

## Introduction

This lecture note describes the progression of the empirical asset pricing literature begun by Fama and French in their 1992 paper. The main papers discussed are

1. Fama French 1992 *The Cross-Section of Expected Stock Returns*
  - Size and Book to Market capture the cross-sectional variation in expected stock returns associated with beta. The relationship between expected return and the component of beta unrelated to size is flat, even when beta is the only explanatory variable in the regression.
2. Fama French 1993 *Common Risk Factors in the Returns on Stocks and Bonds*
  - Defines the basic FF 3-factor model.
3. Fama French 1996 *Multifactor Explanations of Asset Pricing Anomalies*
  - Explores whether anomalies can be explained by the FF 3-factor model.

Along the way we will relate these papers to, among others

1. Kothari Shanken and Sloan (1995)
2. Daniel and Titman (1997)

## 1 FF (1992)

- Note Banz (1981) size effect (low is good)
- Note Book/Market effect (high is good)
- leverage apart from beta (taxes?)
- Basu (1983) E/P ratio. But Ball argues that this a proxy for risk.

- BJS and FM find pre 1969 positive relationship between leverage returns and  $\beta$

#### Results

- Relationship disappears in 1963–1990 period.
- Also weak in 1941–1990 period.
- But size, Book/market, leverage, E/P all load.
- Most basic prediction of CAPM not found in data.

#### Data

- NYSE NASDAQ AMEX.
- Compustat needed for book values
- Match accounting data for all fiscal year ends in calendar year  $t - 1$  with returns for July of year  $t$  to June of  $t + 1$ . The 6 month gap is conservative.
- Use market equity in December of  $t - 1$  to compute book/market, leverage, E/P ratios for  $t - 1$  and use
- Market equity in June of year  $t$  to measure size

#### Estimating betas

- FM approach
- Form size portfolios
- Then subdivide based on pre ranking betas for individual stocks
- this yields 100 portfolios
- Table 1 provides summary statistics.
  - note that beta decreases with size
  - note that even after accounting for size, there is substantial variation in beta within size deciles

- note that the aforementioned variation in beta occurs even though size is essentially constant across the beta-sorted deciles (within the size deciles).

FM Regressions: Regress sorted portfolios on beta, size, book/market, and other stuff. Results are in table 3.

- Note first that when only beta is included in the regression, the market risk premium is only .15 percent per month (incredibly low, even with a potential errors in variables problem — the betas are measured with error), which is statistically insignificantly different from zero.
- Size and book to market load in the appropriate ways. Size is negatively associated with expected return, and book/market is positively related.
- One explanation for the book/market premium the FF have is financial distress risk premium that is not captured by beta.
- Note that (p. 440) in the 1941–1965 period, which is most of the BJS and FM sample, the simple relationship between beta and average return is present, although it disappears when controlling for size.
- Leverage. Use 2 variables, book assets / market equity and book assets / book equity.
  - opposite slopes but close in absolute value at about .5
  - explanation: difference between market and book leverage helps explain average returns
- E/P ratio: Ball (1978) say this should be related to residual risk if asset pricing model is incorrectly specified.
  - O.k. for positive earnings, what about negative earnings?
  - negative earnings not a proxy for forecasts
  - so have a dummy for negative earnings firms
  - result is that when earnings are positive, expected returns on average are 4.72 percent per month (huge).
  - But adding size and book/market kills effect.

## 2 FF 1993

Defines the basic FF 3-factor model. Extends asset pricing tests of FF 1992 in three ways:

1. tries to explain both stock and bond returns
2. add term structure variables to help explain bond returns (in addition to SML and B/M)
3. uses a slightly different approach to test - runs time series regressions on the factors where the slopes are the traditional factor loadings (ask why this is so in class)<sup>1</sup> Then they do a test ala GRS (1989). This is a big improvement.
  - What's nice about the approach is that from the time series regression, the  $R^2$  has meaning (how much cross-sectional variation explained).

### Main Results

- For stocks, portfolios constructed to mimic size and B/M capture strong common variation in returns, no matter what else is in the time series regressions.
- These factor mimicking portfolios proxy for some unknown factors.
- The intercepts are close to zero (that doesn't mean that some anomalies don't remain anomalies vs. the FF 3 factor model - that sort of alternative is not explored here.
- Although the size and B/M portfolios explain cross sectional variation in stock returns, they don't explain the equity premium. This is left to the market factor. Essentially, all of the stock portfolios produce market betas close to one.
- So, the equity premium is left unexplained. The FF model just says that the difference between the returns on individual stocks and bills can be

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<sup>1</sup>The answer is that size and book to market don't mean anything for bonds.

explained by the market risk premium. Where that premium comes from is left unexplored.

- For bonds, the mimicking portfolios for the 2 term structure factors - a term premium and a default premium (as in CRR 1985) capture variations in the returns on bonds.
- The term structure factors also “explain” the average returns on bonds, but the average premia for the term structure factors are about zero, so that all bond portfolios statistically speaking, have the same returns (this is bad for the model).
- The stock returns are explained by 3 factors, the bonds by 2, but if you only include the terms structure factors and try to explain stock returns, you’re not unsuccessful.
- The bond returns can be explained by the 3 stock factors, but these are driven out when the term structure factors are put back, the stock factors don’t load except for with risky bonds.

## 2.1 Factors

Bond factors

1. Term is the difference between the monthly long term government return and the one month t-bill rate
2. DEF is the difference between a portfolio of long-term corporates and the long-term government return

Stock Factors:

Size and book/market factors. This is how it works.

- In June of each year, all NYSE stocks on CRSP are ranked on size.
- The median NYSE size is used to split up NYSE, NASDAQ, and AMEX stocks into S and L categories.
- Also, NYSE, Amex, and NASDAQ stocks are broken into 3 B/M groups

- Low 30%
  - Medium 40%
  - High 30%
- Details are on PP 8–9 of paper
  - The splits are arbitrary
  - Then, construct 6 portfolios: (S/L, S/M, S/H, B/L, B/M, B/H) from the intersections of the above portfolios.
  - Monthly value weighted returns are calculated from July of that year to June of the next and then the portfolios are reformed next June.
  - Now, the portfolio SMB is simply the difference between the simple average of the returns on the 3 S portfolios and the 3 B portfolios.
  - HML is defined similarly, but the medium book/market stocks are not included in constructing this factor.
  - The correlation between these two factors in the 1963–1991 period is -0.08!
  - Finally, the market factor is simply the excess return on the market over the t-bill rate.

The returns to be explained. Bonds.

- Excess returns on 2 government and 5 corporate bond portfolios.
- Governments: 1–5 years; 6–10 years
- Corporate: Aaa, Aa, A, Baa, LG

The returns to be explained. Stocks.

- Excess returns on 25 portfolios formed on size and book/market equity.
- Later on, use portfolios formed on E/P and Div/P to check robustness
- Sort by size and (independently) B/M
- The sorts use NYSE breakpoints.

- Then, combine into the 25 portfolios.
- this is done in June of each year and as above, the portfolios live for a year before the sort is done again.
- Table 1 (p. 11) gives descriptive statistics.

#### Return Characteristics: Dependent Returns

- Wide range of excess returns, from 0.32% to 1.05% per month.
- Negative relation between size and average return
- a stronger positive relation between B/M and return
- Most of the 10 portfolios in the bottom two B/M quintiles are not statistically significantly different from zero.
- For bonds, average excess returns are puny, less than 0.15% per month.
- Government returns don't increase with maturity
- Corporates have higher returns than governments
- Low grade bonds have higher returns than high grade

#### Return Characteristics: Factors

- Market risk premium in sample averages 0.43% per month
- SMB: 0.27% per month (slopes will be high though for our portfolios)
- HML: 0.40% per month
- TERM: 0.06% per month (statistically insignificant)
- DEF 0.02% per month (statistically insignificant)

## 2.2 Results

Table 3: Regressors are bond factors only.

- Bond factors explain stock returns when stock factors are not included, but regression  $R^2$  are low.

- Bond market factors explain bond returns very well.
- TERM slopes are higher for long-term securities — one would expect long term securities to be more sensitive than short-term securities to shifts in interest rates.
- DEF seems to capture a common default risk in returns (bigger for stocks than risky bonds than treasuries)
- one problem is that the risk premia on the bond factors is tiny, and is not likely to be able to explain the size effect for stocks
- When stock factors are added to the regressions the loadings on the bond factors (for stocks) diminish or vanish.

Table 4: CAPM

- Regressions fit reasonably well for stocks, but not for bonds.
- bond regressions at least make sense (of course, the stock regressions do too) - corporates are more risky than governments.

Table 5: Regressors are stock factors but not market factor.

- bond  $R^2$  are zero
- Stock  $R^2$  are lower than in table 4!

Table 6: 3 Factor FF Model

- good fit! Note that the  $R^2$  here are not the .5  $R^2$  that JW are talking about in the cross-sectional regressions like FM (1973). The  $R^2$  reported here are for time series regressions.
- The factors aren't independent. The correlation between the market risk premium and SML and HML are .32 and -.38. That's not that high.
- Note pattern in the betas. There's not much cross-sectional variation in beta any more. Beta behaves a lot like a (changing) intercept term.

- That is, it looks not like the excess return on a portfolio in a particular period equals the excess return on the market in that period plus the size and book/market loadings (where there *is* cross-sectional variation. That is saying that stocks move with the market really well, but the extent to which there is cross-sectional variation in stock returns, it is driven by cross-sectional variation in size and book/market factors.
- **In my mind, this is the most important result in the paper.** This is the only way to get FF 1993 and FF 1992 to tell a consistent and powerful story. I think that the paper essentially makes this point in the introduction, but I would have liked to see it made here again.
- The bond fit is much less good.

Table 7a: 5 Factor FF Model (Kitchen sink) dependent variable is stocks

- Fit is still good — bond factors don't matter much

Table 7b: 5 Factor FF Model (Kitchen sink) dependent variable is bonds

- Fit is good — stock factors matter (but not much)

Table 8: RMO stuff. RMO is an orthogonalized market factor — regress  $R_M - R_f$  on other factors.

- Table 8a Now term structure variables load for stocks
- Table 8b and beta loads for bonds

Table 9: Intercepts

- 9a. 2 factor bond model produces large positive intercepts
- 9a. CAPM produces a lot of cross-sectional variation in intercept
- 9a. 2 factor stock model produces large positive intercepts
- 9a. 3 and 5 factor models do much better but 5 factor intercepts are almost same as 3 factor.

GRS Test (the formal test on intercepts)

- reject at the .95 level for the 3-factor model

## 2.3 Diagnostics

- Regression residuals appear to be unpredictable.
- January effect largely explained. Essentially, there's a seasonality in the size risk factor. This is contrary to results in CK (1986, 1988 1993) where curve fitting for factors (which allows time variation in factor premia as well) cannot explain the January effect.
- Portfolios formed on E/P
  - confirm Basu that E/P not explained by the market model
  - FF 3-factor model looks good, but where's the GRS test?
- Portfolios formed on D/P
  - see table 11 - a lot of cross-sectional variation explained, but where's the F-test?

## 3 FF 1996

The basic model:

$$E[R_i] - R_f = b_i(E[R_M] - R_f) + s_i E[SMB] + h_i E[HML]$$

The basic time-series regression:

$$R_{it} - R_{ft} = a_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t$$

with zero intercept.

- FF 1995: Slopes on HML and Book/Market proxy for relative distress (also in 1992 paper)
- FF 1994: Use basic model to explain industry returns.

This paper:

- Shows that the 3-factor model captures returns to portfolios formed on
  1. E/P

2. C/P

3. Sales growth

- Low E/P, C/P, and high sales growth are typical of strong firms (which have a negative loading on HML — the average HML return is strongly positive — 6% premium).
- Also, the model explains long-term reversals (see e.g. DeBondt and Thaler 1985, FF 1988) but not 3–12 month momentum (JT 1993)

Given results the authors claim that the 3-factor model is an equilibrium asset pricing model but that

- Their “factors” are actually factor-mimicking portfolios.

There has been some skepticism

1. Kothari Shanken Sloan (1995) say that the HML factor is overstated due to survivorship bias on compustat. A disproportionate number of high book/market firms actually survive distress.
2. There may also be a problem with data snooping Lo MacKinlay (1989) where the results only hold in sample.
3. There may also be some irrationality at work (Lakonishok, Schleifer, Vishny (1994)) where overreaction leads to underpricing of distressed stocks.

The paper discusses these competing stories in section VI.

### 3.1 Tests on the 25 Size-BE/ME Portfolios

Table 1

- $R^2$  high
- What about cross-sectional variation in beta?
- Test interpretation? (This is given in my notes on FF 1993, but I want to ask the class about it. It is a very important point.
- GRS test: reject. FF spin: intercepts are measured very accurately because model explains so much cross-sectional variation.

### 3.2 LSV Deciles

Sort on

1. B/M
2. E/P
3. Cash/P
4. 5 year sales rank

Table 2, 3, 4, 5 shows that the 3 factor model explains this cross-section of average returns.

- for example: C/P deciles. High C/P are high SMB and high HML. High C/P stocks are relatively distressed (interpretation).
- sales rank explained less well (intercepts have a pattern)
- GRS: don't reject!
- tables 4, 5: double-sort portfolios, similar results

### 3.3 Long-term winners become losers

DeBondt and Thaler (1985). Portfolios are formed based on long-term (3 to 5 year) past returns). This is explained.

- past losers load on SMB and HML. They behave like small distressed stocks, which have high future returns.

Table 7: can't explain momentum.

### 3.4 Exploring 3-factor models

Tests: essentially, of M, S, H, L, can any three of these explain the fourth? Put another way, loosely speaking, are three factors enough? The answer appears to be yes.

- Note that LSV proxies cannot replace L or H in the three factor model

### 3.5 Can Loadings on 3 factors explain the cross-section of average returns?

3 Stories

1. Asset pricing is rational, and that the equilibrium model is a 3 factor ICAPM or APT
2. Irrationality (overreaction) causes a high premium for relative distress. (but table 9 shows that relative distress looks like a factor, and has a big enough standard deviation that there's no arbitrage opportunity.)
3. CAPM holds but is spuriously rejected either because
  - (a) Survivor bias in returns used to test the model KSS (1995)
  - (b) Data snooping (counterarguments: holds in 1941-1962 and internationally)
  - (c) Bad proxies (JW)

## 4 Daniel and Titman 1997

### 4.1 Introduction

Disagreement about the high discount rates for firms with

1. small size
  2. high book/market
- FF have made the case that it's systematic risk — that B/M proxies for a distress factor. For example, distressed firms are sensitive to uncertain market conditions, credit, to name one.
  - LSV claim that high B/M is due to market overreaction — bad past performance leads these firms to be irrationally "undervalued." In addition, good firms may be overvalued (also due to investor naivete).
  - FF 1993 tests:

- prices of high B/M firms move together
- B/M factor explains cross section of expected returns
- LSV then say that the factor risk premium on the B/M factor is too big, and it's not correlated with macro factors anyway.
- DT say that LSV results are not inconsistent with a Merton-type factor model where there is a priced factor (or os) associated with changes in the investment opportunity set that is orthogonal to the market return (continuous time conditional CAPM). However, this is a difficult thing to find.
- So instead, what DT do is look
  1. are there pervasive factors associated with size and B/M
  2. Are there risk premia associated with the factors?
- The results are
  1. No discernable risk factor associated with high B/M
  2. No return premium associated with any of the 3 factors. (strange)
  3. Although high B/M stocks covary, they covaried just as much before they became distressed — the covariance is due to something else, like industry, or some other firm characteristics.
  4. Perhaps the main result is that portfolios with similar characteristics, but different FF factor loadings, have different returns, and they don't.

## 4.2 Summary of return patterns of size and B/M portfolios

Take the 25 FF (1993) portfolios over 7/63–12/93.

- Panel A: high B/M quintiles outperform low B/M quintiles after controlling for size. After controlling for B/M, size is a large firm anomaly — large firms have significantly lower returns than the rest.
- Panels B and C: Size and January are the same effect.

### 4.3 A model of the return generating process

3 models

1. Null: FF 3 factor model
2. Alternative with stable factor structure, but expected returns are determined by firm's loading on factors with time-varying return premia.
3. Firm characteristics, not factor loadings, determine expected returns.

Model 1: standard

Model 2: Time-varying factor risk premia.

- factors don't change as firms become distressed
- However, distressed firms will have loadings on factors with bad outcomes in the past.
- For example, if oil realizations bad, high B/M (and small size) firms will be more weighted to oil stocks.
- Also, changes in the time-varying risk premia are negatively correlated with past performance of firms loading on that factor.
- Finally, there exists an observable variable  $\theta_{it}$  that is mean reverting and innovations in  $\theta$  are negatively correlated with past returns. So across firms,  $\theta$  should be correlated with the firms loading on the distressed factor.
- That is, high  $\theta$  stocks have factor loadings on factors with high  $\lambda$ s so that they get high expected returns.

Model 3: Characteristics-based model

- Time-invariant  $J$  factor structure

$$r_{it} = Er_{it} + \sum_J \beta_{ij} f_{jt} + \epsilon_{it}$$

with  $f_{jt} \sim N(0, 1)$ .

- But factor loadings do not describe expected returns

$$Er_{it} = a + b_1\theta_{it-1}$$

where  $\theta$  is some slowly-decaying firm attribute. Innovations in  $\theta$  are negatively correlated with returns on the stock, but  $\theta$  is not directly related to loadings on the distress factors.

- As in model 2, innovations in  $\theta$  are negatively correlated with returns on the stock, but  $\theta$  is not directly related to the loadings on the distress factors.
- What is unique about model 3: firms exist that load on the distress factors but are not themselves distressed, and therefore have a low  $\theta$  and commensurately low return.
- If model 3 is true, there may be some stocks which despite high loadings on an oil factor that has had a series of bad realizations, are still not distressed.
- Model 2 says that they should still earn the distress premium.
- Model 3 says that they shouldn't — it's all about  $\theta$

Empirical implications of the models

- FF: (1) high B/M stocks covary and (2) they have high returns.
- The conclusion from (1) and (2) is that there is a B/M factor that has a high premium.
- Models 2 and 3: this conclusion need not follow from the evidence.
- The reason is that a string of negative factor realizations will cause firms that load on that factor to become distressed. Distressed firms covary, but not because of a distress factor.
- To discriminate between model 1 and models 2 and 3, see if the return s.d. of a portfolio of firms increases if they all simultaneously become distressed.

- If the factor structure is stable and there is no separate distress factor, the return s.d. should be constant.
- What would time-varying betas on the distress factor do to this test?
- Finally, model 3 also indicates that these observations don't necessarily mean that returns determined by factor loadings.
- In the characteristics based model, high returns are earned by all distressed firms, whether or not they load on the distress factor.
- Note that the stability of the covariance matrix is important for testing pricing aspects of characteristics based model.

#### 4.4 Covariation of stocks with similar characteristics

Characteristics model differs from model 1 in 2 ways

1. Characteristics model has no distress factor
  2. Average returns determined by characteristics, not factor loadings
- (1) is important because common variation among value and growth stocks has been interpreted as evidence of a distress factor.
  - The reasoning is: if you select 1000 stocks and go long, and 1000 stocks and go short, the resulting portfolio has low return variance.
  - But HML portfolio has a much higher standard deviation than that.
  - In contrast, the characteristics model assumes that this common variation arises because the HML portfolio changes, and always has stocks that move together in it. They are just different stocks at different points in time.

The Portfolio returns

- If model 1 characterizes data, stocks should have higher covariances when they are in the high B/M portfolio than when they are not.
- If 2 or 3 true, covariances constant over time.

- So DT form the 6 portfolios based on HML and BS interaction and then form SMB and HML.
- Then calculated pre formation and post formation return standard deviations in 10 years centering around portfolio formation date. Keep portfolio weights constant.
- Before looking at these, look at average returns of stocks in the HML portfolios prior to formation date.
- Pre formation returns negative (no surprise)
- s.d.'s should go up, but it doesn't. Of course, this is because all these firms experience negative returns at the time leading up to portfolio formation.
- But this is also true as the stocks go forward!

#### Cross sectional test of factor model

- If factor model correct, high B/M factor loading = high E[return]
- need portfolios with low correlation between factor loadings and characteristics (high B/M ratios but low loadings on HML factor).
- So, first rank firms on B/M into High, medium, and low and on size.
- Then, place these 9 portfolios into smaller ones, based on HML factor loadings. That is, stocks have same size, and B/M but different factor loadings.
- Do they have the same returns (as characteristics based model predicts) or different ones (like a factor model predicts)?
- Table 3: mean excess returns for the 45 portfolios. Weak relation between returns and factor loadings for larger stocks only.
- Maybe that is true because in sorting on HML factor loading, we are picking up some variation in book/market. This is borne out in table 4.
- Table 5 shows that there is considerable dispersion in post-formation factor loadings but when you regress post formation excess returns for each of the 45 portfolios in the factors you get

- HML coefficients are different for different B/M groups
  - But WITHIN a B/M size group, the sort of pre formation HML factor loadings produces a monotonic ordering in post formation factor loadings.
  - Models 1 and 2 say intercepts should be zero in factor regressions. Model 3 says alphas of low factor loading portfolios should be positive and high loadings should have negative intercepts. This is true (table 5 column 5). There is a formal test in table 6.
- Table 7,8 tests to see if SMB and MKT factors are priced after controlling for characteristics.
  - Size is marginally significant.
  - Mkt: reproduce FF 92 - after controlling for size, relationship for beta is slightly negative.