The Cross Section of Expected Stock Returns in Taiwan

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1 Introduction

Asset pricing is one of the most important issues in finance research. Markowitz (1952) proposed a scientific way for rational investors to form portfolios. The Markowitz method to construct portfolios is called mean-variance analysis. Following this context, Sharpe (1964) and Lintner (1965) derived that under certain assumptions such as investors are rational and following mean-variance analysis method (i.e., market is mean-variance efficient), perfect market, homogeneous expectations...and so on, the market achieves equilibrium the expected return of stocks are determined by market risk, β, which is the comovement of an individual stock and market. The Sharpe and Lintner model, i.e, the Capital Asset Pricing Model (CAPM), has shaped how academics and practitioners think about the relationship between expected stock returns and risks. Fama and MacBeth (1973) also used an empirical method called Fama-MacBeth regression in the later context to test if CAPM holds in the real world. The evidence from Fama and MacBeth (1973) supports the CAPM, at least during their 1943-1968 sample period.

However, more and more empirical works contradict the prediction of the CAPM. For example, Banz (1981) finds that after controlling for their market β's, stocks with low market values have higher expected returns than expected returns predicted by the CAPM. Others also find anomalies such as leverage (Stattman (1980)), EP ratio (Basu (1983), etc, when using CAPM as the pricing model. Such anomalies imply that the single factor, market β, might be insufficient for explaining the cross-section of expected stock returns. Thus, extending the existing single factor into a multi-factor pricing model becomes a popular research issue. Though most of such extensions are done in empirical ways, not in theoretical ones, these attempts to the extent the single factor model do have their theoretical backgrounds. In 1976, Ross proposed the Arbitrage Pricing Theory

(APT), which argues that the expected stock returns are determined by some common factors.

Among many pricing models for stocks, the Fama-French three-factor model, which is proposed by Fama and French in 1993, is one of the most popular models. The specific form of the Fama-French three-factor model from Fama and French (1996) is:

$$R_i - R_f = \alpha_i + b_i(R_M - R_f) + s_i SMB + h_i HML + \epsilon_i, \tag{1}$$

where R_i is the return of portfolio i, R_f is the risk-free return, $R_M - R_f$ is the excess return on a broad market portfolio, SMB (small minus big) is the difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks , and HML (high minus low) is the difference between the return on a portfolio of high-book-to-market stocks and the return on a portfolio of low-book-to-market stocks. Before their 1996 paper, Fama and French had used Fama-MacBeth regression to test for market β, size, book-to-market equity, leverage, and EP ratios in 1992. They conclude that size and book-to-market equity together absorb the effect of leverage and EP ratios on the variation of expected stock returns and that market β alone cannot explain the cross-section of expected stock returns.

Since the role of the Taiwan stock market has increasingly gained importance due to the prosperity of the semiconductor industry and most of the research is conducted by using US data. Finding out which factors can explain the expected returns in the Taiwan stock market could be both beneficial. As pointed out by Nguyen et al. (2020), various studies found that in terms of stock return predictions, Fama-French three-factor model is more suitable than CAPM. Moreover, it is reasonable to expect that in different industries, these factors might behave differently.

Following the above context, this article aims to apply Fama-MacBeth regression to see how market β, size, and book-to-market equity perform in explaining the expected returns in the Taiwan stock market and to see how these factors act at the industry level. Though there are several works have done research on how factors perform in explaining the expected returns in the Taiwan stock market, most of them use old data and do not address this problem at the industry level.

In section 2, we will introduce our data and methodology. We will also present our regression results at the market level, whereas at the industry level, we only provide some primary results by data description for now. Finally, the conclusion of our primary results, some possible research topics, and some cautions in conducting such research will be shown in section 3.

2 Data, Methodology, and Results

2.1 Data

For stock returns, we use stock returns adjusted for dividends and stock splits as well as firms' financial statement data such as market values, and book values from 2000/7/31 to 2020/12/31 from Taiwan Economic Journal (TEJ). Furthermore, We only test for companies listed on Taiwan Stock Exchange (TWSE). To estimate β's, we choose TWSE Capitalization Weighted Stock Index (TAIEX, TEJ code: Y9999) as the market proxy.

Since in the financial industry, leverages have different meanings than those in other industries, financial companies are excluded, i.e., those companies with TWSE industry code equal to 17. Then we use the FM regression in Fama and French (1992) to perform the test.

2.2 Methodology: Fama-MacBeth Regression

We use the Fama-MacBeth (FM) regression method in Fama and French (1992) to test for market β, size, and BM ratio in Taiwan during 2005/7-2020/6 (180 months).

The steps of the FM regression are as follows:

1. Run time series regressions of returns of individual stocks on the returns of market proxy in the portfolio formation period to get $\hat{\beta}_i$'s for individual stocks.

2. Form portfolios on the basis of ranked values of $\hat{\beta}_i$ (pre-ranking β's) for individual securities.

3. Sort the stocks by size and pre-ranking β's into 100 groups and compute their monthly returns (180 returns in this case) in the full period (2005/7 - 2020/6).

4. Calculate post-ranking β's for the size-beta portfolios obtained in step 3. Then assign the post-ranking β's to stocks within the portfolio.

5. Run the cross section regressions between returns and risks, which we want to test, month by month in the testing period. That is, at time t, for $i = 1, 2, ..., \#companies$:

$$Return_{it} = \gamma_{0t} + \gamma_{1t} Factor1_{i,t-1} + \gamma_{2t} Factor2_{i,t-1} + \epsilon_{it}$$

6. Carry out t test on average slopes of month by month regressions with $H_0: \bar{\gamma_j} = 0, n = number\ of\ months\ in\ the\ testing\ period$:

$$t(\bar{\hat{\gamma}}_j) = \frac{\bar{\hat{\gamma}}_j}{s(\hat{\gamma}_j)/\sqrt{n}}$$

In short, the regression is:

- Each month the cross-section of returns on stocks is regressed on variables hypothesized to explain expected returns. (i.e., conduct a FM regression each month).
- The time-series means of the monthly regression slopes then provide standard tests of whether different explanatory variables are on average priced.

Next, we implement the above steps.

2.3 Results

2.3.1 Market Level

In this section, we will present the regression results. Conceptually, the cross section regressions are in the following form:

$$Return_{it} = \gamma_{0t} + \gamma_{1t}Factor1_{i,t-1} + \gamma_{2t}Factor2_{i,t-1} + \epsilon_{it}, \tag{2}$$

which is the equation in section 2.2 step 5. Note that in our empirical work, factor 1 and factor 2 are ln(Market Equity) and ln(BM Ratio).

Before showing the results, we have to go through more details and variable definitions. Assume that the FM regression is for returns from July 31, year t to June 30, year $t+1$, then we can define the following variables:

- β: Full period post-ranking β's of individual stocks. (instead of using the β of the stock itself, we assign β of the size-β portfolio to the stock)
- Size: Market value on June 30, year t.
- B/M: Book equity/market value on Dec 31, year $t-1$. (6 months lag for accounting variables)

The average number of companies in FM regression each month is 711.

As for some missing data (nan values), we simply drop them from data. Note that we drop the monthly returns of size-β portfolios on 2009/1 when we calculate the pre-ranking β's. And also drop some nan values in regressions. Table 1 shows the t-test results.

From table 1, we can know that during 2005/7-2020/6:

t-test for time series coefficients (%)		
β	$\ln(size)$	$\ln(BE/ME)$
-0.08		
(-0.16)		
	-0.18***	
	(-2.97)	
		0.28*
		(1.94)
-0.15	-0.18***	
(-0.31)	(-3.00)	
-0.20	-0.17***	0.11
(-0.42)	(-2.81)	(0.82)
	-0.17***	0.11
	(-2.79)	(0.80)

Table 1: t-test results, *denotes significant at 10% level; **denotes significant at 5% level; ***denotes significant at 1% level.

1. Under any combination, the coefficients of β are not statistically significant under 0.05 significance level, even under 0.1 significance level.

2. Under any combination, the coefficients of β are negative, contrary to the prediction of SLB model.

3. Size (even under 0.01 level) and BM ratio (roughly) are statistically significant under 0.05 significance level, when both of them are the only explanatory variable, respectively.

4. Signs of the coefficients of size and BM ratio are consistent with those in Fama and French (1992), negative and positive, respectively.

5. When both size and BM ratio are included in the regression, both or their significances and effects are weaken. Besides, BM ratio becomes statistically insignificant. This is different from the result of Fama and French (1992). This result might indicate that size effect explains most of BM ratio effect in Taiwan.

6. Size effect is more strong and robust.

2.3.2 Industry Level (Primary Results Only)

As mentioned in the previous section, factors might act differently in different industries. As a result, in order to find out the reason why β is "dead" in this case and to interpret the regression results more precisely. Exploring how these factors act in industries could provide some valuable insights.

Here, we only examine some industries (food and semiconductor, two totally different industries in nature). We use data from 2015/8-2021/1 from TEJ (4551 data points for semiconductors, 1448 for food) to explore the possibility of factors acting differently in different industries. For β's, we use 5-year beta for individual stocks from TEJ as estimates for true β's. Since it is only a simple primary observation, we only use figures to discuss this problem.

From these 6 figures, we can conclude that:

1. On average, the relation of β and monthly return in the semiconductor industry is stronger than that in the food industry. Furthermore, β's are higher in the semiconductor industry.
2. On average, the relation of BM ratio and monthly return in semiconductor industry is strong than that in food industry.
3. It seems that size effects in both industries do not have significant differences.

The semiconductor industry and the food industry are two very different industries in nature. And from the above analyses, we can expect that factors act differently in industries. But this is just a simple analysis, to dig deeper into this problem, conducting regression analyses in industries will be more convincing.

3 Conclusion

3.1 On Market Level

Our empirical result shows that the size effect can strongly explain the cross-section of expected stock returns of companies listed on TWSE during 2005/7-2020/6. Tough, the effect of the BM ratio is positive, the result seems not to be reliable due to its low t-statistics. Moreover, under any combination, β does not explain the cross-section of expected stock returns in Taiwan during 2005/7-2020/6. Fama and French (1992) interpret size and BM ratio as proxies for financial distress risk, that is, small-size companies and high BM ratio companies tend to have more financial distress risk. And these types of companies are punished by investors with low stock prices (therefore small sizes and high BM ratios).

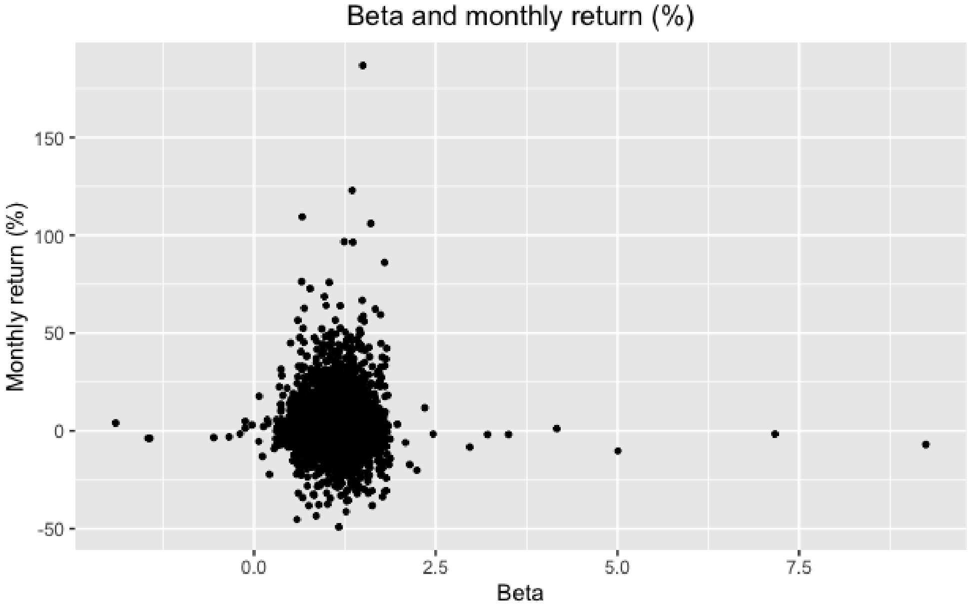

Figure 1: Beta and monthly return (%), semiconductor industry

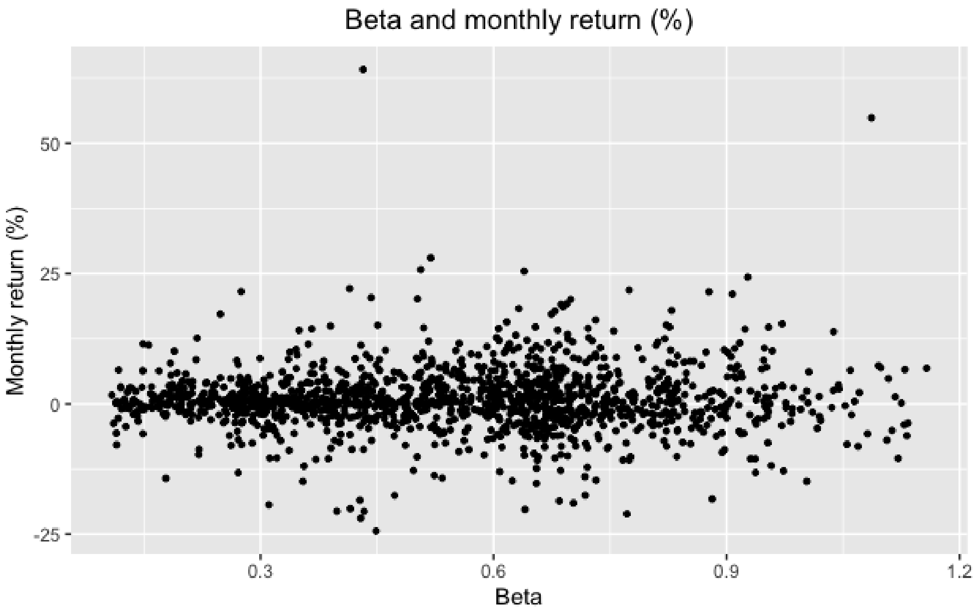

Figure 2: Beta and monthly return (%), food industry

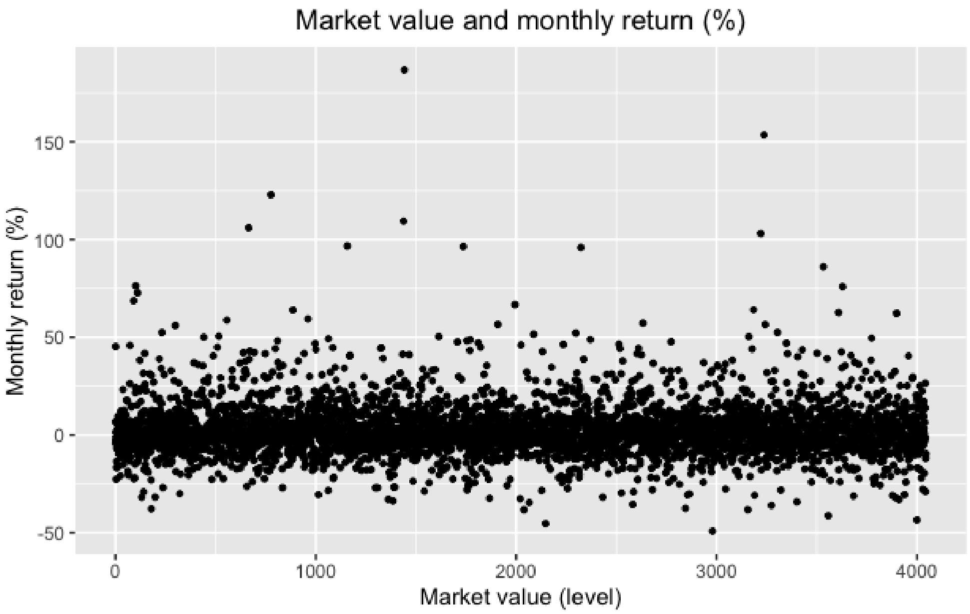

Figure 3: Market value (level) and monthly return (%), semiconductor industry

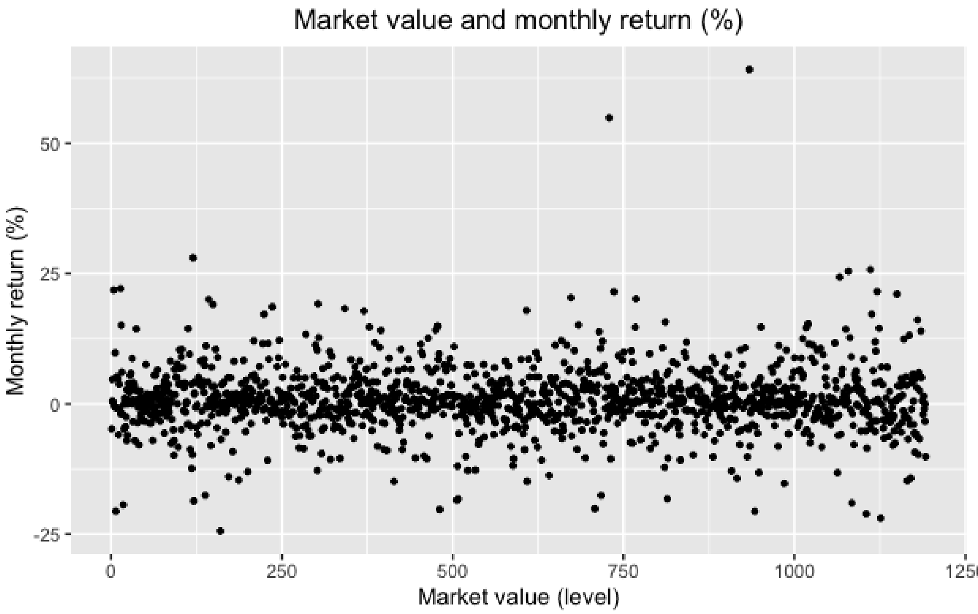

Figure 4: Market value (level) and monthly return (%), food industry

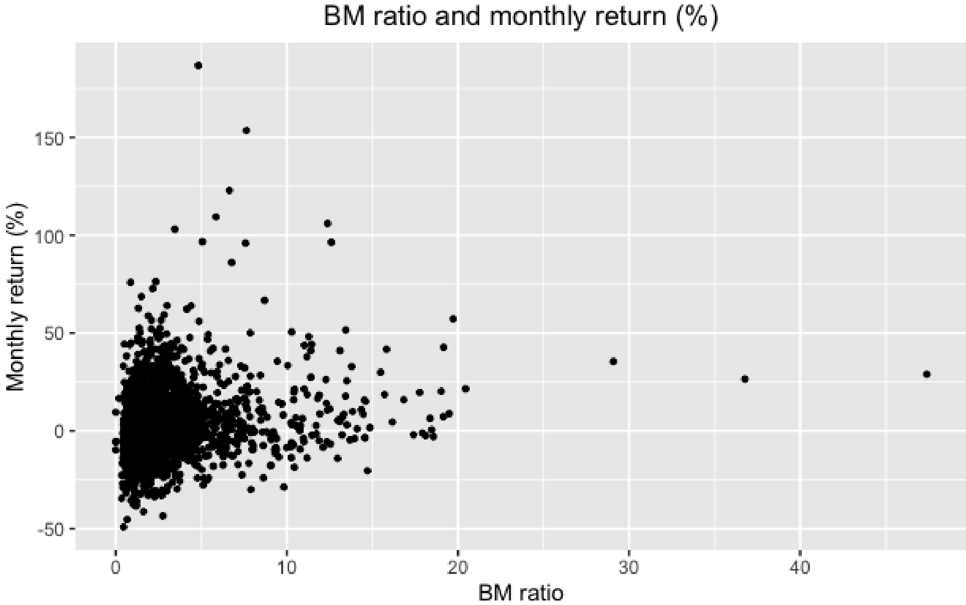

Figure 5: BM ratio and monthly return (%), food industry

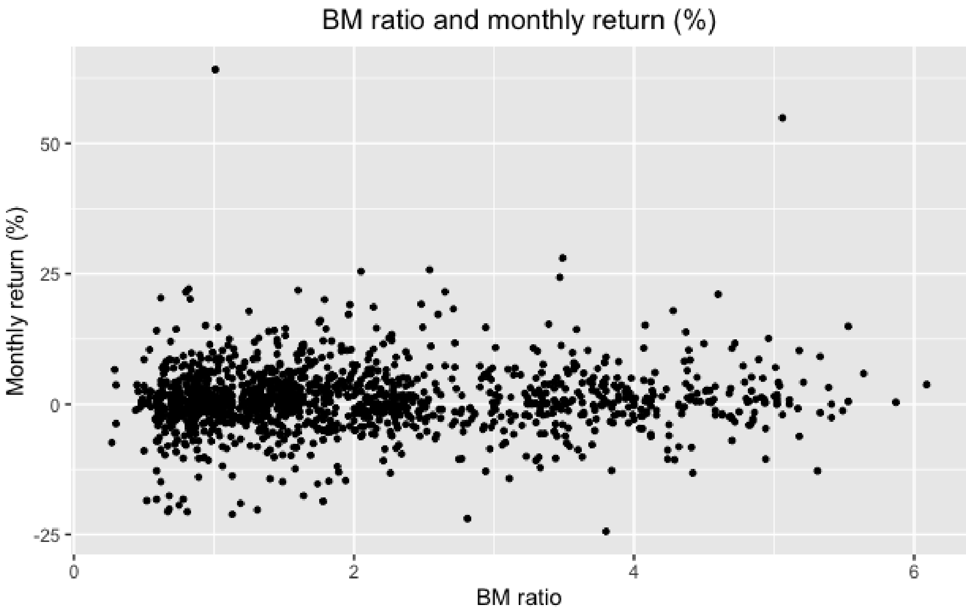

Figure 6: BM ratio and monthly return (%), food industry

3.2 On Industry Level

Our primary analysis (using the semiconductor industry and the food industry as an example) shows that there might exist heterogeneous behaviors between industries in a single market. Nonetheless, to get more robust results, conducting some regression analyses is necessary.

3.3 Improvements and Future Works

However, we have to be cautious with our results. As Nguyen et al. (2020) point out that these kinds of empirical research depend heavily on econometrics methods and portfolio formation. Thus the negative coefficient of β must explain with caveats. After all, β has its theoretical background, but other factors often result from empirical studies.

All in all, this article provides some primary FM regression results of testing if β, size, and BM ratio can explain the cross-section of expected stock returns in Taiwan from 2005-2019. And we find that size is the strongest and most robust factor. Moreover, to find out factor behaviors at the industry level, we use the semiconductor industry and food industry as an example. We compare these two different industries. By observing data from 2015/8-2021/1 using some figures, we find that the beta effect and BM ratio effect act differently between these two industries, whereas the difference in size effect is not so clear.

Since our analyses only provide some very elementary results, some problems should be dealt with, if one wants to explore deeper in this research. First of all, the econometrics and estimating problems, "how to choose proper econometrics tools". Second, the interoperation problems, "how should we explain such phenomena, a behavioral bias? or risks?". Third, are there any other factors? For this problem, Sheu et al. (1998) argue that market β, trading volume, and sales-to-price can explain can jointly explain the cross-section of expected stock returns during 1976-1996 in Taiwan and that this effect is due to investors' overreaction. And many other methods and models can be applied to find factors in the Taiwan stock market. Finally, it is interesting that different industries might have different behaviors. To look further into this issue, one should do more studies on Taiwan's industrial structure.

4 References

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