

## Excess Returns Methodology (the basics)

We often ask whether some event, like a merger announcement, dividend omission, or stock split, has an impact on stock prices. Since we have CRSP data available, it is pretty easy to construct a test to answer this question. In general the idea is simple; first determine what a "normal" return ought to be for the stock in question, and then see whether the actual return during the "event window" is more or less than this "normal" return. Of course the devil is in the details: What is a "normal" return? Over what time period do you determine this "normal" return? How long is the event window? Are there characteristics of reported stock returns that make these measurements unreliable? I'm not going to answer all of these questions for this problem set. You'll get some answers in your seminar. Instead, I'm going to focus on how to construct some of the more basic tests so you can get experience programming them.

All of this can be done in SAS--albeit with some difficulty. I think it is easier to do it in Fortran, if you know enough Fortran. Over the semester we'll look at both ways.

You should read "Using Daily Stock Returns; The Case of Event Studies" by Stephen J. Brown and Jerold B. Warner in *Journal of Financial Economics* Volume 14, Issue 1 (March, 1985) pages 3-31, and also "Valuation Effects of Security Offerings and the Issuance Process" by Wayne H. Mikkelson and Meghan Partch in *Journal of Financial Economics* Volume 15, Issue 1 (March 1986) pp. 31-60. I have a master that you can use to make copies.

## Terminology

**Event date**--the date the event occurred

**Event window**--several days before and after the event. This is the time period over which you think you will observe some market reaction to the event. We use some days before the event because lots of time news leaks out before the public announcement. We use some days after the event because sometimes it takes a day or two for the market to fully impound the effects of the event into the stock price.

**Event time**--trading days relative to the event date. Usually the event date is considered day 0 and days before the event date are negative. So day -5 is 5 days before the event, day +5 is 5 days after the event.

**Normal return**--the return you would expect on the stock during the event window if there had been no event.

**Abnormal return**--the actual stock return less the predicted normal return.

## What types of returns should be used?

We have daily and monthly returns available. If you really want, you can construct other interval returns--weekly, two-weekly, annual, etc. Since most of the events we look at are of short duration you will usually use daily, or at most weekly, returns. For these exercises we'll use daily returns.

## What is a "normal" return?

There are at least three ways to identify a "normal" return.

1. The average return during some estimation period that doesn't include the event window. This is called the comparison period.
2. The market return on a given day.
3. The return that would be predicted by the CAPM on a given day..
4. There are others that use more sophisticated models of the return-generating process, for example, the Fama-French 3 factor model or Scholes-Williams betas, or Dimson betas.

We won't talk about the pros and cons of these methods here. You will get some of that in your seminar. Once you have determined what is a normal return, the abnormal return is just the actual return minus the predicted normal return. We'll estimate the first three measures.

## Over what time period should the normal return be estimated?

You can estimate the normal return before, during, or after the event. For the purposes of our exercises we will use days -104 to -5 for the estimation period. We'll use days -4 to +1 for the event window.

## How do you test whether the abnormal return is significant?

There are a number of ways to test for significance, depending on how you characterized normal above. I'll specify a test for each of your exercises.

## Portfolios or individual stocks?

Identifying abnormal returns is usually easier in a portfolio than in individual stocks. For that reason the tests will be on portfolios of stocks rather than on individual stocks.

## Test statistics--Brown and Warner

Brown and Warner used the following test statistics for the null hypothesis that excess returns are zero. These tests assume you are testing a collection of firms' abnormal returns.

### One day event window, N days in estimation period:

Let  $A_{i,t}$  be firm  $i$ 's abnormal return (either mean adjusted, market adjusted, or market model adjusted) on day  $t$ .

Let  $Abar_t$  be the mean (over all the companies in the sample) abnormal return on day  $t$ .

Let  $\sigma$  be the standard deviation of the  $Abar_t$  over all days in the estimation period (using N-1 weighting, so it is an estimate of the population standard deviation).

The test statistic for a given mean (over all the companies) abnormal return on a given day,  $Abar_t$ , is

$$T = Abar_t / \sigma$$

If enough days are in the estimation period--over 200, then the statistic is assumed to be normal. Otherwise it is Student-t.

### Multiple day event window (n days in the event window):

Let  $\Sigma Abar$  be the sum of the average abnormal returns during the event window.

Since  $\sigma$  is the estimate of the standard deviation of one day's abnormal return,  $\sigma n^{1/2}$  is an estimate of the standard deviation of the sum of n independant abnormal returns.

The test statistic is

$$z = \Sigma Abar / (\sigma n^{1/2})$$

and is assumed to be unit normal. n is the number of days in the event window.

## Test statistics--Mikkelson and Partch

Mikkelson and Partch only use market model abnormal returns so  $A_{i,t} = R_{i,t} - (\alpha + \beta R_{M,t})$ -- they call these prediction errors, PE (We'll still use the Abar terminology). On day t,  $Abar_t$  is calculated just as above--the mean abnormal return over all firms on day t.

The difference between Mikkleson and Partch's test statistic, and that of Brown and Warner, is in how the expected standard deviation of abnormal returns is calculated and the fact that they allow for different numbers of days in the event window for each firm. Mikkleson and Partch allow for each calendar day's abnormal return to have a different standard deviation. So corresponding to each abnormal return  $A_{i,t}$  is a standard deviation  $\sigma_{i,t}$  calculated as follows:

Let  $v_i^2$  be the variance of the residual from firm i's market model regression (the one you used to find alpha and beta). Assume you used N observations in this regression (i.e. N days in the estimation period) then:

$$\sigma_{i,t} = \sqrt{v_i^2 \left( 1 + \frac{1}{N} + \frac{(R_{M,t} - \bar{R}_M)^2}{\sum_{t=1}^N (R_{M,t} - \bar{R}_M)^2} \right)}$$

is the standard deviation of each day  $t$ 's abnormal return for company  $i$ , where the  $R_M$  with the bar over it is the mean market return over the  $N$ -day estimation period. Note that this will differ for each firm because the average of the market return is over different days, unless of course some of the firms share the same event date.

Then the standardized prediction errors for each day and each company,

$$\text{SPE}_{i,t} = A_{i,t} / \sigma_{i,t}$$

should all be Student- $t$  with variance  $N/(N-2)$ .

### One day event window:

For a given day, the average of these prediction errors over all the firms in the sample (there are  $M$  firms in the sample),  $\text{ASPE}_t$  is approximately normal with variance  $1/(\# \text{ firms in sample}) = 1/M$ . This gives us the test statistic for an abnormal return on a given day,  $t$ , as

$$Z_t = M^{1/2} (\text{ASPE}_t)$$

Under the null hypothesis,  $Z_t$  is distributed unit normal.

### Multiple and varying event windows:

Sometimes you want to test whether the abnormal performance over a number of days is zero--like Brown and Warner did above. This just means having an event window that is longer than one day. But suppose you have different length event windows for different companies? Company A's event window might be days  $-3$  to  $+2$ , company B's might be days  $-5$  to  $+2$ . To aggregate all these potentially different-length event windows you need to create a different variable for each company such that they are all distributed the same. So if for company  $i$  the event window runs from  $T_{i,1}$  to  $T_{i,2}$  then first calculate the standardized interval prediction error for company  $i$ ,  $\text{SIPE}_i$ , as

$$\text{SIPE}_i = \frac{\sum_{t=T_{i,1}}^{T_{i,2}} \text{SPE}_{i,t}}{\sqrt{T_{i,2} - T_{i,1} + 1}}$$

Then just average all of these across all of the firms and normalize by multiplying by  $M^{1/2}$  to get the test statistic:

$$Z = \frac{\sqrt{M}}{M} \sum_{i=1}^M \text{SIPE}_i$$

which should be asymptotically unit normal.

Note: If all of the event windows are the same length and cover the same (event-time) days,  $T_1$  to  $T_2$ , then this test statistic just becomes:

$$Z = \frac{\sqrt{M}}{M \sqrt{T_2 - T_1 + 1}} \sum_{i=1}^M \sum_{t=T_1}^{T_2} \text{SPE}_{i,t}$$

## Assignment 1:

1. Do this for a single stock, IBM with permno 12490, to get the hang of it. You'll have to do it in Fortran.
  - The event date is June 6, 1978 (the day I turned 18). This is day 0.
  - The event window is days -4 to +1 (6 days)
  - The estimation period is days -104 to -5
  - Calculate the **comparison period return** and the **mean adjusted abnormal return**:
    - Calculate IBM's average daily return over the estimation period (remember, only use non-missing returns, and delete the return following a -99.0 return as well since it is a multi-day return)
    - Calculate the **mean adjusted abnormal return** for each day in the event window *and for each day in the estimation period* as the actual return minus the average comparison period return.
  - Calculate the **market adjusted abnormal return**:
    - Calculate the market adjusted abnormal return for each day in the event window *and for each day in the estimation period* as the actual return minus the market return (both equal weighted and value weighted) on each day during the event window.
  - Calculate the **market model adjusted abnormal return**:
    - Calculate the company's alpha and beta from a market model regression over the estimation period. Use both the equal weighted and value weighted indices--so you'll get two alphas and two betas.
    - Calculate the market model adjusted abnormal return as actual return - (estimated alpha + actual market return x estimated beta) for each day in the event window *and for each day in the estimation period*.
2. Next class we'll discuss significance tests and then perform significance tests for these abnormal returns and then try this on a portfolio.

My results:

Just for comparison, my results for the first couple of days during the estimation period for the exercise above are:

```

CALENDAR LOADED. 9943 DAYS IN CALENDAR - (19620702-20011231)
n-ew = 100
alpha-ew = -1.757551567E-3
beta-ew = 0.769114435
stdres-ew = 8.181140758E-3
SASs RMSE = 8.264199831E-3
n-vw = 100
alpha-vw = -7.125223638E-4
beta-vw = 0.829781473
stdres-vw = 7.093603257E-3
SASs RMSE-vw = 7.1656215E-3
time comp-per mktadjew mktadjvw mmadjew mmadjvw ret ewretd
-104 0.00043 0.01064 0.01256 0.01005 0.01121 0.00047 -0.01018
-103 0.00698 0.01831 0.01858 0.01746 0.01733 0.00702 -0.01129
-102 -0.00701 -0.00200 -0.00084 -0.00139 -0.00117 -0.00697 -0.00497
-101 -0.00332 -0.00082 0.00186 0.00037 0.00170 -0.00328 -0.00246
-100 0.00184 -0.00197 -0.00022 0.00068 0.00085 0.00188 0.00384
-99 -0.00238 -0.00542 -0.00221 -0.00295 -0.00152 -0.00234 0.00307
-98 0.00560 0.00817 0.00891 0.00934 0.00907 0.00564 -0.00253
-97 0.00557 0.00043 0.00020 0.00338 0.00184 0.00561 0.00518

```

## Assignment 2:

The program you wrote for IBM in assignment 1 can be used for a bunch of companies. Write a loop around your program above to:

1. You will need to modify your regression subroutine to spit out the residual variance of the regression. Use  $n-2$  as the divisor.
2. Read in a permno and an event date from a file (I'll give you the data below--you can cut and paste it into a text file)
3. Calculate the various abnormal returns for the event window--days -4 to +1, and the estimation period-- days -104 to -5.
4. Write out a text dataset that can be read into sas that has for each record (there will be 106 records, I think):
  - o Permno
  - o Event date (that is, the yyymmdd event date)
  - o Event time (that is, the number between -104 and +1 representing the date)
  - o mean-adjusted abnormal return
  - o market-adjusted abnormal return
  - o market-model adjusted abnormal return
  - o for the Mikkelson and Partch stuff:

- $\sigma_{i,t}$  as calculated above--you will need the residual variance from 1 above.
- equal weighted and value weighted returns on the market (for the Mikkelson and Partch stuff)

5. Write a sas program to read the data in. We'll analyze it next time.

Permno and event data data for assignment 2:

Permno	Event date
12060	19880421
80718	19820212
88322	19870623
88306	19871113
77002	19940713
79084	19941010
85013	19980623
34826	19840506