-pricing models. Finally Fama and French (1993) suggested an alternative to the CAPM that included two additional factors which helped explain the excess returns on a portfolio. In addition to the market factor, or R_m-R_f, Fama and French added SMB (Small minus Big) and HML (High Minus Low). The factor SMB represented the average return on three small portfolios (small cap portfolios), less the average return on three big portfolios (large cap portfolios). The HML factor represented the average return on two value portfolios less the average return on two growth portfolios. The value portfolios represented stocks with a high Book Equity (BE)/ to Market Equity (ME) ratio and the growth portfolios represented the complete opposite with low BE/ME ratios. Fama and French found that the addition of these two factors enabled a more robust explanation of the variability in portfolio returns.

The three-factor model is described by equation (3) where the expected excess return on portfolio *i* is

$$\mathbf{E(R_i) = R_f + \beta_i[E(R_m)-R_f] + s_iE(SMB) + h_iE(HML)\ (3),}$$

and where $E(R_M) - R_f$, E(SMB), and E(HML) are expected premiums, and the factor sensitivities or loadings β_i, s_i, and h_i, are the slopes in the time series regression,

$$\mathbf{R_i-R_f = \alpha_i + \beta_i(R_m-R_f) + s_iSMB+ h_iHML +\varepsilon_i\ (4)}$$

Fama and French (1992, 1995, 1996, and 2004) share one consistent theme, in that the CAPM with its single beta factor fails to price other risks which contribute to the explanation of a portfolio's expected returns. Based on their own evidence and that of their predecessors, they proposed an alternative asset-pricing model that would be better able to explain an asset's expected returns and to price additional risks that helped explain those returns. The authors regarded the sea of evidence that included many of the early tests of the simplistic CAPM model as evidence itself that a more complicated asset-pricing model was needed.[6]

The parameters for the model are outlined in equation (4) and with the benefit of hindsight it is easy to see the reasoning that led to the inclusion of the two additional factors, SMB and HML, to help price risk. It would seem that the work of Statman (1980) and Banz (1981) could have provided the inspiration for these two forward thinkers to include these two additional factors. In fact, the authors themselves specifically credit the evidence of Huberman and Kandel (1987) for using the SMB factor and the evidence of Chan and Chen (1991) for inclusion of the HML factor.[7]

The effectiveness of this model may also be judged by the intercept in the Equation (4). Again Fama and French (2004, pp 21) noted that if their model holds then the value of α_i or the intercept must equal zero for all assets i. If judging by the value of the intercepts, the Fama and French three-factor model (1993, 1996) captures most of the variation in average returns on portfolios formed on various price ratios which are not captured by the CAPM including: size, and book-to-market equity.[8] The three-factor model is now used in many applications from the returns on specific groups of industries, to capital budgeting decisions, as well as international capital markets.

Fama and French (1997) look at the ability of both the CAPM and their own three-factor model in calculating industry costs of equity. If judging solely by the mean

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[6] Fama and French (2004), pg 18.
[7] Fama and French (1997), pg 156.
[8] Fama and French (2004), pg 21.

absolute value of the intercept from table 2 in this paper, the Fama and French model outperforms the CAPM across the 48 industries considered.[9] The authors themselves did not come to a definitive conclusion other than to observe that estimates for the industry costs of equities are imprecise. They also found that even though their model and the CAPM share the same estimate for market risk premium, that their estimates of the cost of equities for many of the 48 industries differed by more than 2.0% per year. Both models also displayed disturbing large standard errors in the order of 3.0% per year across all industries. These large standard errors are thought to be the result of uncertainty about true factor risk premiums,"…. in addition to imprecise estimates of period-by-period risk loadings."[10] In short, attempting to explain the costs of equity across 48 industries with varying characteristics and price movements is a difficult empirical task. It may even necessitate a more complicated multi-factor model.

Connor and Senghal (2001) looked at testing the Fama and French three-factor model in India. Specifically, they put both the one factor CAPM and three-factor Fama French model side by side to see which model was more effective at predicting portfolio returns in India's stock market. Their sample companies form part of the CRISIL-500 which is akin to the S&P 500 Index in the US. They then created six portfolios from the intersection of two size and three book-to-market equity groups (Small/Low S/M, S/H, B/L, B/M,B/H). The authors judged the effectiveness of the models by examining and testing the intercepts. They first looked at the levels of the intercepts and their t-statistics and test the intercepts simultaneously by employing the adjusted Wald Statistic first introduced by Gibbons, Ross and Shanken or GRS (1989).

[9] Fama and French (1997), pg 158.
[10] Fama and French (1997), pg 178.

Connor and Senghal (2001, pp 8) generally concluded that the three-factor model was superior because of the evidence provided by the intercepts of the time series regressions on the two asset-pricing models. For the CAPM model, three of the six portfolios contained intercepts that were positive and all significant at the 95% confidence level. In testing the intercepts jointly, the GRS statistic for the CAPM was much larger at 3.8069 with a p-value of 0.0017 which suggests the intercepts stray further away from zero.[11] For the three-factor model the intercept values for all six portfolios are statistically different than zero at the 95% confidence level. In addition, the GRS statistic of 1.7478 was much lower for the three-factor model than for the CAPM and the p-value was 0.1168 which means that we cannot reject the null that $H_o:\alpha_i = 0$ for all of i $\alpha_i=0$.[12] When used in an international setting, it seems that the addition of two extra factors does make a difference in explaining the variation in the returns of a portfolio, and in this case demonstrates the superiority of the three-factor model versus the one factor CAPM.

[11] Connor and Sehgal (2001), pg 17.

[12] Connor and Sehgal (2001), pg 17.

3. METHODOLOGY FOR EMPIRICAL TESTS

For each test, I began by running a time series regression on the excess returns of the 25 size and book-to-market portfolios and 12 industry portfolios against the factors in each model. For the CAPM, the time series regression is given in equation (2) and for the Fama and French model the time series regression is given in equation (4). These regressions provide separately 25 and 12 intercept values, or alphas, which I will test using two different methods to see which model is most effective at capturing the variation in returns.

As mentioned, my methodology for evaluating the asset-pricing models will focus on the intercepts of the models. This paper will use two methods to examine the effectiveness of the Fama and French three-factor model and the CAPM model. I will first examine the MAV or mean absolute value for the alphas, along with examining the t-statistics to observe their statistical significance. The model with the lowest MAV for the alphas, or intercepts, is theoretically a better model at predicting the variation in portfolio returns, as the factors in the model are doing their job in that they explain more of the variation in returns.

The second method for testing the intercepts of both models will be employ the Gibbons, Ross and Shanken (1989), or GRS, statistic to test the null $H_o{:}\alpha_i = 0$ for all of i, or simply to test the intercepts jointly. The GRS test is performed by running an OLS regression and computing the intercepts or alphas then testing whether the alphas are jointly zero.[13] The GRS test states that should all of the intercepts or α's jointly equal

[13] Chollette Loran, (2004), pg 16.

zero, then the statistic will also equal zero. As the α's increase in absolute value so too will the value of the GRS statistic.[14]

The GRS statistic is constructed using the intercepts and error terms described in equations (2) and (4). For the CAPM we let $\boldsymbol{\alpha} = (\alpha_1, ..., \alpha_n)'$ and $\boldsymbol{\varepsilon}_t = (\varepsilon_{1t}, ..., \varepsilon_{nt})'$ be *n*-vectors that include the intercepts and error terms from equation (2). We must assume that $E(\boldsymbol{\varepsilon}_t) = \mathbf{0}$, $E(\boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}_t') = \boldsymbol{\Sigma}$, $\text{cov}(r_{mt}, \boldsymbol{\varepsilon}_t) = \mathbf{0}$, and $\boldsymbol{\varepsilon}_t$ are jointly normally distributed. The equation for the single factor CAPM which tests the null H_0:$\alpha_i = 0$ for all of i is shown in (5) below.[15]

$$J = \frac{(T-N-1)}{N} \left(1 + \frac{\hat{\mu}_m^2}{\hat{\sigma}_m^2}\right)^{-1} \hat{\boldsymbol{\alpha}}' \hat{\boldsymbol{\Sigma}}^{-1} \hat{\boldsymbol{\alpha}}, \quad \textbf{(5)}$$

Where $\hat{\mu}_m$ and $\hat{\sigma}_m$ are the average excess return and standard deviation of the market portfolio. The number of assets or portfolios equals N, and T is the number of time series observations. The J statistic under the null hypothesis follows a central F distribution with N degrees of freedom in the numerator and T-N-1 degrees of freedom in the denominator.

The equation for the GRS test for the Fama and French three-factor model is an extension of equation (5) which will now incorporate multiple factors. The equation for the GRS test when applied to the three-factor Fama and French model is described in equation (6). Jobson and Korkie (1985) introduced the concept that if there are *k* factors then the multivariate test becomes

$$J = \frac{(T-N-k)}{N} \left(1 + \boldsymbol{\mu}_k' \boldsymbol{\Omega}^{-1} \boldsymbol{\mu}_k\right)^{-1} \hat{\boldsymbol{\alpha}}' \hat{\boldsymbol{\Sigma}}^{-1} \hat{\boldsymbol{\alpha}}, \quad \textbf{(6)}$$

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[14] Karl Diether (2001), slide 7.

[15] Grauer (2001), pg 20.

where μ_k is a *k*-vector of factor means, Ω is the $k \times k$ covariance matrix of the factor returns and the alphas are sourced from a multivariate regression as in equation (4).

A larger value of the GRS statistic is undesirable when it comes to the effectiveness of an asset-pricing model. A larger value indicates that the value of the intercepts jointly are different from zero, and by extension the factors of the model do not do as effective a job in explaining the variation of returns for a portfolio. A small p-value indicates that we can reject the null that $H_o:\alpha_i = 0$ for all of i. The larger the value of the GRS statistic, the larger the joint values of those alphas, the farther they stray from zero and the poorer an asset-pricing model performs.

The reason I chose to run multiple time periods on both sets of portfolios was that I wished to see whether the effectiveness of an asset-pricing model is a function of the number of observations, or a specific time period. It was important to see whether the three-factor model continues to be effective when both increasing the number of observations and incorporating more recent data.

Fama and French (1996) have already run a regression for the 1963:07 to 1993:12 time period, incidentally I have ran and replicated their findings, but omitted showing the full results of that particular regression. For my first regression on these 25 portfolios, I have updated the Fama and French (1996) time period to the present day running the test from 1963:07 to 2003:12 for a total of 486 observations. I then selected a much longer time period which covers the full data set from 1926:07 to 2003:12 for a total of 930 observations.

I have chosen three time different time periods to test the effectiveness of the Fama and French and CAPM models in explaining the variation in returns in the 12 industry portfolios. First, I selected the time period which encompasses the full data set from 1926:07 to 2003:12 for a total of 930 observations. I then chose to run the test for the same time period that Fama and French (1996) employed, which ran from 1963:07 to 1993:12 for a total of 366 observations. Finally, I chose to update the Fama and French (1996) time period to the present running the final test from 1963:07 to 2003:12 for a total of 486 observations.

The reason I chose to run a test on separate grouping of portfolios sorted by different criteria, was to answer the question as to whether the effectiveness of a model is sample specific. For an asset-pricing model to be truly effective its superiority must be demonstrated across different groupings and time periods. The ideal is to create and fashion an asset-pricing model that produces consistent results, captures a high percentage of the variation in the returns of any grouping of portfolios, exhibits intercepts very close to zero, and low intercepts that are statistically significant.

4. DATA

The data for the following tests of the Fama and French three-factor model and the CAPM was provided by Ken French's website.[16]

With respect to the first portfolio grouping, I used the excess returns of 25 Portfolios for my dependent variable in both time series regressions, equations (2) and (4). These 25 portfolios are formed by the intersection of both size (from small market cap to big market cap) as well as book-to-market equity (from low to high). The construction and composition of these 25 portfolios are described in detail in Table 2. The returns on these portfolios run from a monthly basis from 1926:07 to 2003:12 for a total of 930 observations. The factors for both the CAPM and Fama and French three factor model including R_m-R_f, SMB, HML were also sourced from Ken French's website and are described in detail in Table 4.

In my second portfolio data set, I used the excess returns of 12 Industry Portfolios for my dependent variable in both regression equations (2) and (4). These industry portfolios are composed of: 1) Consumer Non-Durables, 2)Consumer Durables, 3) Manufacturing, 4) Energy, 5) Chemicals, 6) Business Equipment, 7) Telecom, 8) Utilities, 9) Shops 10) Healthcare, 11) Money (Finance), 12) Other. For a more detailed description of sub-sectors in each industry and SIC groupings please see Table 1.

I chose this portfolio of twelve industries due to data availability as all 12 industry groupings had return data stretching back to July of 1926 and going forward to December, 2003. Returns were computed monthly for a total of 930 observations for

[16] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

this dataset. The excess returns must be calculated with the use of R_f, or the risk free rate of interest which was represented by the one month Treasury yield provided by Ibbotson and Associates. The independent and dependent variables for both the CAPM and Fama and French three-factor model were also sourced from Kenneth French's website. These factors have been described in detail in the literature review and are also listed in the caption of Table 4.

5. RESULTS

5.1 Results for 25 Size and Book-to-Market Portfolios

Fama and French (1996) have already examined the 1963:07 to 1993:12 regression. For my first test of the 25 portfolios, I simply took this regression and updated it for the present day which covers 1963:07 to 2003:12. The results for the regression on these 25 size and book-to-market portfolios and the complete description of these 25 portfolios can be seen in Table 2.

Looking at the MAV of the alphas in Table 2, it becomes clear that the three-factor model demonstrates its superiority. The CAPM displays a value of 0.30 for the MAV of its alphas, versus a value of 0.13 for the Fama and French three-factor model. In addition, the Fama and French model shows a higher value for R^2 across the 25 portfolios than the CAPM. The average R^2 for the Fama and French three-factor model is 0.89 versus only 0.72 for the CAPM. The CAPM had 19 positive alphas and 6 negative with 12 alphas statistically significant at the 95 percent confidence interval. The Fama and French three factor model showed 14 alphas to be positive and 11 negative with 6 alphas statistically significant at the 95 percent confidence interval.

Using the GRS-F test as another measure of an asset-pricing model's effectiveness, we see that the values drift further away from zero with this more recent time period. We see that both models are rejected strongly in this time period with the CAPM displaying a value of 4.07 for the GRS statistic with the Fama and French three-factor model at 3.64. The p-values for both models were effectively zero, suggesting that we can reject the null that $H_0{:}\alpha_i = 0$ for all of i. Again, the further the GRS values move away from zero, the further the alphas jointly are from zero which does not bode well for the effectiveness of either model in explaining the variation in returns for the 25 portfolios.

The results for the 1926:07 to 2003:12 regression on 25 size and book-to-market portfolios can be seen in Table 3. Looking at the MAV of the alphas, both models display relatively high intercepts, with the Fama and French three-factor model coming out slightly ahead with a value of 0.19 percent per month versus 0.23 for the CAPM model. The Fama and French model shows a higher value for the mean R^2 across the 25 portfolios versus the CAPM. The average R^2 for the Fama and French three-factor model is 0.88 versus only 0.77 for the CAPM. The Fama and French model is nearly equally divided by having 13 positive intercepts and 12 negative intercepts. Fama and French have show 6 out of the 25 regressions to demonstrate statistically significant intercepts at the 95% confidence level. The CAPM is heavily weighted towards positive intercepts with 17 of the 25 alphas showing as positive, and 10 out of 25 alphas that are statistically significant at the 95% confidence interval.

Looking at the GRS values, the models are rejected, but less strongly than the 1963:07 to2003:12 time period. The CAPM underperforms the Fama and French model with a higher value of 3.31 as compared to 3.08 for the three-factor model. Both models display p-values close to zero which would indicate that we can reject the null that $H_o:\alpha_i = 0$ for all of i for both asset-pricing models.

5.2 Results for 12 Industry Portfolios

The industry name, as well as the four-digit SIC codes that help form each industry group are listed in Table 1.[17] The results for the 1926:07 to 2003:12 regressions on the 12 industry portfolios can be seen in Table 4. Interestingly, when looking at the

[17] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/det_12_ind_port.html

MAV of the alphas under this industry grouping, the CAPM displays slightly better results than the three-factor model. The CAPM displayed a mean absolute value for the alphas at 0.11 versus 0.14 for the Fama and French three-factor model. The mean value for the R^2 was nearly equal for the two models with the CAPM at 0.75 trailing the Fama and French model with an average R^2 of 0.77 across industries. For the CAPM, 9 of the 12 alphas were positive, with the three negative alphas appearing in the Manufacturing, Business Equipment and Other Industrial Groupings. The Fama and French three-factor model had 8 out of the 12 alphas as positive, with the negative intercepts present in the Manufacturing, Utlities, Money and Other Industrial Groupings. Finally, for the CAPM only three of 12 alphas were statistically significant at the 95% confidence interval in the Consumer Non-Durables, Health and Money Industrial Groupings. The Fama and French three-factor model showed four of 12 alphas to be statistically significant at the 95% confidence interval. The statistically significant alphas were found in the Consumer Non-Durables, Manufacturing, Health and Other Industrial Groupings.

Looking at the GRS values in Table 4, the CAPM again is shown to be the more effective model as it scored a lower value of 1.90 as compared to the Fama and French three-factor model which stands at 3.59. This supports the results of the mean absolute value of the alphas which also demonstrated the CAPM to be the more effective model.

The results for the 1963:07 to 1993:12 regression on 12 industry portfolios can be seen in Table 5. Given a new time period and data set, I wanted to see if the empirical results would turn out differently and whether the superiority of one model over another in explaining the variation in industry returns would be evident.

Looking again at the MAV of the alphas, both models were affected somewhat differently by the new time period, but this did not result in radically different values. The CAPM improved slightly with a MAV for their alphas of 0.10. The Fama and French model fared slightly worse with a value of 0.14 versus 0.12 in the first empirical test. The most important result was that under a different grouping, the three-factor model no longer proves to be more effective than the CAPM due to the higher value of the intercepts. The mean value for the R^2 lowered for the CAPM from the prior test from 0.75 to 0.73. This average R^2 for the Fama and French model remained the same at 0.77 across all industries.

Under this new time period, 8 of the 12 alphas were positive for the CAPM, with negative alphas appearing in the Manufacturing, Chemicals, Business Equipment and Other Industrial Groupings. Interestingly, the Fama and French three-factor model had 7 of the 12 alphas as positive with the negative intercepts present in the Consumer Durables, Manufacturing, Utlities, Money and Other Industrial Groupings. In this test only one of 12 alphas was statistically significant at the 99% confidence interval for the CAPM and it showed in the Consumer Non-Durables Industrial Grouping. The same held true for the Fama and French model as the only statistically significant alpha at the 99% confidence Interval appeared in the Health Industrial Grouping.

With this new time period it was interesting to note that the GRS values improved for both models. From Table 5 we can see that the CAPM's GRS statistic has lowered to a value of 1.17 as compared to the Fama and French three-factor model which stands at 1.95. The p-value for the GRS result from the CAPM stands at 0.30 which means that we cannot reject the null that $H_o:\alpha_i = 0$. Again this supports the conclusion that the Fama and French three-factor model no longer demonstrates superiority under an industry grouping. The three-factor model displayed a p-value of 0.03 which enables the null to be rejected and bodes poorly for the intercepts and effectiveness of the model.

My final regression on the industry portfolios involved taking the Fama and French (1996) time period and updating it for the present day. The results for the regression now span from 1963:07 to 2003:12 and can be seen in Table 6. I was eager to see how these results would be affected by this new time period and whether the results from the first two time periods would be replicated. By adding on ten years to the Fama and French (1996) time period we now incorporate the returns from the late 1990's and the technology bubble which resulted in a euphoric rise for all equity markets.

The MAV for the alphas generated by the CAPM regression did not fluctuate significantly with a value of 0.11 for this final test. This value is equivalent to that of the first test which employed the full data set reaching back to 1926. The MAV for the alphas generated by the Fama and French regression improved slightly over the second test with a value of 0.13 as compared to 0.14 for the prior period. The CAPM model continued to display a lower value for their intercepts, albeit by a small margin. Looking at the mean value for the R^2, it lowered for the CAPM from 0.73 in the second empirical test to 0.66. This also occurred for the Fama and French model as the average R^2 dropped from 0.77 across all industries in the second empirical test to 0.70 in this final test.

After adding on the past ten years to the prior empirical test, 8 of the 12 alphas still remained positive for the CAPM with negative alphas appearing in the Manufacturing, Business Equipment, Telecom and Other Industrial Groupings. The Fama and French model differed slightly from the second empirical test in that 6 of the 12 alphas were positive, with the negative intercepts present in the Consumer Durables, Manufacturing, Telecom, Utlities, Money and Other Industrial Groupings. As well, the statistical significance of the alphas remained the same for the CAPM in that one of 12 alphas was statistically significant at the 95% confidence interval for the CAPM and it showed in the Consumer Non-Durable industrial grouping. For the Fama and French three-factor model, the statistical significance of the alphas improved in that three of 12 alphas were statistically significant at the 95% confidence interval and it showed in the Manufacturing, Telecom and Utilities industries.

The addition of the ten most recent years from 1993 to 2003 did manage to lower the GRS F-statistics when compared to the full time period examined in the first empirical test. The GRS values were largely in line with those of the second empirical test. Once again, the lower GRS value for the CAPM demonstrates superiority of the model with a value of 1.12 as compared to 2.07 for the Fama and French three-factor model. Once again, the p-values support the superiority of the CAPM over the three-factor model. The p-value for the CAPM stood at 0.34 which means that we cannot reject the null that the null H_o:$\alpha_i = 0$. The p-value for the Fama and French three-factor model is close to zero which means that we can reject the null, and that the model is inferior when examining the joint value of its intercepts.

Table 1 12 Industry Groupings using four-digit SIC Codes.

Industry Grouping	Industry Composition by SIC Codes
Consumer Non-Durables including: Food, Tobacco, Textiles, Apparel, Leather, Toys	0100-0999, 2000-2399, 2700-2749, 2770-2799, 3100-3199, 3940-3989
Consumer Durables including: 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
Manufacturing including: Machinery, Trucks, Planes, Office Furniture, Paper, Commercial Printing	2520-2589, 2600-2699, 2750-2769 3000-3099, 3200-3569, 3580-3629 3700-3709, 3712-3713, 3715-3715 3717-3749, 3752-3791, 3793-3799 3830-3839, 3860-3899
Energy including: Oil, Gas, and Coal Extraction and Products	1200-1399, 2900-2999
Chemicals including: Chemicals and Allied Products	2800-2829, 2840-2899
Business Equipment including: Computers, Software, and Electronic Equipment	3570-3579, 3660-3692, 3694-3699 3810-3829, 7370-7379
Telecom including: Telephone and Television Transmission	0100-0999, 2000-2399, 2700-2749, 2770-2799,3100-3199,3940-3989
Utilities	4900-4949
Shops including: Wholesale, Retail, and Some Services (Laundries, Repair Shops)	5000-5999,7200-7299, 7600-7699
Health including: Healthcare, Medical Equipment, and Drugs	2830-2839, 3693-3693, 3840-3859 8000-8099
Money including: Finance	6000-6999
Other including: Mines, Construction, Building Materials, Transportation, Hotels, Business Services, Entertainment	NA

Table 2 CAPM and Fama and French three-factor regressions for 25 Portfolios sorted on Size, Book-to-Market Equity (BE/ME) 1963:07 to 2003:12.

The following table displays the regression results for both the CAPM and Fama and French three-factor model for 25 portfolios. The 25 portfolios are constructed at the end of each June and represent the intersections of five portfolios formed on size (market equity, ME) and five portfolios formed on the ratio of book equity to market equity (BE/ME). The size breakpoints for year t are the NYSE market equity quintiles at the end of June of t (1926-2003). BE/ME for June of year t is the book equity for the last fiscal year end in t-1 divided by ME for December of t-1. The BE/ME breakpoints are NYSE quintiles. The portfolios for July of year t to June of t+1 include all NYSE, AMEX, and NASDAQ stocks for which we have market equity data for December of t-1 and June of t, and (positive) book equity data for t-1.

The data runs monthly from 1963:07 to 2003:12 for a total of 485 observations. All figures presented except for the R^2 are represented as percentages per month. Please see table 4 for descriptions of all regression variables. MAV = Mean Absolute Value.

	CAPM $R_i - R_f = \alpha_i + \beta_i[R_m - R_f] + \varepsilon_i$ (2)				Fama and French three-factor model $R_i - R_f = \alpha_i + \beta_i(R_m - R_f) + s_i SMB + h_i HML + \varepsilon_i$ (4)					
Size, BE/ME	α	t (α)	β	R^2	α	t (α)	β	s	h	R^2
Small, Low	-0.44	-1.87	1.44	0.61	-0.59	-5.03	1.07	1.47	-0.27	0.91
Small, 2	0.24	1.15	1.22	0.59	0.01	0.13	0.92	1.36	-0.04	0.92
Small, 3	0.35	2.08	1.07	0.62	0.08	1.11	0.86	1.14	0.14	0.93
Small, 4	0.62	3.80	0.98	0.61	0.30	4.03	0.82	1.07	0.26	0.92
Small, High	0.69	3.90	1.01	0.58	0.26	3.41	0.88	1.14	0.48	0.92
2, Low	-0.31	-1.72	1.43	0.73	-0.34	-4.12	1.13	1.07	-0.34	0.94
2, 2	0.08	0.59	1.16	0.74	-0.13	-1.84	0.98	0.93	0.09	0.94
2, 3	0.40	3.11	1.02	0.73	0.13	1.93	0.92	0.80	0.27	0.92
2, 4	0.49	3.76	0.96	0.70	0.16	2.28	0.90	0.74	0.41	0.91
2, High	0.53	3.46	1.04	0.66	0.12	1.46	0.98	0.87	0.55	0.91
3, Low	-0.24	-1.65	1.36	0.78	-0.21	-2.69	1.10	0.79	-0.38	0.94
3, 2	0.17	1.53	1.10	0.81	-0.01	-0.14	1.02	0.57	0.16	0.91
3, 3	0.24	2.24	0.97	0.77	-0.01	-0.10	0.95	0.46	0.36	0.88
3, 4	0.42	3.71	0.91	0.72	0.13	1.54	0.93	0.42	0.48	0.86
3, High	0.53	3.80	0.98	0.67	0.13	1.45	1.02	0.57	0.66	0.88

Table 2 - Continued

	CAPM $R_i\text{-}R_f = \alpha_i + \beta_i[R_m\text{-}R_f] + \varepsilon_i$ (2)				Fama and French three-factor model $R_i\text{-}R_f = \alpha_i + \beta_i(R_m\text{-}R_f) + s_iSMB + h_iHML + \varepsilon_i$ (4)					
Size, BE/ME	**α**	**t (α)**	**β**	**R^2**	**α**	**t (α)**	**β**	**s**	**h**	**R^2**
4, Low	-0.09	-0.80	1.25	0.84	0.02	0.27	1.08	0.41	-0.39	0.93
4, 2	-0.02	-0.24	1.07	0.85	-0.15	-1.76	1.06	0.24	0.18	0.88
4, 3	0.25	2.50	0.97	0.80	0.04	0.46	1.02	0.20	0.38	0.86
4, 4	0.40	3.79	0.91	0.76	0.16	1.85	0.96	0.21	0.44	0.85
4, High	0.40	2.91	0.99	0.68	0.05	0.49	1.08	0.27	0.66	0.83
Big, Low	-0.07	-0.88	1.01	0.88	0.11	1.83	1.00	-0.23	-0.29	0.93
Big, 2	0.00	0.04	0.95	0.87	-0.02	-0.28	1.03	-0.21	0.13	0.90
Big, 3	0.08	0.86	0.85	0.78	-0.01	-0.17	0.97	-0.22	0.29	0.85
Big, 4	0.19	1.71	0.79	0.68	-0.01	-0.16	0.95	-0.20	0.51	0.85
Big, High	0.16	1.14	0.83	0.59	-0.13	-1.26	1.00	-0.08	0.67	0.78
MAV	**0.30**		**1.05**	**0.72**	**0.13**		**0.98**	**0.63**	**0.35**	**0.89**
GRS F-Test	**4.07**				**3.64**					
p-value	**0.00**				**0.00**					

Table 3 CAPM and Fama and French three-factor regressions for 25 Portfolios sorted on Size, Book-to-Market Equity (BE/ME) 1926:07 to 2003:12.

The following table displays the regression results for both the CAPM and Fama and French three-factor model for 25 portfolios. The data runs monthly from 1926:07 to 2003:12 for a total of 930 observations. All figures presented except for the R^2 are represented as percentages per month. Please see Table 1 for a description of the 25 portfolios and Table 4 for descriptions of all regression variables. MAV = Mean Absolute Value.

	CAPM $R_i\text{-}R_f = \alpha_i + \beta_i[R_m\text{-}R_f] + \varepsilon_i$ (2)				Fama and French three-factor model $R_i\text{-}R_f = \alpha_i + \beta_i(R_m\text{-}R_f) + s_i SMB + h_i HML + \varepsilon_i$ (4)					
Size, BE/ME	α	t (α)	β	R^2	α	t (α)	β	s	h	R^2
Small, Low	-0.60	-2.05	1.65	0.52	-0.87	-3.46	1.32	1.34	0.44	0.64
Small, 2	-0.22	-0.98	1.52	0.60	-0.47	-2.99	1.18	1.54	0.27	0.81
Small, 3	0.13	0.73	1.39	0.66	-0.12	-0.99	1.08	1.24	0.41	0.85
Small, 4	0.41	2.39	1.30	0.66	0.12	1.41	0.97	1.27	0.54	0.91
Small, High	0.50	2.49	1.39	0.61	0.12	1.34	0.98	1.43	0.85	0.92
2, Low	-0.27	-1.89	1.24	0.71	-0.33	-3.78	1.07	1.08	-0.26	0.89
2, 2	0.10	0.82	1.25	0.76	-0.05	-0.77	1.03	1.03	0.14	0.93
2, 3	0.26	2.17	1.19	0.76	0.07	1.11	0.96	0.92	0.33	0.93
2, 4	0.28	2.33	1.22	0.77	0.06	0.98	0.98	0.84	0.49	0.95
2, High	0.31	2.01	1.35	0.72	0.00	0.06	1.05	0.95	0.76	0.94
3, Low	-0.17	-1.55	1.28	0.81	-0.22	-3.15	1.14	0.82	-0.18	0.93
3, 2	0.13	1.60	1.14	0.86	0.05	0.81	1.02	0.55	0.08	0.93
3, 3	0.19	2.21	1.14	0.85	0.06	0.95	1.01	0.45	0.32	0.92
3, 4	0.27	2.74	1.12	0.81	0.10	1.51	0.96	0.50	0.47	0.92
3, High	0.18	1.26	1.38	0.76	-0.10	-1.30	1.15	0.53	0.86	0.93

Table 3 -Continued										
Size, BE/ME	**α**	**t (α)**	**β**	**R^2**	**α**	**t (α)**	**β**	**s**	**h**	**R^2**
4, Low	-0.04	-0.50	1.08	0.87	0.02	0.32	1.07	0.28	-0.35	0.92
4, 2	0.02	0.26	1.10	0.90	-0.05	-0.79	1.02	0.28	0.13	0.92
4, 3	0.16	2.06	1.09	0.87	0.06	0.88	1.00	0.24	0.29	0.91
4, 4	0.18	1.74	1.18	0.82	0.01	0.11	1.05	0.21	0.56	0.91
4, High	0.13	0.89	1.45	0.75	-0.15	-1.56	1.24	0.32	0.96	0.91
Big, Low	-0.04	-0.71	0.98	0.92	0.04	1.00	1.04	-0.14	-0.23	0.95
Big, 2	-0.01	-0.27	0.93	0.91	0.01	0.16	0.96	-0.18	0.00	0.93
Big, 3	0.03	0.46	0.98	0.85	-0.02	-0.39	0.98	-0.21	0.32	0.90
Big, 4	0.00	0.05	1.12	0.79	-0.14	-2.20	1.06	-0.16	0.66	0.92
Big, High	-1.15	-2.87	1.35	0.27	-1.40	-3.65	1.21	-0.09	1.01	0.34
MAV	**0.23**		**1.23**	**0.77**	**0.19**		**1.06**	**0.66**	**0.44**	**0.88**
GRS F-Test	**3.31**				**3.08**					
p-value	**0.00**				**0.00**					

Table 4 CAPM and Fama and French three-factor regressions for 12 Industries 1926:07 to 2003:12

The following table displays the regression results for both the CAPM and Fama and French three-factor model for 12 industry groups defined in Table 3. The data runs monthly from 1963:07 to 2003:12 for a total of 930 observations. All figures presented except for the R^2 are represented as percentages per month. The model factors R_m, SMB, HML are created as follows. R_m, which represents the excess return on the market, is defined as the value-weighted return on all NYSE, AMEX, and NASDAQ stocks from the CRSP database less the one-month Treasury bill rate from Ibbotson Associates. Both SMB, and HML, are constructed from the intersection of six size and book-to-market benchmark portfolios. SMB (Small Minus Big) is the average return on three small portfolios minus the average return on three big portfolios, SMB = 1/3 (Small Value + Small Neutral + Small Growth) - 1/3 (Big Value + Big Neutral + Big Growth). HML (High Minus Low) is the average return on two value portfolios minus the average return on two growth portfolios, HML =1/2 (Small Value + Big Value) - 1/2 (Small Growth + Big Growth).[18] The coefficients α, β, s,h represent the intercepts and factor loadings of both regression equations (2) and (4). The term t (α) represents the t-statistic for the regression intercept. MAV = Mean Absolute Value. The GRS statistic is a joint test that all 12 industry intercepts together or $\alpha_i = 0$.

	CAPM $R_i\text{-}R_f = \alpha_i + \beta_i[R_m\text{-}R_f] + \varepsilon_i$ (2)				Fama and French three-factor model $R_i\text{-}R_f = \alpha_i + \beta_i(R_m\text{-}R_f) + s_i SMB + h_i HML + \varepsilon_i$ (4)					
Industry	α	t (α)	β	R^2	α	t (α)	β	s	h	R^2
Consumer Non-Durables	0.17	2.22	0.78	0.78	0.17	2.20	0.78	-0.03	0.02	0.78
Consumer Durables	0.09	0.79	1.18	0.77	0.08	0.65	1.17	0.00	0.06	0.77
Manufacturing	-0.10	-1.49	1.19	0.91	-0.17	-2.73	1.14	0.14	0.21	0.92
Energy	0.16	1.29	0.86	0.62	0.13	1.08	0.87	-0.21	0.22	0.64
Chemicals	0.10	1.23	0.98	0.82	0.14	1.72	1.03	-0.21	-0.05	0.83
Business Equipment	-0.02	-0.20	1.29	0.82	0.03	0.24	1.31	0.08	-0.22	0.84
Telecom	0.11	1.08	0.67	0.58	0.14	1.37	0.69	-0.08	-0.08	0.59
Utilities	0.03	0.21	0.81	0.59	-0.03	-0.25	0.80	-0.14	0.28	0.63
Shops	0.06	0.63	0.97	0.78	0.08	0.85	0.97	0.11	-0.13	0.79
Healthcare	0.26	2.27	0.87	0.66	0.32	2.86	0.91	-0.09	-0.20	0.67

[18] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/f-f_bench_factor.html

Table 4 - Continued										
	CAPM $R_i\text{-}R_f = \alpha_i + \beta_i[R_m\text{-}R_f] + \varepsilon_i$ (2)				Fama and French three-factor model $R_i\text{-}R_f = \alpha_i + \beta_i(R_m\text{-}R_f) + s_i SMB + h_i HML + \varepsilon_i$ (4)					
Industry	**α**	**t (α)**	**β**	**R^2**	**α**	**t (α)**	**β**	**s**	**h**	**R^2**
Money	0.02	0.17	1.14	0.84	-0.04	-0.50	1.11	-0.04	0.25	0.86
Other	-0.21	-2.32	1.15	0.84	-0.31	-4.09	1.05	0.30	0.28	0.89
MAV	**0.11**		**0.99**	**0.75**	**0.14**		**0.98**	**0.12**	**0.16**	**0.77**
GRS F-Test	**1.90**				**3.59**					
p-value	**0.03**				**0.00**					

Table 5 CAPM and Fama and French three-factor regressions for 12 Industries 1963:07 to 1993:12.

The following table displays the regression results for both the CAPM and Fama and French three-factor model for 12 industry groups. These 12 industry groups are defined in Table 3. The data runs monthly from 1963:07 to 1993:12 for a total of 365 observations. All figures presented except for the R^2 are represented as percentages per month. Please see table 4 for descriptions of all regression variables. MAV = Mean Absolute Value.

	CAPM $R_i - R_f = \alpha_i + \beta_i[R_m - R_f] + \varepsilon_i$ (2)				**Fama and French three-factor model** $R_i - R_f = \alpha_i + \beta_i(R_m - R_f) + s_i SMB + h_i HML + \varepsilon_i$ (4)					
Industry	α	t (α)	β	R^2	α	t (α)	β	s	h	R^2
Consumer Non-Durables	0.20	2.05	0.97	0.84	0.19	1.92	0.94	0.08	-0.01	0.84
Consumer Durables	0.00	0.03	1.07	0.74	-0.15	-1.01	1.10	0.09	0.26	0.76
Manufacturing	-0.09	-1.08	1.10	0.91	-0.12	-1.54	1.07	0.16	0.01	0.92
Energy	0.15	0.77	0.86	0.52	0.12	0.64	0.98	-0.36	0.18	0.56
Chemicals	-0.04	-0.45	1.01	0.85	0.00	0.01	1.03	-0.12	-0.04	0.86
Business Equipment	-0.14	-0.94	1.12	0.75	0.02	0.11	0.98	0.27	-0.41	0.79
Telecom	0.17	1.15	0.66	0.51	0.06	0.44	0.77	-0.23	0.30	0.56
Utilities	0.04	0.30	0.63	0.50	-0.12	-0.92	0.78	-0.26	0.42	0.60
Shops	0.09	0.69	1.13	0.80	0.08	0.65	1.05	0.28	-0.08	0.82
Healthcare	0.16	1.01	0.97	0.67	0.50	3.51	0.89	-0.18	-0.59	0.75
Money	0.01	0.08	1.05	0.84	-0.12	-1.15	1.08	0.07	0.23	0.85
Other	-0.06	-0.58	1.22	0.87	-0.15	-1.68	1.09	0.52	-0.03	0.92
MAV	**0.10**		**0.98**	**0.73**	**0.14**		**0.98**	**0.22**	**0.21**	**0.77**
GRS F-Test	**1.17**				**1.95**					
p-value	**0.30**				**0.03**					

Table 6 CAPM and Fama and French three-factor regressions for 12 Industries 1963:07 to 2003:12.

The following table displays the regression results for both the CAPM and Fama and French three-factor model for 12 industry groups. These 12 industry groups are defined in Table 3. The data runs monthly from 1963:07 to 1993:12 for a total of 485 observations. All figures presented except for the R^2 are represented as percentages per month. Please see table 4 for descriptions of all regression variables. MAV = Mean Absolute Value.

	CAPM $R_i\text{-}R_f = \alpha_i + \beta_i[R_m\text{-}R_f] + \varepsilon_i$ **(2)**				**Fama and French three-factor model** $R_i\text{-}R_f = \alpha_i + \beta_i(R_m\text{-}R_f) + s_iSMB + h_iHML + \varepsilon_i$ **(4)**					
Industry	**α**	**t (α)**	**β**	**R^2**	**α**	**t (α)**	**β**	**s**	**h**	**R^2**
Consumer Non-Durables	0.23	1.98	0.88	0.68	0.15	1.34	0.88	-0.02	0.17	0.70
Consumer Durables	0.02	0.12	1.11	0.71	-0.06	-0.44	1.11	-0.06	0.19	0.72
Manufacturing	-0.08	-0.93	1.07	0.86	-0.19	-2.27	1.07	0.15	0.18	0.87
Energy	0.18	1.01	0.88	0.45	0.12	0.68	0.88	-0.24	0.23	0.49
Chemicals	0.03	0.28	0.95	0.72	0.04	0.33	0.95	-0.21	0.07	0.74
Business Equipment	-0.07	-0.44	1.13	0.72	0.07	0.44	1.13	0.27	-0.40	0.77
Telecom	0.00	-0.03	0.86	0.53	-0.02	0.86	0.77	-0.16	0.11	0.54
Utilities	0.06	0.38	0.68	0.35	-0.10	-0.74	0.68	-0.19	0.42	0.47
Shops	0.08	0.68	1.03	0.75	0.02	0.13	1.03	0.17	0.08	0.76
Healthcare	0.26	1.76	0.86	0.59	0.46	3.24	0.86	-0.26	-0.32	0.64
Money	0.11	1.01	1.09	0.77	-0.02	-0.23	1.09	-0.09	0.33	0.81
Other	-0.17	-1.66	1.11	0.85	-0.31	-3.66	1.11	0.44	0.13	0.90
Mean Absolute Value	**0.11**		**0.97**	**0.66**	**0.13**		**0.97**	**0.19**	**0.22**	**0.70**
GRS F-Test	**1.12**				**2.70**					
p-value	**0.34**				**0.00**					

6. DISCUSSION AND CONCLUSION

I have addressed the effectiveness of the CAPM and Fama and French three-factor model by examining the mean absolute values of the intercepts, and jointly testing whether the intercepts are close to zero using the GRS F-test introduced by Gibbons, Ross and Shanken (1989). I have also examined whether the effectiveness of a model is sample specific by using two separate portfolio groupings, the first grouping using the 25 size and book-to-market equity portfolios provided by Ken French, and the second grouping which looks at 12 industries.

Fama and French (1996) have pointed out the superiority of their model with respect to one set of grouping criteria, that of size and book-to-market. For an asset-pricing model to be truly effective, it must maintain its superiority regardless of the grouping methodology. I extended their original study by including more recent data to 2003:12, as well as including a time period that stretched back to 1926:07. I expected to see the superiority of the three-factor model to continue even with the addition of these two time periods under this grouping of 25 portfolios. The statistical results supported my expectation and the three-factor model maintained its dominance over the CAPM. Examining the GRS statistics both models were rejected, but more strongly under the 1963:07 to 2003:12 time period than from 1926:07 to 2003:12.

My second test examined a different portfolio grouping, which focused on 12 industries. I wanted to see if the effectiveness of a model was sample specific and whether the superiority of the three-factor model was maintained against the CAPM. The results from the industry portfolios were very interesting. The CAPM now demonstrated superiority over the three-factor model with both lower mean absolute values for the intercepts, and smaller GRS values which tested the intercepts jointly. As well, under two time periods the p-values demonstrated that the CAPM cannot be rejected.

Ultimately, using either a single factor model or adding the Fama and French size and value factors may not capture the differing characteristics and price movements of diversified industries. Fama and French (1997) have documented difficulties in using their multi-factor model to capture returns from an even broader sample of 48 industries. Their general conclusion was that the costs of equity for industries was imprecise and that both the single factor CAPM, and their own three-factor model differ greatly when it comes to estimating returns across this diverse set of industries.

Interestingly, the three-factor model performed well on firm specific variables, but there may be unique features of industry portfolios that are difficult to capture. However, if an asset-pricing model is claimed to be superior, the evidence should not be based on only one type of portfolio grouping.

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