



# Estimating a market model: Step-by-step

Prepared by Pamela Peterson Drake  
Florida Atlantic University

The purpose of this document is to guide you through the process of estimating a market model for the purpose of estimating the beta of a stock. The beta of a stock is the slope coefficient in the following equation:

$$r_{it} = \alpha + \beta r_{mt} \quad t = 1, 2, \dots, T$$

where  $r_{it}$  is the return on stock  $i$  in period  $t$  and  $r_{mt}$  is the return on the market in period  $t$ . Some of the more challenging elements of this process is gathering the necessary data and then putting it in a form that allows us to use Microsoft Excel<sup>®</sup> to estimate the regression.

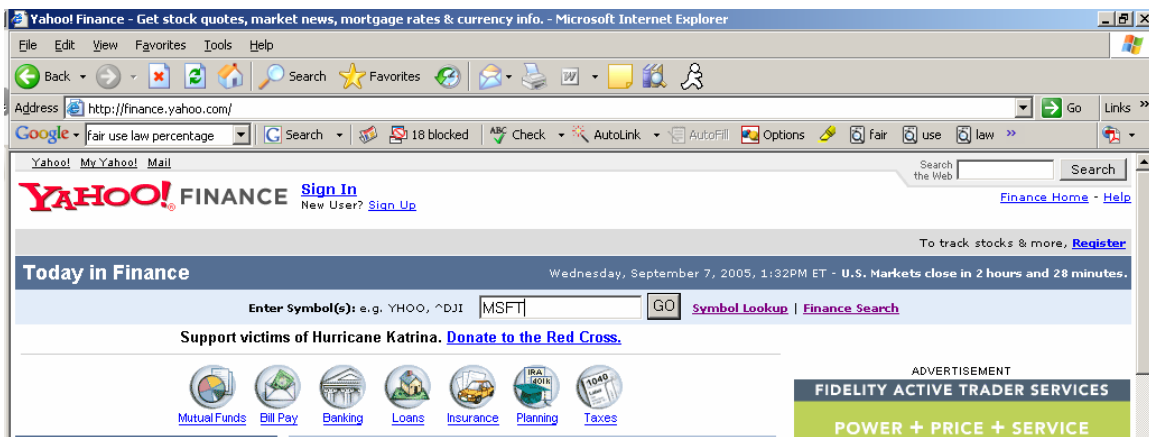
In this example, I will demonstrate how to estimate the beta of Microsoft stock using sixty months of returns.

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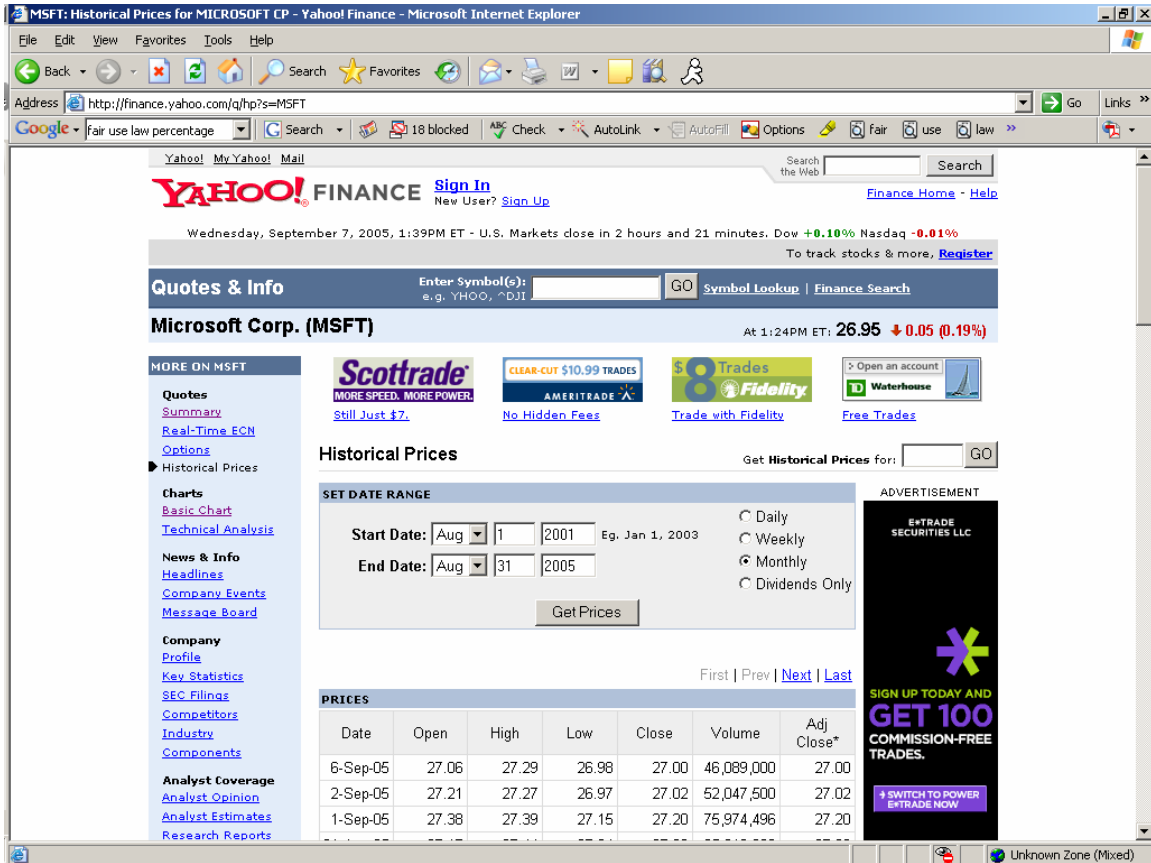
## 1. Obtaining stock prices and dividends

There are many sources of downloadable stock prices on the Internet. One such source is Yahoo! Finance. There are several paths to the stock prices and I will demonstrate one of these paths for you. Using the main page of Yahoo! Finance, type in the ticker symbol of the stock of interest into the **Enter Symbol(s)** box and click on **GO**:



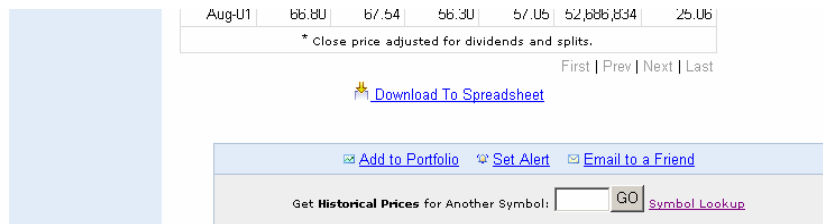
This will produce the current day's information on the stock's trading, along with links to company and industry specific information. In the left-most menu, click on **Historical Prices**.

Now we specify the information that we need, which is monthly prices. Ideally, we want to estimate the market model using at least sixty monthly returns. This means that we need sixty-one months of prices. Specifying the start and end date,

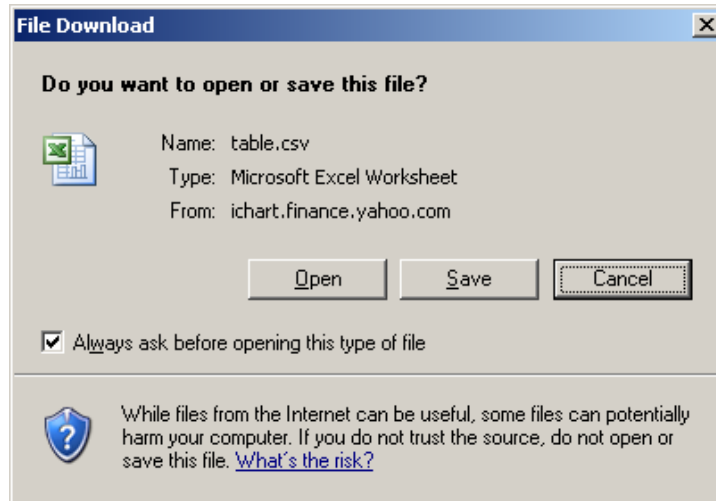


We then **Get Prices**.

We see the prices and dividends, starting with the most recent period. Because we don't want to retype all this ourselves, we click on the link in the lower portion of this page to **Download To Spreadsheet**:



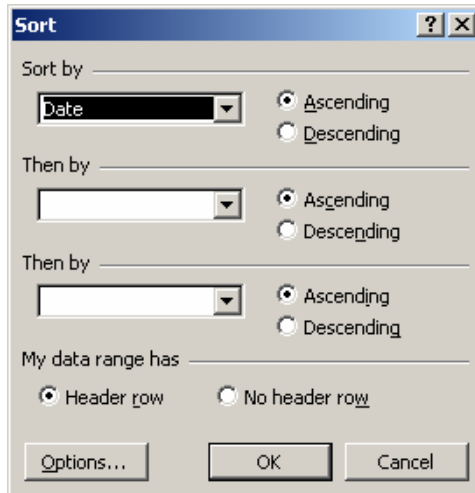
We then are given a choice to **Open** or **Save**:



Choosing **Save**, I then specified the name as **msft**. I now have a common-separated-value (.csv) file named **msft.csv**. When I open this file in Microsoft Excel®, I now see the data as follows:

	A	B	C	D	E	F	G	H	I	J
	Date	Open	High	Low	Close	Volume	Adj. Close*			
2	1-Aug-05	25.81	27.94	25.76	27.38	65529978	27.38			
3	1-Jul-05	24.85	26.48	24.5	25.61	69046604	25.53			
4	1-Jun-05	25.73	26	24.82	24.84	62956713	24.77			
5	2-May-05	25.23	26.09	24.64	25.8	62699752	25.72			
6	1-Apr-05	24.24	25.45	23.94	25.3	77090234	25.15			
7	1-Mar-05	25.19	25.79	23.82	24.17	72899708	24.02			
8	1-Feb-05	26.25	26.5	25.13	25.16	75992316	25.01			
9	3-Jan-05	26.8	27.1	25.64	26.28	79642818	26.04			
10	1-Dec-04	26.95	27.44	26.68	26.72	84488054	26.48			
11	1-Nov-04	28.16	30.2	26.1	26.81	86446079	26.56			
12	1-Oct-04	27.82	28.89	27.55	27.97	65742918	24.87			
13	1-Sep-04	27.23	27.79	26.74	27.65	57725252	24.58			
14	2-Aug-04	28.27	28.55	26.85	27.3	52104636	24.27			
15	1-Jul-04	28.7	29.89	27.25	28.49	76666657	25.25			
16	1-Jun-04	26.13	28.8	25.86	28.56	77068290	25.32			
17	3-May-04	26.19	26.6	25.42	26.23	58942495	23.25			
18	1-Apr-04	24.95	27.72	24.85	26.13	77386665	23.16			
19	1-Mar-04	26.63	26.72	24.01	24.93	77111922	22.1			

For purposes of calculations and graphing, it is easier to have the data sorted in chronological order (instead of reverse chronological order), so I highlight the rows 2 through 61 and then use Excel commands of **Data -- Sort**:



and sort by date:

	A	B	C	D	E	F	G	H
1	Date	Open	High	Low	Close	Volume	Adj. Close*	
2	1-Aug-00	69.94	74.87	68.12	69.81	56172834	30.67	
3	1-Sep-00	70	72.06	58.63	60.31	74979370	26.49	
4	2-Oct-00	60.5	70.12	48.44	68.87	1.17E+08	30.26	
5	1-Nov-00	68.5	72.37	57	57.38	1.04E+08	25.21	
6	1-Dec-00	58.06	60.63	40.31	43.38	1.08E+08	19.06	
7	2-Jan-01	44.13	64.75	42.88	61.06	99401428	26.82	
8	1-Feb-01	60.81	65.06	53.88	59	85342315	25.92	
9	1-Mar-01	58.56	61.13	49.75	54.69	90297790	24.03	
10	2-Apr-01	54.81	71.1	51.06	67.75	1.08E+08	29.76	
11	1-May-01	67.66	72.15	67.25	69.18	83999472	30.39	
12	1-Jun-01	69.6	76.15	66.01	73	73498171	32.07	
13	2-Jul-01	72.05	73.15	64.2	66.19	72106314	29.08	
14	1-Aug-01	66.8	67.54	56.3	57.05	52686834	25.06	
15	4-Sep-01	57.19	59.08	47.5	51.17	1.08E+08	22.48	
16	1-Oct-01	50.94	63.63	50.41	58.15	78938739	25.55	
17	1-Nov-01	60.08	68.34	59.6	64.21	65676323	28.21	
18	3-Dec-01	63.83	69.89	63.8	66.25	51004760	29.1	
19	2-Jan-02	66.65	70.62	61.33	63.71	68080095	27.99	

I can use the same Yahoo! Finance page to get the dividends as well by selecting the **Dividends Only** choice. This produces a list of cash dividends over the same period:

[Quotes](#)  
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[Real-Time ECH](#)  
[Options](#)  
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[Charts](#)  
[Basic Chart](#)  
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Start Date: Aug 1 2000 Eg. Jan 1, 2003

End Date: Aug 31 2005

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 Monthly  
 Dividends Only

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This produces the list of dividends as follows:

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SET DATE RANGE

Start Date: Aug 1 2000 Eg. Jan 1, 2003  
 End Date: Aug 31 2005

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PRICES

Date	Open	High	Low	Close	Volume	Adj Close*
15-Aug-05				\$ 0.08		Cash Dividend
16-May-05				\$ 0.08		Cash Dividend
15-Feb-05				\$ 0.08		Cash Dividend
15-Nov-04				\$ 3.08		Cash Dividend
23-Aug-04				\$ 0.08		Cash Dividend
15-Oct-03				\$ 0.16		Cash Dividend
19-Feb-03				\$ 0.08		Cash Dividend
18-Feb-03				2 : 1		Stock Split

\* Close price adjusted for dividends and splits.

Download To Spreadsheet

which I can then download to a spreadsheet or simply type into the stock price worksheet. Because there are so few of these, I simply insert them into the work sheet by hand. You will notice that Microsoft had a 2:1 stock split on February 18, 2003.

We need to be alert for stock dividends and stock splits because it affects the data we are using. Fortunately, Yahoo! Finance adjusts the stock prices for stock dividends and stock splits, Please note, however, that not all online sources do so. Further, Yahoo! Finance does *not* adjust cash dividends for stock splits and dividends, so if there are any cash dividends prior to the split, we need to adjust these appropriately; failure to do so will result in an error in the returns.<sup>1</sup>

Be sure to save the file as a Microsoft Excel workbook because we will be adding elements to this worksheet that may be lost if we keep it as a .csv file. Just use the **File – Save As** command and then specify the file type as a workbook.

## 2. Calculating returns on the stock

Once we've entered the cash dividends into our worksheet, we are now ready to calculate returns. Remember that a monthly return is calculated as:

$$\text{Monthly return} = \frac{\text{Price at the end of the month} - \text{Price at the beginning of the month} + \text{cash dividend}}{\text{Price at the beginning of the month}}$$

In the worksheet, this translates into referring to the cells for the prices and the dividend. For the return for September 2000, we calculate this as  $= (G3 - G2 + H3) / G2$ :

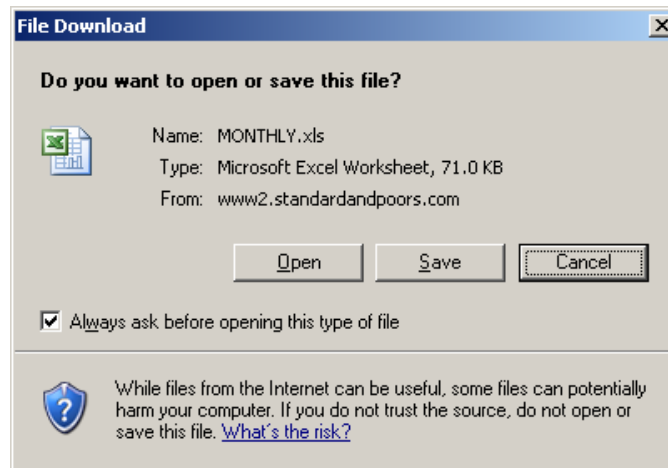
<sup>1</sup> For example, if Microsoft had paid a dividend of, say, \$0.10 prior to the 2:1 split, I would have to adjust it to \$0.05 so that it is consistent with the split-adjusted share prices.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Date	Open	High	Low	Close	Volume	Adj. Close	Cash dividend	Return on MSFT			
2	1-Aug-00	69.94	74.87	68.12	69.81	56172834	30.67					
3	1-Sep-00	70	72.06	58.63	60.31	74979370	26.49		-0.13629			
4	2-Oct-00	60.5	70.12	48.44	68.87	1.17E+08	30.26					
5	1-Nov-00	68.5	72.37	57	57.38	1.04E+08	25.21					
6	1-Dec-00	58.06	60.63	40.31	43.38	1.08E+08	19.06					
7	2-Jan-01	44.13	64.75	42.88	61.06	99401428	26.82					
8	1-Feb-01	60.81	65.06	53.88	59	85342315	25.92					
9	1-Mar-01	58.56	61.13	49.75	54.69	90297790	24.03					
10	2-Apr-01	54.81	71.1	51.06	67.75	1.08E+08	29.76					
11	1-May-01	67.66	72.15	67.25	69.18	83999472	30.39					
12	1-Jun-01	69.6	76.15	66.01	73	73498171	32.07					
13	2-Jul-01	72.05	73.15	64.2	66.19	72106314	29.08					

Copying this cell's formula to the remaining cells in column I, we then have the returns on MSFT for each month for sixty months.

### 3. Obtaining returns on a market index

This is actually a tough part of the calculation. It is easy to retrieve the level of an index, say the S&P 500, but it is difficult to find the corresponding dividends on the index. Because dividends can be a significant part of the return, we don't want to leave them out. One of the few places on the Internet where we can find the return on the S&P 500 index that includes dividends is at [Standard & Poor's site](#). This is a downloadable spreadsheet – simply **Save** the file when prompted:<sup>2</sup>



<sup>2</sup> I have found that Internet Explorer will often freeze when I try to open an Excel file from such an option. It seems to work well to save the file first and then open it in Excel.

MONTH OF	PRICE CLOSE	PRICE CHANGE	1 MONTH CHANGE	3 MONTH CHANGE	6 MONTH CHANGE	1 YEAR CHANGE	5 YEARS CHANGE	10 YEARS CHANGE	1 MONTH TOTAL RETURN	12 MONTH TOTAL RETURN
08/2005	1220.33	-13.85	-1.12%	2.42%	1.39%	10.51%	-19.59%	117.19%	-0.91%	12.56%
07/2005	1234.18	42.85	3.60%	6.68%	4.48%	12.02%	-13.74%	119.58%	3.72%	14.05%
06/2005	1191.33	-0.17	-0.01%	0.91%	-1.70%	4.43%	-18.10%	118.69%	0.14%	6.32%
05/2005	1191.50	34.65	3.00%	-1.01%	1.51%	6.32%	-16.13%	123.38%	3.18%	8.24%
04/2005	1156.85	-23.74	-2.01%	-2.07%	2.36%	4.47%	-20.35%	124.76%	-1.90%	6.34%
03/2005	1180.59	-23.01	-1.91%	-2.59%	5.92%	4.83%	-21.22%	135.78%	-1.77%	6.69%

Using the same method to sort the data as we used previously, I sort the data:

MONTH OF	PRICE CLOSE	PRICE CHANGE	1 MONTH CHANGE	3 MONTH CHANGE	6 MONTH CHANGE	1 YEAR CHANGE	5 YEARS CHANGE	10 YEARS CHANGE	1 MONTH TOTAL RETURN	12 MONTH TOTAL RETURN
12/1987	247.08	16.78	7.29%	-23.23%	-18.72%	2.03%	75.68%	159.81%		
01/1988	257.07	9.99	4.04%	2.10%	-19.33%	-6.21%	76.92%	188.03%		
02/1988	267.82	10.75	4.18%	16.29%	-18.79%	-5.76%	80.89%	207.70%		
03/1988	258.89	-8.93	-3.33%	4.78%	-19.56%	-11.25%	69.25%	190.20%		
04/1988	261.33	2.44	0.94%	1.66%	3.79%	-9.37%	58.93%	169.89%		
05/1988	262.16	0.83	0.32%	-2.11%	13.83%	-9.63%	61.44%	169.60%		

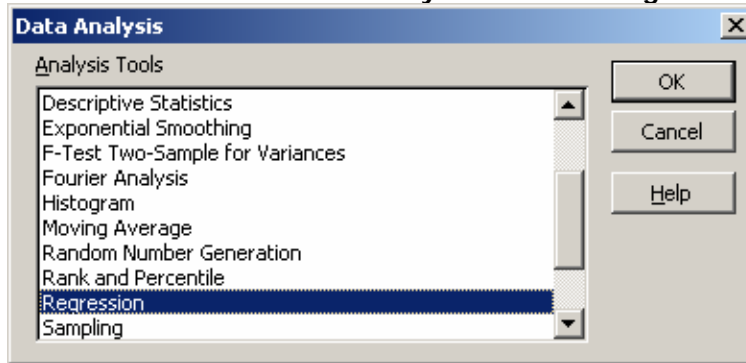
#### 4. Estimating the market model

We now have data in two workbooks: **msft.xls** and **MONTHLY.xls**. But we need the data in one worksheet. Do accomplish this, I'll go into my **msft.xls** worksheet, **Insert – Worksheet**, and then copy what I need from **MONTHLY.xls** (the 1-month total return for each month) to **msft.xls**, which will be the returns from September 2000 through August 2005 (sixty months):<sup>3</sup>

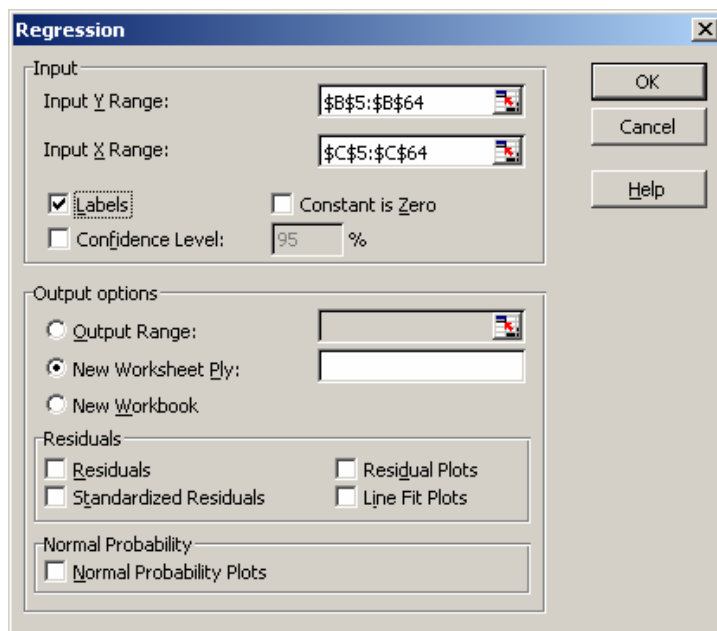
<sup>3</sup> If you are copying a value from a worksheet that was computed in that worksheet (as opposed to a value simply typed in), when you copy and then paste the value into the new worksheet, you need to specify **Edit -- Paste-special** and check the **Values** option.

Month	Return on MSFT	Return on S&P 500 Index
09/2000	-13.63%	-5.28%
10/2000	14.23%	-0.42%
11/2000	-16.69%	-7.88%
12/2000	-24.40%	0.49%
01/2001	40.71%	3.55%
02/2001	-3.36%	-9.12%

The market model is the regression of the returns on the stock against the return on the market. Therefore, I use the Microsoft Excel **Tools – Data Analysis** and select **Regression**:



I then need to specify the Y and X variables, which I do by clicking on the worksheet icon in the selection boxes and then highlighting the cells in the worksheet:



When I select OK, I end up with a regression output as a new worksheet:



The screenshot shows an Excel spreadsheet with a regression analysis summary output table. The table is titled 'SUMMARY OUTPUT' and is located in the range A1:K24. The table is divided into two main sections: 'Regression Statistics' and 'ANOVA'. The 'Regression Statistics' section includes values for Multiple R (0.577283), R Square (0.333255), Adjusted R Square (0.321558), and Standard Error (0.085455). The 'ANOVA' section includes a table with columns for 'df', 'SS', 'MS', 'F', and 'Significance F'. The 'ANOVA' table shows that the regression is significant (F=28.49001, p=1.7E-06). Below the ANOVA table is a table of coefficients, including the intercept (0.008426) and the slope coefficient (1.348861).

SUMMARY OUTPUT						
<b>Regression Statistics</b>						
Multiple R	0.577283					
R Square	0.333255					
Adjusted R Square	0.321558					
Standard Error	0.085455					
Observations	59					
<b>ANOVA</b>						
	df	SS	MS	F	Significance F	
Regression	1	0.208052	0.208052	28.49001	1.7E-06	
Residual	57	0.41625	0.007303			
Total	58	0.624303				
<b>Coefficients</b>						
	Coefficient	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.008426	0.011126	0.757359	0.451955	-0.01385	0.030705
	-0.05279	1.348861	0.252709	5.337604	1.7E-06	0.84282
					1.654902	0.84282
					1.654902	1.654902

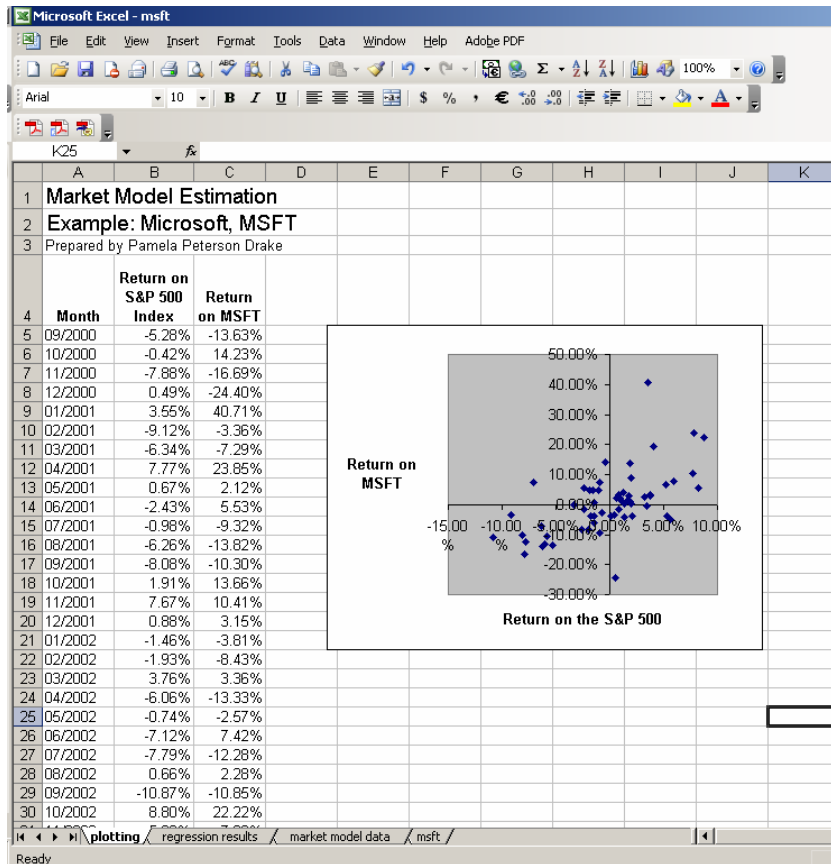
The slope coefficient, beta, is 1.348860788. Rounding to three decimal places, the equation is

$$r_{it} = 0.008 + 1.349 r_{mt}$$

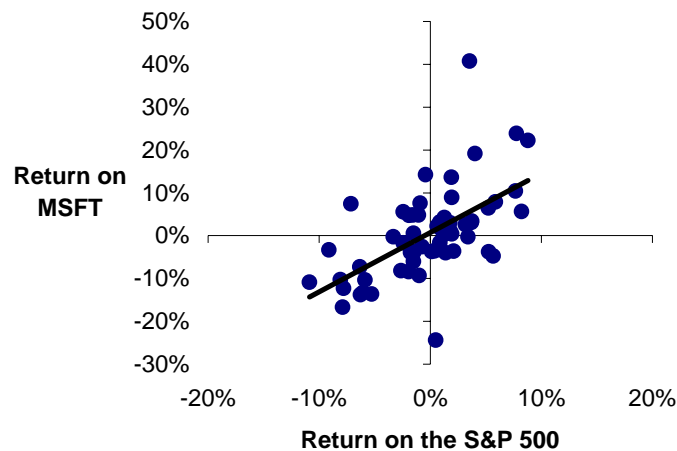
We can see this relationship by graphing the returns. To prepare for the charting, I created a new worksheet by copying the market model data worksheet [**Edit – Move or Copy Sheet – Create a copy**] and then reordered the return columns so the returns on the market (the X axis) are listed first and then the returns on MSFT (Y-Axis). Then

- Highlight the data (the cells B5:c64)
- Insert – Chart -- XY (Scatter)

I placed the chart on the same worksheet as the plotting data (sheet named **plotting**). With only specifying the X and Y titles and removing the legend (which is meaningless in this type of chart), I have the following:



which is not very easy to interpret. Fixing up the graph (by double-clicking what I want to fix the formatting on and then specifying it to my preferences, I end up with the following graph, including the trendline:



## 5. Determining the growth in value

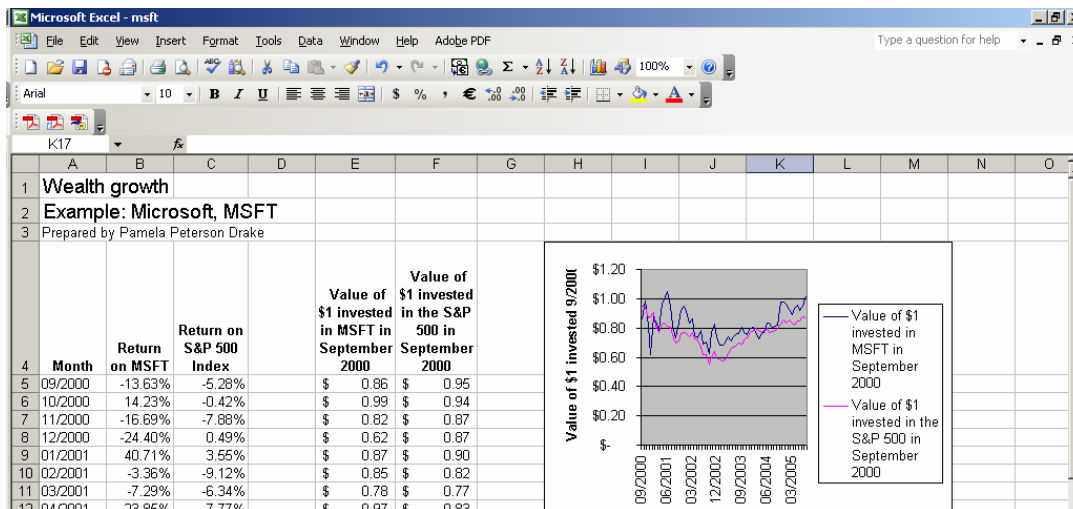
We have captured the relation between Microsoft's stock returns and those of the S&P 500 using regression, arriving at a security beta of 1.35. Another way of comparing the two investments is by

looking at wealth changes from each investment. To do this, we use the returns that we have already calculated and then use compounding to look at the growth in value over this same period.

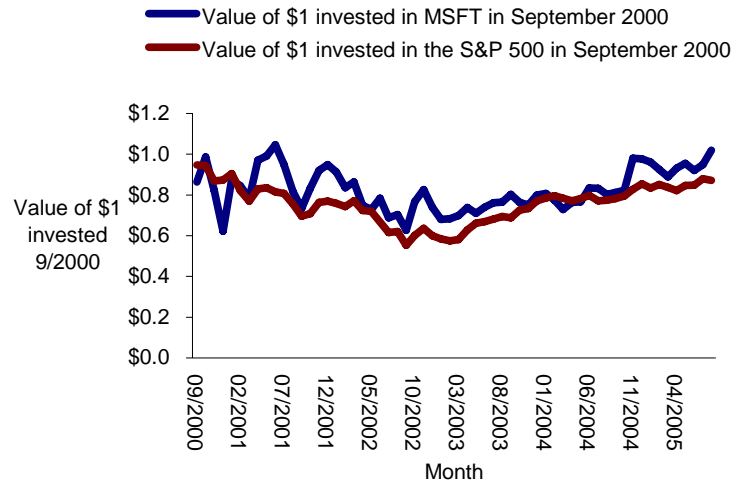
First, we need to create another worksheet, so we will again **Edit – Move or copy worksheet – Create a copy** from our **market model data worksheet** to create the new worksheet we'll call **wealth**. We will calculate the value of \$1 invested at the beginning of September 2000 in each investment, MSFT and the S&P 500. Starting with the basic worksheet and entering the compounded value calculation. For the month of September, 2000, the ending wealth is \$1 multiplied by the return for the month; for the MSFT investment, the entry into cell E5 is:  $1 * (1 + B5)$  and for the S&P 500 the entry into cell F5 is  $1 * (1 + C5)$ . For the next month, value of \$1 invested is the value in E5 multiplied by 1 plus the return in B6, and so on:

Month	Return on MSFT	Return on S&P 500 Index	Value of \$1 invested in MSFT in September 2000	Value of \$1 invested in the S&P 500 in September 2000
09/2000	-13.63%	-5.28%	\$ 0.86	\$ 0.95
10/2000	14.23%	-0.42%	$=E5*(1+b6)$	
11/2000	-16.69%	-7.88%		
12/2000	-24.40%	0.49%		
01/2001	40.71%	3.55%		
02/2001	-3.36%	-9.12%		
03/2001	-7.29%	-6.34%		
04/2001	23.85%	7.77%		

Once we have these values computed, we can graph these values using a simple line graph over time. Using the default settings for this graphing, we end up with:



But after working with this graph a bit, we can produce:



From looking at the worksheet, we conclude that if we invested \$1 in Microsoft in September 2000, we will now have \$1.02 of value. If we had invested \$1 in the S&P 500, we would have \$0.87 at the end of August 2005.

You can find the worksheet that resulted from this effort [here](#).