Paper Replication: Fama and French (1992), The Cross Section of Expected Stock Returns in Taiwan

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Overview

Overview

Review (Fama and French, 1992)

The purpose of the paper is to test whether **market β, size, book-to-market ratio, leverage, E/P ratio have abilities to explain the cross section of average return.**

Review (Fama and French, 1992) (cont)

Here, I summarize some main problems they face in the tests and the corresponding solutions:

Problems and Solutions

(P1) Errors-in-the-variables: They want to test the effect of true β's, but the β's they have is the estimated β's, $\hat{\beta}$s. There are errors between true β's and $\hat{\beta}$s.

(S1) Testing by portfolios: Use "portfolios" to test factors. Since within a portfolio, the errors between individual stocks may be averaged out.

Review (Fama and French, 1992) (cont)

Problems and Solutions (cont)

(P2) High collinearity between size and β: Size and β are highly negatively correlated.

(S2) Size-β sort method: Use two-pass criteria to form portfolios. First, use size to sort stocks into 10 portfolios. Second, use pre-ranking β to further divide these size portfolios into 100 size-β portfolios. Repeat these steps from year to year to update size-β portfolios.

Review (Fama and French, 1992) (cont)

Problems and Solutions (cont)

(P3) Model expected return and lag of accounting information: The average returns they want to explain are the expected returns. Moreover, the accounting information is always lag.

(S3) Match lag accounting data $t-1$ with return t Use accounting variables at December $t-1$ to match returns from July, year t to June $t+1$, i.e, 6 months lag of accounting information.

FM Regression

To minimize the errors between β_i's (true) and $\hat{\beta}_i$'s (estimates), they group stocks into portfolios, which are sorted by pre-ranking $\hat{\beta}_i$'s. Therefore, we use the following steps:

Fama-MacBeth Regression

Step 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.

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

Step 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).

FM Regression (cont)

Fama-MacBeth Regression (cont)

Step 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.

Step 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 $i = 1, 2, ..., \#companies$:

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

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

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

FM Regression (cont)

To sum up:

- **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.

Result

Size ($\ln(ME)$) and book-to-market equity ($\ln(BE/ME)$), combine to capture the cross-sectional variation in average stock returns associated with market, size, leverage, book-to-market equity, and earnings-price ratios.

Moreover, when the tests allow for variation in β that is unrelated to size (using 100 size-β portfolios), the relation between market β and average return is flat, even when β is the only explanatory variable.(i.e., the empirical evidence from 1963-1990 period does not seem to support the SLB (CAPM) model)

Overview

1. Fama and French (1992)
2. Case in Taiwan (2005/7-2020/6)

Data

In this paper replication, we only test whether β, $\ln(size)$, and $\ln(BE/ME)$ can explain the cross section expected returns of stocks. Here's the data description:

- Data period: 2000/7/31-2020/12/31 (2000/7/31-2005/6/30 for calculating pre-ranking β's)
- Testing period: 2005/7-2020/6 (180 months)
- Company type: Companies listed on TWSE. (Financial companies are excluded, industry code = 17)
- Data type: Monthly returns (adjusted), market values, and book values.

Data (cont)

- Data source: Taiwan Economic Journal (TEJ)
- Market proxy: TAIEX (TEJ code: Y9999)

Then we use the FM regression in Fama and French (1992), which we have mentioned in the previous section, to test which variable(s) explain(s) the cross section of expected stock returns in Taiwan during 2005/7 to 2020/6.

Regression

Define variables, assume the FM regression is for returns from July 31, year t to June 30, year $t+1$:

- 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)

Average number of companies in FM regression each month $= 711$

Regression (cont)

As for some missing data, we drop the “nan” values 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 regression analysis.

T test results

T test for regression 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)

*Red: 0.05 significance level ; Green: 0.05-0.1 significance level

T test results (cont)

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

T test results (cont)

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 be that size effect explains most of BM ratio effect in Taiwan.)
6. **Size effect is more strong and robust.**

Conclusion

Our empirical results show that 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 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.

References

1. Fama, E.F., & French, K.R. (1992). The Cross-Section of Expected Stock Returns. *The Journal of Finance*, 47: 427-465. https://doi.org/10.1111/j.1540-6261.1992.tb04398.x

The End. Thank You.