PE Factor in the Asset Pricing

Jiaxin Lyu

jlyu04@qub.ac.uk

University Rd, Belfast BT7 1NN., the United Kingdom

Abstract: This paper attempts to study the relationship between price-earnings ratio and stock returns. We find that stocks with lower price-earnings ratio can obtain higher returns than stocks with higher price-earnings ratio. This finding applies not only to simple returns, but also to risk-adjusted returns based on CAPM, as well as Fama-French (1993) three-factor model. In addition, to test the ability of PE risk factors in explaining asset prices, this price-earnings ratio factor is added into the Fama- French three-factor model as a new pricing factor. The results show that PE risk factor significant affect stock returns. This contributes to the asset pricing literature.

Keywords: P/E ratio, Asset Pricing, Fama-French Three Factor Model, CAPM.

1 INTRODUCTION

In the era of digital economy, data has become a new key factor of production. Investors try to find factors related to stock returns with a large number of corporate information datasets. These pricing factors are then used to predict future stock prices and generate investors additional returns. The existing capital asset pricing model (CAPM) propose that stock market premium is the key systematic risk factor that influences individual asset returns. Later, the Fama- French (1993) three-factor model (FF3) propose additional two factors which can explain the stock returns, namely, the size factor and value factor. Relevant literatures show that the price-earnings ratio is very useful for stock valuation [1-2]. Stocks with low P/E ratios usually outperform stocks with high P/E ratios, which means investors can get higher returns by choosing stocks with low P/E ratios.

The purpose of this paper is to study whether the price-earnings ratio can explain the return of the stock, and whether the stock with lower price-earnings ratio can obtain higher return than the stock with higher price-earnings ratio. In addition, we use the long-short investment strategy that we hold stocks with low price-earnings ratio and short-sell stocks with high price-earnings ratio. The evidence shows that such investment strategy could generate significant positive returns. Afterwards, we add the P/E ratio to the FF3 as a new pricing factor, namely, the PE risk factor. We then examine whether the PE risk factor is useful in explaining the return on the portfolio, in addition to the FF3.

The paper is organized in the following way. Section 1 is the introduction. Second 2 reviews relevant literate and discusses the contributions of this paper. The third section describes the sample details and data sources. The empirical methodology is presented in the fourth section. Section 5 analyses the empirical results and discusses the application. Section 6 analyses the new pricing factors. Section 7 concludes.

BDEDM 2023, January 06-08, Changsha, People's Republic of China

DOI 10.4108/eai.6-1-2023.2330278

2 LITERATURE REVIEW

According to Sharpe (1989), Harry Markowitz proposed the concept of (mean-variance) efficient portfolio in 1952. Mean-variance analysis can determine the maximum return at a given risk level or the minimum risk at a given return level. Markowitz's portfolio theory is based on the mean-variance optimization process of finding an effective portfolio. Markowitz (1952, 1959) develop a portfolio model to measure the relationship between risk and expected return. The author shows that under a set of reasonable assumptions, the variance of return is a meaningful measure of portfolio risk [8]. However, when using Markowitz's portfolio theory to evaluate the risk of portfolio, extensive computing power are needed to construct the variance-covariance matrix across various number of assets. The amount of computation required by Markowitz method is one of the reasons that stimulate other investment management methods [7].

Sharpe (1964) and Lintner (1965) propose the CAPM on the model of portfolio choice developed by Markowitz (Fama and French 2004). Furthermore, CAPM adds two factors to the Markowitz model, risk-free rate (RFR) and market risk premium (E(RM) - RFR). According to Reilly and Brown (2011), CAPM redefines the related measure of risk from the total risk defined by capital market line (CML) to only the non-diversifiable part of the total risk. This is termed as the systematic risk, which is called beta. Then, CAPM redefines the expected risk premium per unit of risk by using beta as the relevant systematic risk measure.

However, Fama and French (1996) claim that CAPM did not capture certain risks and therefore could not explain the abnormal returns of some stocks. Therefore, Fama and French proposed a three-factor model to test the average stock returns. The three-factor model adds a size factor and a value factor to the CAPM model. According to Reilly and Brown (2011), SMB aims to capture the risk elements associated with company size, while HML aims to differentiate the risk differences associated with "growth" (i.e., low book- to-market ratios) and "value" (i.e., high book- to-market ratios) companies. However, both price-earnings ratios and book- to-market ratios are commonly used to classify growth and value stocks. Therefore, as it is evidence, P/E ratio plays a crucial part in asset pricing.

Basu (1975) uses the NYSE industrial firms from the COMPUSTAT dataset, the related Investment Return file from the CRSP and a file containing selected financial statement and investment return data for securities subsequently delisted from the NYSE. In addition, this study compute earnings yields of each stock and then rank from minimum to maximum and 5 portfolios are formed. Finally, monthly and cumulative abnormal returns are calculated for each portfolio. This article of Basu (1975) attempts to ascertain whether securities with different P/E ratios are appropriately priced, or whether certain groups can gain abnormal returns. Finally, the results of Basu (1975) shows that low PE ratio portfolios outperform high PE ratio portfolios generating positive and higher risk-adjusted rates of return.

As an extension, Basu (1977) further investigates to determine whether the investment performance of securities is related to their P/E ratios. Basu (1977) uses that same database as Basu (1975) and calculate the P/E ratio of each stock and rank the P/E ratios to form five portfolios. Calculating the monthly rate of return for each portfolio over the past 12 months and then selects a portfolio to buy and hold for the next 12 months. Reordered each year and then reinvested same portfolio with the previous period. The results indicate that the return of a portfolio with low P/E ratio is higher than that of a portfolio with high P/E ratio. Basu (1977)

shows that the behavior of securities prices during the sample period may not be fully described by the efficient market hypothesis, and the portfolio with low P/E ratio does earn higher returns.

In Basu (1983), it studies the relationship between P/E ratio and firm size on stock returns. The database includes accounting earnings per share from Compusta and the stock price, return and ordinary shares data from the CRSP monthly return data and all sample stocks must be listed on the NYSE. Basu (1983) calculates the P/E ratio each year and ranks them in ascending order to form five portfolios. In addition, five size portfolios are formed based on market value. By controlling the firm size and P/E ratio respectively, the author constructs the portfolio of yield and market value. Calculate and compare the relationship between risk and return of these portfolios, and finally make a statistical test on their risk-adjusted returns to determine whether there is a significant yield/size effect. The research results confirm that the stocks with high P/E ratio earn higher risk-adjusted returns on average than the stocks with low price-earnings ratio, and even if the experimental control is implemented on the difference in company size, this effect is also significant.

Afterwards, Noda, Martelanc and Kayo (2015) examine whether the return of the portfolio based on the E/P ratio of stocks is significantly different from that predicted based on CAPM model. The sample includes all companies listed on the Sao Paulo Stock Exchange (BOVESPA) from January 1995 to March 2013. The authors sort the stocks according to the market value, B/M and E/P ratio, classifies them into the portfolio, and then calculates the portfolio return. In order to check whether the portfolio composed of E/P ratio has a significantly different return from that provided by CAPM, the ordinary least square regression method is used. The regression intercept, alpha, therefore measures the abnormal return of the stock. In addition, Noda, Martelanc and Kayo (2015) add an earnings/price factor, i.e., high earnings minus low earnings, as a new risk factor in addition to the FF3. The empirical evidence suggests that portfolio with high E/P ratio is often higher than the return predicted by CAPM. E/P risk coefficient is very important to explain the return of portfolio, whether in CAPM or FF3.

3 DATA & VARIABLE

There are three main sources of data for this survey. Monthly securities price data are obtained from the CRSP. We include the stocks of non-financial companies listed on the NYSE, the Amex and the NASDAQ stock exchanges. That is, we exclude companies with four-digit SIC codes between 6000 and 6999, which stands for financial firms. The sample period ranges from 1963 to 2022. Ultimately, we have 3207 firms and 124950 firm-month observations. In addition, company annual financial statements and accounting information are downloaded from the Compustat data center. Furthermore, we extract the time series of Fama-French three factors and risk-free rate from the Kenneth French's online Data Library. We combine the three datasets together.

The dependent variable is the excess return of individual firms. It is calculated as below in equations (1). We first calculate the log stock return, and then compute the excess stock return by subtracting risk free rate from it.

$$R_{it} = \ln\left(\frac{P_{it}}{P_{it-1}}\right) \quad (1)$$

$$EXR_{it} = R_{it} - R_f$$

For the primary explanatory variable, price-to-earning (P/E) ratio, is calculated as the year-end market capitalization value (MK_{it}) divided by the same year income before interest and taxation (I_{it-1}), as shown in equation (2).

$$P/E_{it} = \frac{MK_{it}}{I_{it}} \quad (2)$$

When analyzing the explanatory power of P/E ratio on stock returns, we also include the FF3 model as the benchmark. These three factors are: Market risk factor (RM - RF), Size risk factor (SMB) and Book-to-Market ratio factor (HML), whereas this multi-factor equilibrium pricing model can be expressed as:

$$R_{it} - R_{ft} = \alpha_i + b_{i1}(RM_t - R_{ft}) + b_{i2}SMB_t + b_{i3}HML_t + e_{it} \quad (3)$$

- $(RM_t - R_{ft})$ is the market risk factor which measures the overall market performance.
- SMB is calculated as the return to a portfolio of small capitalization stocks minuses the return to a portfolio of big capitalization stocks.
- HML is the difference between the return to a portfolio of stocks with high ratios of book-to-market value and the return to a portfolio of low book-to-market value stocks.

4 METHODOLOGY

To construct the P/E factor, at the end of June of each year, we sort all stocks in the sample based on their previous year's annual price-earnings ratio and divide them into 10 portfolios. Each portfolio contains the same proportion of firms of the sample. In particular, portfolio 1 contains the companies with the lowest price-earnings ratio while portfolio 10 contains the companies with the highest price-earnings ratio. Then, starting from July of the same year, we use the classic long-short investment strategy. That is, we hold stocks in portfolio 1 and short-sell stocks in portfolio 10, forming a zero-cost investment strategy. We hold the portfolio for 12 months until the June of the following year. Then we construct a new portfolio ranking in June of the new year and hold the long-short strategy for another year. We repeat the steps until the end of our sample period. We calculate the equally weighted as well as the value-weighted returns for each portfolio. In addition, the average return for the long-short strategy, which is difference in return of portfolio 1 and the portfolio 10, over the sample period is also calculated.

In addition to the simple return series, the risk-adjusted return is also used to measure the performance of the portfolios. Two asset pricing models are used to estimate the risk-adjusted return, namely CAPM and the FF3. This risk-adjusted return series is then alpha when apply the risk models to the actual return data series.

Once we confirm the significance of the long-short investment strategy returns, we then use it as the new pricing factor, namely the PE factor. The new asset pricing equation is then performed as equation (4).

$$R_{it} - R_{ft} = \alpha_i + b_{i1}(RM_t - R_{ft}) + b_{i2}SMB_t + b_{i3}HML_t + b_{i4}P/E_t + e_{it} \quad (4)$$

5 EMPIRICAL RESULTS

Table 1 presents the summary statistics of variables that used in this study, including the number of observation (count), sample average (Mean), standard deviation (Std), minimum (Min), the 25th percentile (25%), median (50%), the 75th percentile (75%), and maximum (Max). As shown in Table 1, there are 124,950 observations for firm return, whose average value is 1.008159, the minimum value is 0.086356, the maximum value is 15.458016, and the standard deviation is 0.134208. In addition, it is apparently, for the PE ratio, the standard deviation is 532.092166, more than 10 times the average. This shows the diversity of companies as the large variation between the maximum value and the minimum value, which are 102842.40 and 0.024265 respective.

Table 1: Summary statistics

	Equally weighted return										
	1	2	3	4	5	6	7	8	9	10	1-10
Excess return	0.011582	0.010358	0.009289	0.008792	0.008960	0.009113	0.007938	0.007328	0.007467	0.005354	0.006228
t	4.572402	4.577559	4.402711	4.270839	4.282832	4.262975	3.601975	3.126009	3.012558	1.947100	4.583864
CAPM alpha	0.0052	0.0044	0.0036	0.0031	0.0031	0.0031	0.0017	0.0007	0.0005	-0.0021	0.0073
t	3.367	3.478	3.255	3.106	3.151	3.150	1.725	0.665	0.437	-1.445	5.497
FF 3-alpha	0.0028	0.0022	0.0017	0.0016	0.0018	0.0020	0.0010	0.0003	0.0005	-0.0020	0.0048
t	3.013	3.094	2.945	2.600	3.053	3.334	1.619	0.469	0.768	-2.158	4.643

Note: This table presents the summary statistics of variables that used in this study. It includes the number of observation (count), sample average (Mean), standard deviation (Std), minimum (Min), the 25th percentile (25%), median (50%), the 75th percentile (75%), maximum (Max) values of variables.

As shown in Table 2, for each of the three series of returns, we observe a decreasing return trend from portfolio 1 to portfolio 10. For example, the average monthly FF3 alpha showed a downward trend from 0.0028 for portfolio 1 to -0.0020 for portfolio 10, and the t-statistics were

3.013 and -2.158 respectively. There is a same trend in CAPM alpha. The results present that with the increase of P/E ratio, the return of the portfolio shows a decreasing trend. We could expect P/E ratio as a systematic risk factor that would influence asset returns.

Table 2: Equally weighted returns on P/E ratio sorted portfolios

Variable	Count	Mean	Std	Min	25%	50%	75%	Max
Return	124950.0	1.008159	0.134208	0.086356	0.943089	1.00000	1.060924	15.458016
PE ratio	124950.0	43.391069	532.092166	0.024265	9.062699	14.931047	24.683761	102842.40
Mkt-RF	1152.0	0.006691	0.053417	-0.291300	-0.019775	0.010600	0.036350	0.388500
SMB	1152.0	0.001908	0.031745	-0.172900	-0.016025	0.000900	0.017525	0.365600
HML	1152.0	0.003542	0.035602	-0.139200	-0.014025	0.001200	0.017600	0.356100
RF	1152.0	0.002665	0.002521	-0.000600	0.000300	0.002200	0.004200	0.013500

Note: This table describe the equally weighted returns of 10 portfolios sorted by P/E ratio. It also reports the average return of the long-short investment strategy. The top panel reports the original excess return series for the 10 portfolios. And the middle panel presents the risk-adjusted return based on the CAPM model. In addition, the lower panel reports the risk-adjusted return based on the FF3. The t-statistics reported in the second row of each panel. And the last column of this table reports the average return for the long-short investment strategy.

In addition, for the long-short investment strategy, as reported in the last column titled as 1-10, we observe the average return is 0.006228, after adjusting the CAPM model is 0.0073, and after adjusting for the FF3 is 0.0048. Furthermore, the t-statistics for these three sequences are 4.583864, 5.497 and 4.643 respectively. All three t-statistics are greater than 2.32, indicating that the average excess return and the risk-adjusted return based on the CAPM and FF3 are significantly different from 0, at 1% significant level. It is proved that a portfolio constructed based on P/E ratio do generate significant returns.

As shown in table 3, same decreasing trend was observed when sorting the portfolios using the value-weighed return. The average monthly FF3 alpha of portfolio 1 and portfolio 10 are 0.10% and -0.15%, with t-statistics 0.955 and -1.551. There is a same trend in CAPM alpha. For long-short investment strategy, we observe the average return is 0.006228, the risk-adjusted return based on the CAPM model and FF3 are 0.0073 and 0.0048 respectively. The t-statistics for all three sequences are greater than 1.64, indicating that the average excess return and the risk-adjusted return based on the CAPM model and FF3 are significantly different from 0, at 5% significant level. Likewise, it is proved that the long-short investment strategy in table 2 also generates significant returns.

Table 3: Value-weighted returns on P/E ratio sorted portfolios

	Value-weighted Portfolio										
	1	2	3	4	5	6	7	8	9	10	1-10
Excess return	0.008535	0.007441	0.008125	0.007195	0.006004	0.006691	0.005903	0.005399	0.006903	0.003488	0.005047
t	3.975927	3.825500	4.507304	4.118835	3.433375	3.646835	3.302102	2.869269	3.254640	1.413529	2.560484
CAPM alpha	0.0030	0.0021	0.0032	0.0023	0.0010	0.0014	0.0007	-0.0001	0.0008	-0.0034	0.0064
t	2.398	2.154	3.475	2.840	1.335	1.855	0.986	-0.174	0.899	-2.948	3.293
FF3-alpha	0.0010	0.0005	0.0020	0.0013	0.0002	0.0011	0.0008	0.0005	0.0021	-0.0015	0.0025
t	0.955	0.612	2.372	1.736	0.267	1.553	1.244	0.677	2.730	-1.551	1.703

Note: This table describe the value-weighted returns of 10 portfolios sorted by P/E ratio. And reports the average return of the long-short investment strategy. The top, meddle and lower panel reports the original excess return series for the 10 portfolios, the risk-adjusted return based on the CAPM, and the risk-adjusted return based on the FF3 respectively. The t-statistics reported in the second row of each panel. Furthermore, the last column of this table reports the average return for the long-short investment strategy.

All those results confirm that the investment strategy based on the PE factor can generate excess significant return. Our findings confirm with Chu (2016) and Basu (1975,1977). Chu (2016) directly indicates that the price-earnings ratio is an important indicator for evaluating investment opportunities. According to the results showed in Basu (1975,1977), low PE ratio portfolios outperform high PE ratio portfolios generating positive and higher risk-adjusted rates of return. And Basu (1977) considered that the price-earnings ratio information is not "fully reflected" in the security price as quickly as the semi-strong form of EMH assumes. The test results of this paper are consistent with this point of view, that is, investing in low P/E ratio stock portfolio did earn higher returns than investing in high P/E ratio stock portfolio. Also, same as Basu (1983) presented, the stock of higher E/P ratio firms did generate above average risk-adjusted return than the stocks of lower E/P ratio firms.

6 P/E PRICING FACTOR

Based on the research results, it is found that P/E ratio can explain the fluctuation of returns, so we consider P/E ratio as a systematic pricing factor and consider its pricing efficiency. We choose to add a new pricing factor, namely, the PE ratio factor. It is calculated as the average return of low P/E ratio firms minus the average returns of high P/E ratio firm. The new PE factor is the difference between the return to a portfolio of Low P/E ratio stocks and the return to a portfolio of high P/E ratio stocks.

We include this P/E ratio as a new risk factor and added it into the traditional FF3. We then conduct the empirical regression and calculate the sensitivity coefficient of the new pricing factor, as shown in equation (4).

The table 4 shows the sensitivity coefficients, beta, of the PE factor. The t-statistics of beta are reported in the second row of each panel. The beta determines how each stock reacts to the PE factor. In Panel A, there is a decreasing beta trend from portfolio 1 to portfolio 10. For example, the beta of PE decrease from 0.5168 in portfolio 1 to -0.4832 in portfolio 10, and the t-statistics were 17.478 and -16.342 respectively. Similarly, In Panel B, it is shown as a decreasing beta trend from portfolio 1 to portfolio 10. The beta of PE decrease from 0.5377 in portfolio 1 to -0.4623 in portfolio 10, and the t-statistics were 28.802 and -24.765 respectively.

For all stocks, the beta is 0.0535 and 0.0795 in Panel A and Panel B, and the t-statistics is 2.747 and 8.729 respectively. The t-statistics of beta is significant, as it exceeds the 1% significant level of 2.32. This suggests that the P/E ratio is a significant systematic factor that would affect stock returns. These results proved that PE risk coefficient is very important to explain the return of portfolio in FF3.

Table 4: The sensitivity coefficients of the PE factor

	Panel A - Equally Weighted		Panel B - Value-Weighted	
	FF3	P/E	FF3	P/E
Mkt_Rf	0.9953	0.9996	0.9670	0.9767
SMB	0.7329	0.7334	0.0081	-0.0107
HML	0.2849	0.2461	0.0842	-0.0042
P/E		0.0535		0.0795
Constant	0.0012	0.0009	0.0008	0.0006
Adj R2	0.950	0.950	0.961	0.965
N	636	636	636	636

Note: This table shows the sensitivity coefficients of the new pricing factor (PE). Panel A is the 10 equally weighted portfolios, and Panel B is the 10 value-weighted portfolios, those portfolios are all sorted by P/E ratio. In addition, the t-statistics of beta reported in the second row of each panel. Furthermore, the last column of this table reports the beta of PE factor for all stocks.

The table 5 shows the adjusted R-squared results of the FF3 and the new pricing model with PE risk factors. Panel A reports the equally weighted portfolio returns. The adjusted R-squared are both 0.950 based on the FF3 and new pricing model. These figures show the three factors in FF3 can explain 95% changes in stock returns. After adding PE risk factor, the adjusted R-squared did not change. The overall ability to explain returns has not changed. This means that the having PE risk factor does not improve the overall model ability in explaining returns of stocks.

Panel B reports the results based on valued weighted returns, the adjusted R-squared of the new pricing model changes slightly to 0.965, from 0.961 in the standard FF3. These numbers show that the three factors in FF3 can explain 96.1% changes in stock returns. After adding PE risk factor, the overall ability to explain returns has improved slightly, and contribute to explain 96.5% of the returns.

Table 5: the adjusted R-squared results

Panel A - Equally weighted											
	1	2	3	4	5	6	7	8	9	10	All
β_{PE}	0.5168	0.2399	0.1703	0.1434	0.0718	0.0539	0.0046	-0.0537	-0.1288	-0.4832	0.0535
t	17.478	9.371	7.896	6.391	3.241	2.324	0.193	-2.178	-5.209	-16.342	2.745
Panel B - Value-weighted											
	1	2	3	4	5	6	7	8	9	10	All
β_{PE}	0.5377	0.1987	0.1306	0.1259	0.0550	0.1268	0.0533	0.0600	-0.0306	-0.4623	0.0795
t	28.802	9.161	5.846	6.514	2.942	6.499	2.911	3.252	-1.469	-24.765	8.729

Note: This table shows the adjusted R-squared results of the FF3 and the new pricing model with PE risk factors. R-squared represents the ability of the risk factors to explain the return on the stock. Panel A is the equally weighted stocks, and Panel B is the value-weighted stocks.

7 CONCLUSION

This paper attempts to study the relationship between price-earnings ratio and stock returns. We use the long-short investment strategy, holding stocks with low price-earnings ratio and short-selling stocks with high price-earnings ratio. We then test whether the strategy generate significance earnings. In addition to simple returns, we also calculate the risk-adjusted returns of this long-short strategy, based on the CAPM and FF3. The results show that investment strategy formed on PE ratio generates positive simple returns to investors, as well as positive risk adjusted returns based on CAPM model or FF3. Stocks with lower price-earnings ratio can indeed obtain higher returns than stocks with higher price-earnings ratio.

Then, to test the pricing power of the PE risk factor, the price-earnings ratio is added into the FF3, as a new pricing factor. The results show that PE risk factor has significant positive impact on stock returns, therefore, well explains the return of the investment portfolio. However, the overall model pricing power does not change much. This means the PE risk factor only brings marginal pricing power on asset returns. These findings contribute to the asset pricing literature.

REFERENCES

[1] Basu, S. (1975). The Information Content of Price-Earnings Ratios. Financial Management, 4(2), p.53. doi:10.2307/3665200.

[2] Basu, S. (1977). Investment Performance of Common Stocks in Relation to Their Price-Earnings Ratios: A Test of the Efficient Market Hypothesis. The Journal of Finance, 32(3), p.663. doi:10.2307/2326304.

[3] Basu, S. (1983). The relationship between earnings' yield, market value and return for NYSE common stocks. Journal of Financial Economics, 12(1), pp.129–156. doi:10.1016/0304-405x(83)90031-4.

[4] Fama, E.F. and French, K.R. (1996). Multifactor Explanations of Asset Pricing Anomalies. The Journal of Finance, 51(1), pp.55–84.

[5] Fama, E.F. and French, K.R. (2004). The Capital Asset Pricing Model: Theory and Evidence. Journal of Economic Perspectives, 18(3), pp.25–46. doi:10.1257/0895330042162430.

[6] Noda, R.F., Martelanc, R. and Kayo, E.K. (2015). The Earnings/Price Risk Factor in Capital Asset Pricing Models. Revista Contabilidade & Finanças, 27(70), pp.67–79. doi:10.1590/1808-057x201412060.

[7] Pilbeam, K. (2005). The Capital Asset Pricing Model. Finance and Financial Markets, pp.188–214. doi:10.1007/978-1-349-26273-1_8.

[8] Reilly, F.K. and Brown, K.C. (2011). Investment Analysis and Portfolio Management. 10th ed. Cengage Learning.

[9] Sharpe, William F. (1989). The Journal of Finance, vol. 44, no. 2, pp. 531–35. JSTOR, https://doi.org/10.2307/2328607 Accessed 14 Oct. 2022.