Midterm Presentation: Fama and French (1992), The Cross Section of Expected Stock Returns

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Overview

Motivation

Asset pricing is always a critical topic in the investment field, either in industry or in academia: **How to price stocks?** In undergraduate investment courses, the **Capital Asset Pricing Model (CAPM)** is the easiest and the most popular theoretical asset pricing model. Despite that CAPM has theoretical base, some empirical researches (e.g., Fama and French (1992)) seem no evidence to support CAPM.

Therefore, we have the **Arbitrage Pricing Theory (APT)**, which is proposed by Ross in 1976. The theory says that **the expected return of a financial asset can be modeled by various factors (undiversifiable risks, macro) in the form of linear function** in order to cover more risk factors that are not included in the CAPM.

Motivation (cont)

Thus, to find these factors, some asset pricing models are based on empirical researches, such as a commonly used **Fama-French Three-Factor Model**. Fama-French Three-Factor Model, which contends that **the expected returns of stocks can be explanied by the excess return on a broad market portfolio, SMB, and HML**, was proposed by Fama and French in their thesis *Common risk factors in the returns on stocks and bonds* in 1993.

However, before Fama and French (1993) proposed the three-factor, they had already tested on the size effect (SMB) and the book-to-market ratio effect (HML) on expected returns of stocks in Fama and French (1992), *The Cross Section of Expected Stock Returns* . In a nutshell, " **How did they test these two factors?** " is what I want to present to you today.

Roadmap (Fama and French, 1992)

The purpose of this thesis 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.**

Roadmap (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 βs, but the βs they have is the estimating βs, $\hat{\beta}$s. There are errors between true βs 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.

Roadmap (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. Firstly, use size to sort stocks into 10 portfolios. Secondly, use pre-ranking β to further divide these size portfolios into 100 size-β portfolios. Repeat these steps yearly to update size-β portfolios.

Roadmap (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 is the expected return. Moreover, the accounting information is always lag.

(S4) 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.

Roadmap (Fama and French, 1992) (cont)

Abstract (The results of FM regressions)

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)

Introduction

The central prediction of the model is that the market portfolio of invested wealth is **mean-variance efficient** in the sense of Markowitz (1959). The efficiency of the market portfolio implies that:

a. Expected returns on securities are a positive linear function of their market β (the slope in the regression of a security's return on the market's return), and
b. Market β suffice to describe the cross-section of expected returns.

Introduction (cont)

Several empirical contradictions of the Sharpe-Lintner-Black (SLB) model:

- **Size effect** of Banz (1981).
- Positive relation between **leverage** and average return documented by Bhandari (1988).
- Stattman (1980) and Rosenberg, Reid, and Lanstein (1985) find that average returns on U.S. stocks are positively related to the ratio of a textbffirm's book value of common equity, BE, to its market value, ME.
- Chan, Hamao, and Lakonishok (1991) find that **book-to-market equity, BE/ME**, also has a strong role in explaining the cross-section of average returns on Japanese stocks.

Introduction (cont)

- Basu (1983) shows that **earnings-price ratios (E/P)** help explain the cross-section of average returns on U.S. stocks in tests that also include size and market β.
- Ball (1978) argues that **E/P is a catch-all proxy for unnamed factors in expected returns (also apply to size, leverage, B/M)**; E/P is likely to be higher (prices are lower relative to earnings) for stocks with higher risks and expected returns, whatever the unnamed sources of risk.

Introduction (cont)

- All these variables can be regarded as **different ways to scale stock prices, to extract the information in prices about risk and expected returns** (Keim (1988)).
- Since E/P, ME, leverage, and BE/ME are all scaled versions of price, it is **reasonable to expect that some of them are redundant for describing average returns.**

Preliminaries: FM Regression

To test the cross section of expected returns, the authors used the **Fama-MacBeth Regression (FM Regression)**. This method is used in Fama and Macbeth (1973) to test the relationship between market β and expected return.

Here, we first introduce this general approach as follows. Then we will take a closer look at the use of this approach in Fama and French (1992) in the β estimation section. There are some differences between them.

Preliminaries: FM Regression (cont)

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 the 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 $\hat{\beta}_i$ for individual securities. (usually 10 or 20 portfolios)

Step 3. Recalculate the $\hat{\beta}_i$'s for individual stocks in the initial estimation period and calculate $\hat{\beta}$'s of the portfolios, $\hat{\beta}_p$'s, based on simple average of recalculating $\hat{\beta}_i$'s in the portfolios.

Preliminaries: FM Regression (cont)

Fama-MacBeth Regression (cont)

Step 4. 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 $p = 1, 2, ..., 10$ *or* 20:

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

Step 5. Carry out t test on average slopes of month by month regressions with
$H_0 : \bar{\gamma}_j = 0, n = numbers\ of\ months\ in\ the\ testing\ period$:

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

Repeat the above steps.

Preliminaries: FM Regression (cont)

- Though the distribution of return does not seem to follow normality, Fama and MacBeth argue that **using t test is appropriate in this case.**
- Note that we use $t-1$ for factors but t to $t+1$ for returns in the spirit of **modeling future (expected) return**.

Preliminaries: Data

1. All **non-financial firms** in the intersection of:
   - the NYSE, AMEX, and NASDAQ return files from Center for Research in Security Prices (CRSP).
   - the merged COMPUSTAT annual industrial files of income statement and balance sheet data.
2. **Exclude financial companies** because high leverage in financial companies is normal. **The meaning of high leverage for financial companies and that for non-financial companies are different**.
3. Data period: 1962-1989 (1973-1989 for NASDAQ)

Preliminaries: Data (cont)

4. **To ensure that the accounting variables (book equity, total assets, and income) are known before the returns they are used to explain**:
   - matching the accounting variables for all fiscal yearends in year $t-1$ with the returns for July of year t to June of year $t+1$. (6 months lag is conservative)
5. B/M, E/P, and leverage ratios:
   - Market Equity (ME) at the end of December of year $t-1$ + Accounting variables at the end of December of year $t-1$.
6. Size:
   - Market Equity (ME) at the end of June of year t.

Though some companies may not have December fiscal yearends, they report that the impact of non-December fiscal yearends on the tests is little.

Preliminaries: β Estimation

To test the cross section of stock returns, the authors used the FM regression. However, as mentioned previously, the method of Fama and French (1992) is somewhat different from that of Fama and MacBeth (1973). Fortunately, the spirit is the same:

- **Each month the cross-section of returns** on stocks is regressed on variables hypothesized to explain expected returns.
- **The time-series means of the monthly regression slopes** then provide standard tests of whether different explanatory variables are on average priced.

Preliminaries: β Estimation (cont)

Here are some details:

- Most previous tests **use portfolios because estimates of market βs are more precise for portfolios.** ("errors-in-the-variables" problem as mentioned in FM regression). Therefore, they estimate βs for portfolios (i.e., β_p in our previous context) and then **assign a portfolio's β to each stock in the portfolio.**
- In June of each year, all NYSE stocks on CRSP are sorted by size (ME) to determine the **NYSE decile breakpoints for ME.**
  (If they used all 3 exchanges to determine ME breakpoints, NASDAQ stocks would dominate.)

Preliminaries: β Estimation (cont)

- Because that **size and the βs of size portfolios are highly correlated** (-0.988 in Chan and Chen (1988) data), they **subdivide each size decile into 10 portfolios on the basis of pre-ranking βs for individual stocks.** (To separate size from β effect.)
- The pre-ranking, βs are estimated on 24 to 60 monthly returns (as available) in the 5 years before July of year t.
- The β breakpoints are based on **NYSE stocks.** (Avoid NASDAQ stocks bias.)
- Now they have 100 size-β portfolios.
- Calculate the **equal-weighted monthly returns on the portfolios for the next 12 months, from July to June.**

Preliminaries: β Estimation (cont)

- In the end, they have post-ranking monthly returns for July 1963 to December 1990 on 100 size-β portfolios. Keep in mind that **they update size-β portfolios every year.**
- Then estimate βs using the full sample (330 months, i.e., **full period post-ranking β estimates**) of post-ranking returns on each of the 100 portfolios, **with he CRSP value-weighted portfolio of NYSE, AMEX, and (after 1972) NASDAQ stocks used as the proxy for the market.**

Preliminaries: β Estimation (cont)

- They **estimate βs as the sum of the slopes** in the regression of the return on a portfolio on the current and prior month's market return. That is:

$$\beta = \beta_{current\ month's\ mkt\ r} + \beta_{prior\ month's\ mkt\ r}$$

  where these two βs are from one regression. In order to **adjust for nonsynchronous trading** (Dimson (1979): When shares are traded infrequently, β estimates are often severely biased.).
- Chan and Chen (1988) show that **full-period β estimates for portfolios can work well in tests of the SLB model**, even if the true βs of the portfolios vary through time.

Preliminaries: β Estimation (cont)

- Fama and French also report that the use of full-period β estimates is robust by using 5-year pre-ranking βs, or 5-year post-ranking βs, instead of the full-period post-ranking βs.
- Then allocate the full-period post-ranking β of a size-β portfolio to each stock in the portfolio. These full-period post-ranking βs are used in the Fama-MacBeth cross-sectional regressions for individual stocks. Because **they judge that the use of portfolio βs is better than that of individual βs. (Reduce the "errors-in-the-variables" problem.)**
- Note that in Fama and MacBeth (1973), they divide data into three periods; however, in Fama and French (1992), they divide data into two periods. (pre-ranking and post-ranking)

Preliminaries: β Estimation (cont)

As we have mentioned before, **to separate size from β effect, they sort portfolios by size and pre-ranking β.**
From table 1 and table 2, an easy conclusion of β estimates is as follows:

1. Forming portfolios on size and pre-ranking βs (table 1), rather than on size alone (table 2), magnifies the range of full-period post-ranking βs.
2. In each size decile the post-ranking βs closely reproduce the ordering of the pre-ranking βs. (**Evidence that the pre-ranking βs sort captures the ordering of true post-ranking βs**, table 1)

Preliminaries: β Estimation (cont)

So far, our goal is **to reduce the collinearity problem of post-ranking βs, $\hat{\beta}$ and size, $\ln(ME)$)**. We will see that the size-β sort portfolios achieve the goal.

Note that conceptually, the β we test is $\hat{\beta}$, the estimate (not estimator) from time series regression, not true β, β. But for connivence, here, we use β in the later context.

Preliminaries: β Estimation (cont)

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
Panel B: Post-Ranking βs											
All		0.87	0.99	1.09	1.16	1.26	1.29	1.35	1.45	1.52	1.72
Small-ME	1.44	1.05	1.18	1.28	1.32	1.40	1.40	1.49	1.61	1.64	1.79
ME-2	1.39	0.91	1.15	1.17	1.24	1.36	1.41	1.43	1.50	1.66	1.76
ME-3	1.35	0.97	1.13	1.13	1.21	1.26	1.28	1.39	1.50	1.51	1.75
ME-4	1.34	0.78	1.03	1.17	1.16	1.29	1.37	1.46	1.51	1.64	1.71
ME-5	1.25	0.66	0.85	1.12	1.15	1.16	1.26	1.30	1.43	1.59	1.68
ME-6	1.23	0.61	0.78	1.05	1.16	1.22	1.28	1.36	1.46	1.49	1.70
ME-7	1.17	0.57	0.92	1.01	1.11	1.14	1.26	1.24	1.39	1.34	1.60
ME-8	1.09	0.53	0.74	0.94	1.02	1.13	1.12	1.18	1.26	1.35	1.52
ME-9	1.03	0.58	0.74	0.80	0.95	1.06	1.15	1.14	1.21	1.22	1.42
Large-ME	0.92	0.57	0.71	0.78	0.89	0.95	0.92	1.02	1.01	1.11	1.32

Table 1: Post-Ranking βs (Size-β)

β and Size: Informal Tests

	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel A: Portfolios Formed on Size												
Return	1.64	1.16	1.29	1.24	1.25	1.29	1.17	1.07	1.10	0.95	0.88	0.90
β	1.44	1.44	1.39	1.34	1.33	1.24	1.22	1.16	1.08	1.02	0.95	0.90
ln(ME)	1.98	3.18	3.63	4.10	4.50	4.89	5.30	5.73	6.24	6.82	7.39	8.44
ln(BE/ME)	−0.01	−0.21	−0.23	−0.26	−0.32	−0.36	−0.36	−0.44	−0.40	−0.42	−0.51	−0.65
ln(A/ME)	0.73	0.50	0.46	0.43	0.37	0.32	0.32	0.24	0.29	0.27	0.17	−0.03
ln(A/BE)	0.75	0.71	0.69	0.69	0.68	0.67	0.68	0.67	0.69	0.70	0.68	0.62
E/P dummy	0.26	0.14	0.11	0.09	0.06	0.04	0.04	0.03	0.03	0.02	0.02	0.01
E(+)/P	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.09
Firms	772	189	236	170	144	140	128	125	119	114	60	64

Table 2: Portfolios Formed on Size

For size sort portfolios:

1. **Strong negative relation between size and average return.**
2. Strong positive relation between β and average return. However, there's **a tight relation between size and β.** (High collinearity problem)

β and Size: Informal Tests (cont)

Table II—*Continued*

	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel B: Portfolios Formed on Pre-Ranking β												
Return	1.20	1.20	1.32	1.26	1.31	1.30	1.30	1.23	1.23	1.33	1.34	1.18
β	0.81	0.79	0.92	1.04	1.13	1.19	1.26	1.32	1.41	1.52	1.63	1.73
ln(ME)	4.21	4.86	4.75	4.68	4.59	4.48	4.36	4.25	3.97	3.78	3.52	3.15
ln(BE/ME)	−0.18	−0.13	−0.22	−0.21	−0.23	−0.22	−0.22	−0.25	−0.23	−0.27	−0.31	−0.50
ln(A/ME)	0.60	0.66	0.49	0.45	0.42	0.42	0.45	0.42	0.47	0.46	0.46	0.31
ln(A/BE)	0.78	0.79	0.71	0.66	0.64	0.65	0.67	0.67	0.70	0.73	0.77	0.81
E/P dummy	0.12	0.06	0.09	0.09	0.08	0.09	0.10	0.12	0.12	0.14	0.17	0.23
E(+)/P	0.11	0.12	0.10	0.10	0.10	0.10	0.10	0.09	0.10	0.09	0.09	0.08
Firms	116	80	185	181	179	182	185	205	227	267	165	291

Table 3: Portfolios Formed on Pre-Ranking β

For pre-ranking β sort portfolios:

1. The portfolios produce a wider range of βs than those formed on size. (table 2)
2. No obvious relation between β and average return.

β and Size: Informal Tests (cont)

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
Panel A: Average Monthly Returns (in Percent)											
All	1.25	1.34	1.29	1.36	1.31	1.33	1.28	1.24	1.21	1.25	1.14
Small-ME	1.52	1.71	1.57	1.79	1.61	1.50	1.50	1.37	1.63	1.50	1.42
ME-2	1.29	1.25	1.42	1.36	1.39	1.65	1.61	1.37	1.31	1.34	1.11
ME-3	1.24	1.12	1.31	1.17	1.70	1.29	1.10	1.31	1.36	1.26	0.76
ME-4	1.25	1.27	1.13	1.54	1.06	1.34	1.06	1.41	1.17	1.35	0.98
ME-5	1.29	1.34	1.42	1.39	1.48	1.42	1.18	1.13	1.27	1.18	1.08
ME-6	1.17	1.08	1.53	1.27	1.15	1.20	1.21	1.18	1.04	1.07	1.02
ME-7	1.07	0.95	1.21	1.26	1.09	1.18	1.11	1.24	0.62	1.32	0.76
ME-8	1.10	1.09	1.05	1.37	1.20	1.27	0.98	1.18	1.02	1.01	0.94
ME-9	0.95	0.98	0.88	1.02	1.14	1.07	1.23	0.94	0.82	0.88	0.59
Large-ME	0.89	1.01	0.93	1.10	0.94	0.93	0.89	1.03	0.71	0.74	0.56

Table 4: Average Monthly Returns (In Percent, Size-β)

β and Size: Informal Tests (cont)

For size-β sort portfolios:

1. Contrary to the central prediction of the SLB model, **the second-pass β sort produces little variation in average returns.**
2. Although the post-ranking βs in the following table (table 1) increase strongly in each size decile, average returns are flat or show a slight tendency to decline.

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
Panel B: Post-Ranking βs											
All		0.87	0.99	1.09	1.16	1.26	1.29	1.35	1.45	1.52	1.72
Small-ME	1.44	1.05	1.18	1.28	1.32	1.40	1.40	1.49	1.61	1.64	1.79
ME-2	1.39	0.91	1.15	1.17	1.24	1.36	1.41	1.43	1.50	1.66	1.76
ME-3	1.35	0.97	1.13	1.13	1.21	1.26	1.28	1.39	1.50	1.51	1.75
ME-4	1.34	0.78	1.03	1.17	1.16	1.29	1.37	1.46	1.51	1.64	1.71
ME-5	1.25	0.66	0.85	1.12	1.15	1.16	1.26	1.30	1.43	1.59	1.68
ME-6	1.23	0.61	0.78	1.05	1.16	1.22	1.28	1.36	1.46	1.49	1.70
ME-7	1.17	0.57	0.92	1.01	1.11	1.14	1.26	1.24	1.39	1.34	1.60
ME-8	1.09	0.53	0.74	0.94	1.02	1.13	1.12	1.18	1.26	1.35	1.52
ME-9	1.03	0.58	0.74	0.80	0.95	1.06	1.15	1.14	1.21	1.22	1.42
Large-ME	0.92	0.57	0.71	0.78	0.89	0.95	0.92	1.02	1.01	1.11	1.32

β and Size: Informal Tests (cont)

4. Within a size decile, for any β level portfolio, their sizes are quite similar. That is, **Size-β sort creates variation of β, which is unrelated to size.** (Control for size, βs vary. See the following table)

Table I—*Continued*

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
Panel B: Post-Ranking βs											
All		0.87	0.99	1.09	1.16	1.26	1.29	1.35	1.45	1.52	1.72
Small-ME	1.44	1.05	1.18	1.28	1.32	1.40	1.40	1.49	1.61	1.64	1.79
ME-2	1.39	0.91	1.15	1.17	1.24	1.36	1.41	1.43	1.50	1.66	1.76
ME-3	1.35	0.97	1.13	1.13	1.21	1.26	1.28	1.39	1.50	1.51	1.75
ME-4	1.34	0.78	1.03	1.17	1.16	1.29	1.37	1.46	1.51	1.64	1.71
ME-5	1.25	0.66	0.85	1.12	1.15	1.16	1.26	1.30	1.43	1.59	1.68
ME-6	1.23	0.61	0.78	1.05	1.16	1.22	1.28	1.36	1.46	1.49	1.70
ME-7	1.17	0.57	0.92	1.01	1.11	1.14	1.26	1.24	1.39	1.34	1.60
ME-8	1.09	0.53	0.74	0.94	1.02	1.13	1.12	1.18	1.26	1.35	1.52
ME-9	1.03	0.58	0.74	0.80	0.95	1.06	1.15	1.14	1.21	1.22	1.42
Large-ME	0.92	0.57	0.71	0.78	0.89	0.95	0.92	1.02	1.01	1.11	1.32
Panel C: Average Size (ln(ME))											
All	4.11	3.86	4.26	4.33	4.41	4.27	4.32	4.26	4.19	4.03	3.77
Small-ME	2.24	2.12	2.27	2.30	2.30	2.28	2.29	2.30	2.32	2.25	2.15
ME-2	3.63	3.65	3.68	3.70	3.72	3.69	3.70	3.69	3.69	3.70	3.68
ME-3	4.10	4.14	4.18	4.12	4.15	4.16	4.16	4.18	4.14	4.15	4.15
ME-4	4.50	4.53	4.53	4.57	4.54	4.56	4.55	4.52	4.58	4.52	4.56
ME-5	4.89	4.91	4.91	4.93	4.95	4.93	4.92	4.93	4.92	4.92	4.95
ME-6	5.30	5.30	5.33	5.34	5.34	5.33	5.33	5.33	5.33	5.34	5.36
ME-7	5.73	5.73	5.75	5.77	5.76	5.73	5.77	5.77	5.76	5.72	5.76
ME-8	6.24	6.26	6.27	6.26	6.24	6.24	6.27	6.24	6.24	6.24	6.26
ME-9	6.82	6.82	6.84	6.82	6.82	6.81	6.81	6.81	6.81	6.80	6.83
Large-ME	7.93	7.94	8.04	8.10	8.04	8.02	8.02	7.94	7.80	7.75	7.62

β and Size: Informal Tests (cont)

Let's conclude the information we've learned so far:

1. We can not use portfolios sorted by size alone or β alone because size and β have strong negative correlation. Thus, we use size-β sort portfolios, which successively produce variation of βs unrelated to size.
2. Variation in β unrelated to size is not compensated in the average returns of 1963-1990.
3. There is negative relation between size and average return during 1963-1990.
4. For each portfolio, assign the portfolio's β to the firms in that portfolio, and run FM regressions for individual stocks.

β and Size: FM Regressions

The time series average slopes (330 slopes for each variable) from month-by-month FM regressions ($\#$ firms samples at each month) provide standard FM tests for determining which explanatory variables on average have non-zero expected premiums during the July 1963 to December 1990 period.

Before seeing the result, we have to define explanatory variables.

β and Size: FM Regressions (cont)

First of all,

- BE is the book value of common equity plus balance-sheet deferred taxes.
- A is total book assets.
- E is earnings (income before extraordinary items, plus income-statement deferred taxes, minus preferred dividends).

BE, A, and E are for each firm's latest fiscal year ending in calendar year $t-1$.
The accounting ratios are measured using market equity ME in December of year $t-1$.
Firm size $\ln(ME)$ is measured in June of year t.

β and Size: FM Regressions (cont)

Then, define explanatory variables as follows:

- β: sum β
- $\ln(ME)$: size
- $\ln(BM/ME)$: book-to-market equity
- $\ln(A/ME)$: asset-to-market equity (Market leverage)
- $\ln(A/BE)$: asset-to-book equity (Book leverage)
- E/P Dummy: $= 0$ if earnings are positive; $=1$ if earnings are negative, then E(+)/P is 0.
- E(+)/P: The ratio of total earnings to price, if earnings are positive.

These variables are matched with CRSP returns for the months from July of year t to June of year $t+1$. (Because they form portfolios yearly)

$\ln(BM/ME)$, $\ln(A/ME)$, $\ln(A/BE)$ are leverage ratios measure in different ways.

β and Size: FM Regressions (cont)

β	ln(ME)	ln(BE/ME)	ln(A/ME)	ln(A/BE)	E/P Dummy	E(+)/P
0.15 (0.46)						
	−0.15 (−2.58)					
−0.37 (−1.21)	−0.17 (−3.41)					
		0.50 (5.71)				
			0.50 (5.69)	−0.57 (−5.34)		
					0.57 (2.28)	4.72 (4.57)
	−0.11 (−1.99)	0.35 (4.44)				
	−0.11 (−2.06)		0.35 (4.32)	−0.50 (−4.56)		
	−0.16 (−3.06)				0.06 (0.38)	2.99 (3.04)
	−0.13 (−2.47)	0.33 (4.46)			−0.14 (−0.90)	0.87 (1.23)
	−0.13 (−2.47)		0.32 (4.28)	−0.46 (−4.45)	−0.08 (−0.56)	1.15 (1.57)

Table 5: FM Tests (t-statistics)

β and Size: FM Regressions (cont)

Adjust for outliers: the smallest and largest 0.5% of the observations on E(+)/P, BE/ME, A/ME, and A/BE are set equal to the next largest or smallest values of the ratios (the 0.005 and 0.995 fractiles).

The regressions in table 5 say that (about β and size):

1. **Size, ln(ME), helps explain the cross-section of average stock returns.** Average slope = -0.15%, t-statistics = -2.58
2. **This reliable negative relation persists no matter which other explanatory variables are in the regressions**; the average slopes on ln(ME) are always close to or more than 2 standard errors from 0.

β and Size: FM Regressions (cont)

3. **Market β (when control for size effect) does not help explain average stock returns for 1963-1990**, even when the market β is the only explanatory variable. The t-statistics do not indicate the slope of β is statistically significant.
4. They can also report that when the FM regressions use various combinations of β with size, BE/ME, leverage, and E/P, the results are similar to (3.).

Can β be saved?

Since the results are unfriendly to the SLB (CAPM) model, the authors provide the following possibilities to save β and justify their results.

(P1) Collinearlity: Other explanatory variables are correlated with true βs, and this obscures the relation between average returns and measured βs.

(J1) Correlations are weak: Not likely. Since β alone has no power to explain average returns and the correlations β and leverage, book-to-market equity, and E/P are within 0.15 to 0.

Can β be saved? (cont)

(P2) Noice in estimates: As predicted by the SLB model, there is a positive relation between β and average return, but the relation is obscured by noise in the β estimates.

(J2) Small standard errors Not likely. The standard errors of the βs are 0.05 or less, the estimates seem precise. Furthermore the order of the posting-ranking βs of size-β portfolios almost reproduce that of pre-ranking βs.
That is, the post-ranking βs are informative of the ordering of true βs. (table 1)

Book-to-Market Equity, E/P, and Leverage: Average Returns

Portfolio	0	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel A: Stocks Sorted on Book-to-Market Equity (BE/ME)													
Return		0.30	0.67	0.87	0.97	1.04	1.17	1.30	1.44	1.50	1.59	1.92	1.83
β		1.36	1.34	1.32	1.30	1.28	1.27	1.27	1.27	1.27	1.29	1.33	1.35
ln(ME)		4.53	4.67	4.69	4.56	4.47	4.38	4.23	4.06	3.85	3.51	3.06	2.65
ln(BE/ME)		−2.22	−1.51	−1.09	−0.75	−0.51	−0.32	−0.14	0.03	0.21	0.42	0.66	1.02
ln(A/ME)		−1.24	−0.79	−0.40	−0.05	0.20	0.40	0.56	0.71	0.91	1.12	1.35	1.75
ln(A/BE)		0.94	0.71	0.68	0.70	0.71	0.71	0.70	0.68	0.70	0.70	0.70	0.73
E/P dummy		0.29	0.15	0.10	0.08	0.08	0.08	0.09	0.09	0.11	0.15	0.22	0.36
E(+)/P		0.03	0.04	0.06	0.08	0.09	0.10	0.11	0.11	0.12	0.12	0.11	0.10
Firms		89	98	209	222	226	230	235	237	239	239	120	117

Table 6: Stocks Sorted on Book-to-Market Equity (BE/ME)

For BE/ME sort portfolios:

1. There is a **strong positive relation between average return and book-to-market equity, the effect is stronger than that of size.**

Book-to-Market Equity, E/P, and Leverage: Average Returns (cont)

2. This effect is not likely a β effect in disguise, post-ranking market βs vary little across portfolios formed on ranked values of BE/ME. (**low correlation between BE/ME and β**)
3. **Negative BE/ME firms are excluded.** (on average, 50 out of 2317) However, the average returns for negative BE/ME firms are high. (consistent with the hypothesis that BE/ME is related to distress)

Book-to-Market Equity, E/P, and Leverage: Average Returns (cont)

Portfolio	0	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel B: Stocks Sorted on Earnings-Price Ratio (E/P)													
Return	1.46	1.04	0.93	0.94	1.03	1.18	1.22	1.33	1.42	1.46	1.57	1.74	1.72
β	1.47	1.40	1.35	1.31	1.28	1.26	1.25	1.26	1.24	1.23	1.24	1.28	1.31
ln(ME)	2.48	3.64	4.33	4.61	4.64	4.63	4.58	4.49	4.37	4.28	4.07	3.82	3.52
ln(BE/ME)	−0.10	−0.76	−0.91	−0.79	−0.61	−0.47	−0.33	−0.21	−0.08	0.02	0.15	0.26	0.40
ln(A/ME)	0.90	−0.05	−0.27	−0.16	0.03	0.18	0.31	0.44	0.58	0.70	0.85	1.01	1.25
ln(A/BE)	0.99	0.70	0.63	0.63	0.64	0.65	0.64	0.65	0.66	0.68	0.71	0.75	0.86
E/P dummy	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E(+)/P	0.00	0.01	0.03	0.05	0.06	0.08	0.09	0.11	0.12	0.14	0.16	0.20	0.28
Firms	355	88	90	182	190	193	196	194	197	195	195	95	91

Table 7: Stocks Sorted on Earnings-Price Ratio (E/P)

For E/P sort portfolios:

1. The relation between average return and E/P has a familiar **U-shape.** (e.g., Jaffe, Keim, and Westerfield (1989) for U.S. data, and Chan, Hamao, and Lakonishok (1991) for Japan).

Book-to-Market Equity, E/P, and Leverage: Average Returns (cont)

- Table 6, table 7 are formed yearly at the end of each year $t-1$, the accounting ratios use ME at the end of each year $t-1$. (cf: June, year t for size)
- β is the time-series average of the monthly portfolio βs. Stocks are assigned the posting-ranking βs of the size-β portfolio they are in at the end of June of year t.

Book-to-Market Equity, E/P, and Leverage: Fama-Macbeth Regressions (cont)

β	ln(ME)	ln(BE/ME)	ln(A/ME)	ln(A/BE)	E/P Dummy	E(+)/P
0.15 (0.46)						
	−0.15 (−2.58)					
−0.37 (−1.21)	−0.17 (−3.41)					
		0.50 (5.71)				
			0.50 (5.69)	−0.57 (−5.34)		
					0.57 (2.28)	4.72 (4.57)
	−0.11 (−1.99)	0.35 (4.44)				
	−0.11 (−2.06)		0.35 (4.32)	−0.50 (−4.56)		
	−0.16 (−3.06)				0.06 (0.38)	2.99 (3.04)
	−0.13 (−2.47)	0.33 (4.46)			−0.14 (−0.90)	0.87 (1.23)
	−0.13 (−2.47)		0.32 (4.28)	−0.46 (−4.45)	−0.08 (−0.56)	1.15 (1.57)

Table 8: FM Tests (t-statistics)

Book-to-Market Equity, E/P, and Leverage: Fama-Macbeth Regressions (cont)

The regressions in table 8 say that (about BE/ME):

1. **The book-to-market effect is stronger than size effect**, with larger t-statistics and larger average slopes.
2. **Book-to-market equity does not replace size** in explaining average returns. When both variables add to the regression, they are still statistically significant.
3. **Book-to-market effect is robust** when they add E/P and size.

Book-to-Market Equity, E/P, and Leverage: Fama-Macbeth Regressions (cont)

β	ln(ME)	ln(BE/ME)	ln(A/ME)	ln(A/BE)	E/P Dummy	E(+)/P
0.15 (0.46)						
	−0.15 (−2.58)					
−0.37 (−1.21)	−0.17 (−3.41)					
		0.50 (5.71)				
			0.50 (5.69)	−0.57 (−5.34)		
					0.57 (2.28)	4.72 (4.57)
	−0.11 (−1.99)	0.35 (4.44)				
	−0.11 (−2.06)		0.35 (4.32)	−0.50 (−4.56)		
	−0.16 (−3.06)				0.06 (0.38)	2.99 (3.04)
	−0.13 (−2.47)	0.33 (4.46)			−0.14 (−0.90)	0.87 (1.23)
	−0.13 (−2.47)		0.32 (4.28)	−0.46 (−4.45)	−0.08 (−0.56)	1.15 (1.57)

Table 9: FM Tests (t-statistics)

Book-to-Market Equity, E/P, and Leverage: Fama-Macbeth Regressions (cont)

The regressions in table 9 say that (about leverage):

1. They interpret **A/ME as a measure of market leverage**, while **A/BE is a measure of book leverage.**
2. Preliminary tests indicated that logs are a good functional form for capturing leverage effects in average returns.

Book-to-Market Equity, E/P, and Leverage: Fama-Macbeth Regressions (cont)

3. The puzzle:
   The average slopes for the two leverage variables are **opposite in sign** and both are statically significant. It is **weird that higher book leverage (A/BE) is associated lower returns.** (should have default premium)
4. A solution for the puzzle:
   Both variables are close in absolute value, thus it is **the difference between the two variables that helps explain average returns.** But the difference between market leverage and book leverage is $\ln(BE/ME) = \ln(A/ME) - \ln(A/BE)$. (BE/ME = market leverage relative to book leverage)

Book-to-Market Equity, E/P, and Leverage: Fama-Macbeth Regressions (cont)

5. The result from (4.) indicates that:
   - High BE/ME (punish with a low stock price) says that the **market judges the prospects of a firm to be poor relative to firms with low BE/ME.** Thus, BE/ME may capture the **relative-distress effect** (Chan and Chen (1991)).
   - A high book-to-market ratio also says that a **firm's market leverage is high relative to its book leverage.** Because the market judges that high BE/ME firms have poor prospects and discounts its stock price relative to book value. (i.e., **the involuntary leverage effect**)

Book-to-Market Equity, E/P, and Leverage: Fama-Macbeth Regressions (cont)

β	ln(ME)	ln(BE/ME)	ln(A/ME)	ln(A/BE)	E/P Dummy	E(+)/P
0.15 (0.46)						
	−0.15 (−2.58)					
−0.37 (−1.21)	−0.17 (−3.41)					
		0.50 (5.71)				
			0.50 (5.69)	−0.57 (−5.34)		
					0.57 (2.28)	4.72 (4.57)
	−0.11 (−1.99)	0.35 (4.44)				
	−0.11 (−2.06)		0.35 (4.32)	−0.50 (−4.56)		
	−0.16 (−3.06)				0.06 (0.38)	2.99 (3.04)
	−0.13 (−2.47)	0.33 (4.46)			−0.14 (−0.90)	0.87 (1.23)
	−0.13 (−2.47)		0.32 (4.28)	−0.46 (−4.45)	−0.08 (−0.56)	1.15 (1.57)

Table 10: FM Tests (t-statistics)

Book-to-Market Equity, E/P, and Leverage: Fama-Macbeth Regressions (cont)

The regressions in table 10 say that (about E/P):

1. Ball (1978) posits that the earnings-price ratio is a catch-all for omitted risk factors in expected returns. If current earnings proxy for expected future earnings, high-risk stocks with high expected returns will have low prices relative to their earnings.
2. However, this argument **only makes sense when earnings are positive.** (they use E/P dummy to separate + and - E/P)

Book-to-Market Equity, E/P, and Leverage: Fama-Macbeth Regressions (cont)

3. The average slope on the **E/P dummy variable confirms that firms with negative earnings have higher average returns. (very high risk)**
4. Adding size to the regressions kills the explanatory power of the E/P dummy. Thus **the high average returns of negative E/P stocks are better captured by their size.** (also see table 7, the portfolio 0 has $\ln(ME)$=2.48)
5. **Adding both size and book-to-market equity to the E/P regressions kills the E/P dummy and lowers the average slope on E/P.** However, the effects of size and of book-to-market are still robust.

Book-to-Market Equity, E/P, and Leverage: Fama-Macbeth Regressions (cont)

6. Most of the relation between (positive) E/P and average return is due to the **positive correlation between E/P and ln(BE/ME), i.e., the high collinearity problem.** (see the following table, row 4)

Portfolio	0	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel B: Stocks Sorted on Earnings-Price Ratio (E/P)													
Return	1.46	1.04	0.93	0.94	1.03	1.18	1.22	1.33	1.42	1.46	1.57	1.74	1.72
β	1.47	1.40	1.35	1.31	1.28	1.26	1.25	1.26	1.24	1.23	1.24	1.28	1.31
ln(ME)	2.48	3.64	4.33	4.61	4.64	4.63	4.58	4.49	4.37	4.28	4.07	3.82	3.52
ln(BE/ME)	−0.10	−0.76	−0.91	−0.79	−0.61	−0.47	−0.33	−0.21	−0.08	0.02	0.15	0.26	0.40
ln(A/ME)	0.90	−0.05	−0.27	−0.16	0.03	0.18	0.31	0.44	0.58	0.70	0.85	1.01	1.25
ln(A/BE)	0.99	0.70	0.63	0.63	0.64	0.65	0.64	0.65	0.66	0.68	0.71	0.75	0.86
E/P dummy	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E(+)/P	0.00	0.01	0.03	0.05	0.06	0.08	0.09	0.11	0.12	0.14	0.16	0.20	0.28
Firms	355	88	90	182	190	193	196	194	197	195	195	95	91

A Parsimonious Model for Average Returns: Brief Summary

The results to here are easily summarized:

1. When they allow for variation in β that is unrelated to size, there is no reliable relation between β and average return.
2. The opposite roles of market leverage and book leverage in average returns are captured well by book-to-market equity.
3. The relation between E/P and average return seems to be absorbed by the combination of size and book-to-market equity.
   That is, size and book-to-market equity capture the cross-sectional variation in average stock returns that is related to leverage and E/P.

A Parsimonious Model for Average Returns: Average Returns: Size and Book-to-Market Equity

	Book-to-Market Portfolios										
	All	Low	2	3	4	5	6	7	8	9	High
All	1.23	0.64	0.98	1.06	1.17	1.24	1.26	1.39	1.40	1.50	1.63
Small-ME	1.47	0.70	1.14	1.20	1.43	1.56	1.51	1.70	1.71	1.82	1.92
ME-2	1.22	0.43	1.05	0.96	1.19	1.33	1.19	1.58	1.28	1.43	1.79
ME-3	1.22	0.56	0.88	1.23	0.95	1.36	1.30	1.30	1.40	1.54	1.60
ME-4	1.19	0.39	0.72	1.06	1.36	1.13	1.21	1.34	1.59	1.51	1.47
ME-5	1.24	0.88	0.65	1.08	1.47	1.13	1.43	1.44	1.26	1.52	1.49
ME-6	1.15	0.70	0.98	1.14	1.23	0.94	1.27	1.19	1.19	1.24	1.50
ME-7	1.07	0.95	1.00	0.99	0.83	0.99	1.13	0.99	1.16	1.10	1.47
ME-8	1.08	0.66	1.13	0.91	0.95	0.99	1.01	1.15	1.05	1.29	1.55
ME-9	0.95	0.44	0.89	0.92	1.00	1.05	0.93	0.82	1.11	1.04	1.22
Large-ME	0.89	0.93	0.88	0.84	0.71	0.79	0.83	0.81	0.96	0.97	1.18

Table 11: Average Monthly Returns on Portfolios Formed on Size (Rows) and Book-to-Market Equity (Columns)

A Parsimonious Model for Average Returns: Average Returns: Size and Book-to-Market Equity (cont)

1. Within a size decile (across a row of the average return matrix), returns typically increase strongly with BE/ME.
2. Looking down the columns of the average return matrix shows that there is a negative relation between average return and size.

This result is consistent with the results from the regressions.

A Parsimonious Model for Average Returns: The Interaction between Size and Book-to-Market Equity

1. The average of the monthly correlations between the cross-sections of $\ln(ME)$ and $\ln(BE/ME)$ for individual stocks is -0.26.
2. Thus, **firms with low market equity are more likely to have poor prospects, resulting in low stock prices and high book-to-market equity.**
3. The correlation between size and book-to-market equity affects the regressions in the following table.

A Parsimonious Model for Average Returns: The Interaction between Size and Book-to-Market Equity (cont)

4. Thus, **part of the size effect in the simple regressions is due to the fact that small ME stocks are more likely to have high book-to-market ratios,** and **part of the simple book-to-market effect is due to the fact that high BE/ME stocks tend to be small.** (they have low ME)

β	ln(ME)	ln(BE/ME)	ln(A/ME)	ln(A/BE)	E/P Dummy	E(+)/P
0.15 (0.46)						
	−0.15 (−2.58)					
−0.37 (−1.21)	−0.17 (−3.41)					
		0.50 (5.71)				
			0.50 (5.69)	−0.57 (−5.34)		
					0.57 (2.28)	4.72 (4.57)

A Parsimonious Model for Average Returns: Subperiod Averages of the FM Slopes

Variable	7/63–12/90 (330 Mos.) Mean	Std	t(Mn)	7/63–12/76 (162 Mos.) Mean	Std	t(Mn)	1/77–12/90 (168 Mos.) Mean	Std	t(Mn)
NYSE Value-Weighted (VW) and Equal-Weighted (EW) Portfolio Returns									
VW	0.81	4.47	3.27	0.56	4.26	1.67	1.04	4.66	2.89
EW	0.97	5.49	3.19	0.77	5.70	1.72	1.15	5.28	2.82
$R_{it} = a + b_{2t}\ln(ME_{it}) + b_{3t}\ln(BE/ME_{it}) + e_{it}$									
a	1.77	8.51	3.77	1.86	10.10	2.33	1.69	6.67	3.27
b_2	−0.11	1.02	−1.99	−0.16	1.25	−1.62	−0.07	0.73	−1.16
b_3	0.35	1.45	4.43	0.36	1.53	2.96	0.35	1.37	3.30
$R_{it} = a + b_{1t}\beta_{it} + b_{2t}\ln(ME_{it}) + b_{3t}\ln(BE/ME_{it}) + e_{it}$									
a	2.07	5.75	6.55	1.73	6.22	3.54	2.40	5.25	5.92
b_1	−0.17	5.12	−0.62	0.10	5.33	0.25	−0.44	4.91	−1.17
b_2	−0.12	0.89	−2.52	−0.15	1.03	−1.91	−0.09	0.74	−1.64
b_3	0.33	1.24	4.80	0.34	1.36	3.17	0.31	1.10	3.67

Table 12: Subperiod Averages of the FM Slopes

A Parsimonious Model for Average Returns: Subperiod Averages of the FM Slopes (cont)

1. Like the overall period, the subperiods do not offer much hope that the average premium for β is economically important.
2. Unlike the size effect, the relation between book-to-market equity and average return is so strong that it shows up reliably in both the 1963-1976 and the 1977-1990 subperiods.

A Parsimonious Model for Average Returns: Subperiod Averages of the FM Slopes (cont)

3. The subperiod results thus support the conclusion that, among the variables considered here, **book-to-market equity is consistently the most powerful** for explaining the cross-section of average stock returns.
4. There is a **January seasonal in the book-to-market equity effect**, but the positive relation between BE/ME and average return is strong throughout the year.

Conclusions

1. In short, their tests do not support the central prediction of the SLB model, that average stock returns are positively related to market β.
2. Their main result is that for the 1963-1990 period, size and book-to-market equity capture the cross-sectional variation in average stock returns associated with size, E/P, book-to-market equity, and leverage.

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The End. Thank You.