Corporate Finance, Course Project

Daniel Watrous

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Table of Contents

Analysis of Microsoft & Google
Microsoft vs. Google - executive compensation

The course project for Corporate Finance this session involves an analysis of two competing companies, at least one of which is on the Dow. Sources suggested for information include http://finance.yahoo.com, http://www.morningstar.com and http://www.sec.gov/. Additional insights may be available in the Wall Street Journal.

Choice of Microsoft and Google

The first question involves a comparison of executive compensation between the two companies chosen. Since I own a software business, I chose Microsoft (MSFT) and Google (GOOG) as competing companies for my evaluation. In the software space, these two companies also represent very different approaches to software design, development and consumer consumption of the end result.

Business Models

Before I jump in to my analysis, it might be worth mentioning that, while both are software companies, they follow different business models. Microsoft has been more of a traditional software company, selling software as a product. That includes packaging, distribution, wholesale, OEM and other supply chain concerns. Google has been a software as a service (SaaS) company from the beginning. Delivery of their products has been almost exclusively online.

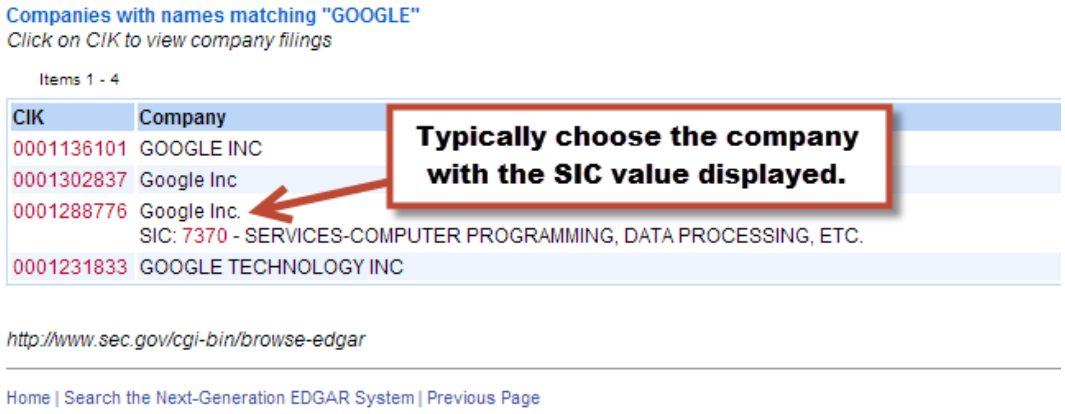
Both companies have deviated from their roots in recent years. For example, Microsoft is attempting to move into the cloud and services space with offerings like Bing, Azure and Office Online. Meanwhile, Google has been moving into a product space with their Android devices and Chromebooks. Google's purchase of Motorola is further evidence of their interest in the product space.

Compensation Analysis

The professor suggested that the 10-k filing would be a good place to get information for this project. Unfortunately, the 10-k filing section for Executive Compensation only made a reference to a Proxy document. I did a little more digging and discovered that I could find the Proxy statement using these steps:

- Go to http://www.sec.gov/
- In the main search type the company name (ticker symbol doesn't work). Also make sure the option next to search has "company filings" selected.

- Click the link under the “CIK” column for the company you want. Multiple results will come up. In my experience, you want the result with the SIC value in the description, *as shown below.*
- In the “filter results” panel near the top, type “DEF” into the “Filter Type” box
- Results are sorted by filing date by default. Choose the top result to get the latest filing.



In some cases, there are a lot of proxy statements. These may include items as trivial as announcements or voting details. You may need to hunt around a bit to find the right one. Dates also seem to vary significantly from one company to another. I’m not sure how frequently these are updated.

Components of Executive Compensation

In the case of Microsoft and Google, the executive compensation is broken down into various components. The two primary components common to both companies are

- Pay based on performance
- Other or fixed pay

Who gets Executive Compensation

Each company names a handful of individuals in the executive pay section. Based on other compensation strategies at the company, including those set by the compensation committees, there doesn’t appear to be a significant deviation in terms of payment structures. The additional scrutiny seems to be justified by the magnitude of the compensation as compared with other employees.

- Microsoft Executives

- Google Executives

- Steven A. Ballmer, our Chief Executive Officer (and our principal executive officer)
- Peter S. Klein, our Chief Financial Officer (and our principal financial officer)
- Kurt D. DelBene, our President, Microsoft Office Division
- Steven J. Sinofsky, our President Windows and Windows Live Division
- B. Kevin Turner, our Chief Operating Officer

- Larry Page Chief Executive Officer (CEO)
- Sergey Brin Co-Founder
- Eric E. Schmidt Executive Chairman of the Board of Directors (Executive Chairman)
- Patrick Pichette Senior Vice President and Chief Financial Officer (CFO)
- Nikesh Arora Senior Vice President and Chief Business Officer
- David C. Drummond Senior Vice President, Corporate Development, Chief Legal Officer, and Secretary

Compensation philosophies and rhetoric

There are some interesting differences between the two companies in terms of their compensation philosophy. For example, the first information Google includes is a summary explaining that executive compensation and employee compensation are governed by the same policies. There is a big focus on the health and well being of the employee and his family. Google executives receive a nominal fixed pay indicating that the majority of their wealth originates in the stock they own in the company. This quote also stood out to me about the lack of so called “golden parachutes” at Google:

> None of our named executive officers have any type of employment agreement or severance arrangement with us.

On the other hand, Microsoft jumps right in to numbers, many of which indicate performance, both

company wide and by segment. Microsoft's compensation philosophy centers on the individual executive and is designed to motivate him to reduce overall risk.

It would be interesting to contrast the culture of risk to innovation of these two companies.

Both companies also review the compensation practices and levels of peer companies. By doing this it seems they want to appear to be normalizing compensation across the C tier of executives in an industry. Whether that happens with such a small sample and broad variance is another matter for debate. Each company includes the other in it's peer review.

Actual Compensation for 2012

Actual compensation values came from MorningStar for Google and Microsoft.

- Microsoft Executives

- Google Executives

Name/Title	2012
Key Executive Compensation	33,601,092
Steven A. Ballmer/Chief Executive Officer and Director	1,318,128
Peter Klein/Chief Financial Officer	5,108,836
B. Kevin Turner/Chief Operating Officer	10,683,671
Steven Sinofsky/President Windows and Windows Live Division	8,583,732
Kurt Delbene/President Microsoft Office Division	7,906,725

Name/Title	2012
Key Executive Compensation	128,817,458
Larry Page/Chief Executive Officer	1
Patrick Pichette/Senior Vice President and Chief Financial Officer	38,741,106
Nikesh Arora/Senior Vice President and Chief Business Officer	51,145,868
David C. Drummond/Senior Vice President, Corporate Development, Chief Legal Officer and Secretary	31,301,858
Eric E. Schmidt/Executive Chairman of the Board	7,628,624

Name/Title	2012
of Directors	
Sergey Brin/Co-Founder	1

Despite the fact that Larry and Sergey took only one dollar in actual compensation, the total executive compensation at Google was about four times greater than at Microsoft. That may also be a reflection of the performance for each company.

Agency Problems

It's interesting that in both cases, the operations officer or business development officer is the highest paid. It'a also interesting that the CEO is among the lowest paid. In the case of Google, they have attempted to perfectly align with shareholder interests

> Larry and Sergey have voluntarily elected to receive only nominal cash compensation. As significant stockholders, a large portion of their personal wealth is tied directly to Google's stock price performance, which provides direct alignment of their interests with stockholder interests.

At Microsoft, the higher compensation for the CEO, than his counterpart at Google, is somewhat insignificant compared to the value of the stock he owns in Microsoft. As a result, he seems about as well aligned as his counterparts at Google with the shareholder interest.

When it comes to perks, the Google culture is much more generous than Microsoft. It could be seen that free meals, shuttle buses and 20% time are extravagances and would conflict with the principle's ideas about expenditure of funds. However, when the culture at Google also innovates at the level it has for so many years, it's difficult to argue against their strategy and policy for hiring and retaining the best talent in the world.

Peer groups

It's interesting that both of these companies made it in to a peer group when compensation policies were put in place, yet the executive compensation varies significantly. Whether it's the founders of Google taking $1, or the nearly $50 million paid to the Chief Business Officer at

Google, these companies clearly have a different approach to executive compensation.

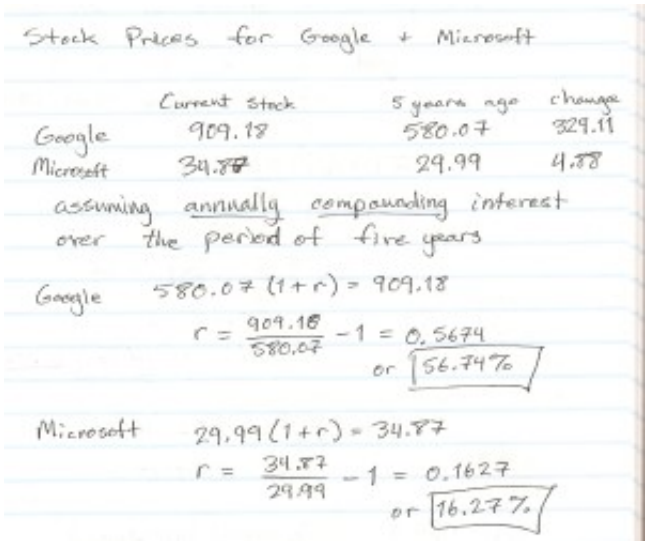
Five year historical compound rate for MSFT & GOOG

A review of the stock price and growth rate for Microsoft and Google over the past five years shows that they track very closely in general. However, the last year shows a marked deviation from this tracking as Microsoft stayed mainly flat and Google demonstrated strong growth.

Using the data from the source above, we can project the anticipated stock price in 2018 if the growth rate remains constant over that time.

Company	Stock May 2008	Current Stock	Effective Rate	Stock May 2018
Google	580.07	909.18	56.74%	1425.05
Microsoft	29.99	34.87	16.27%	40.54

Here are the calculations used to arrive at the effective rates shown above (click to enlarge).



Alternate approach

In the example above, I calculate the effective rate based on the delta between May, 2008 and May, 2013. Another approach would be to start with the stock price five years ago and use Excel to find the annual rate (assuming annually compounding interest). In this case we get the following details.

Company	Annual Rate	-5Y	Today	+5Y
Google	9.40419%	580.07	909.18	1,425.02
Microsoft	3.0615%	29.99	34.87	40.55

The answers come out the more or less the same, but it helps to know what the annual interest rate is, not just the effective rate over the five year window.

Bond ratings for Microsoft and Google

According to the morningstar website, both Microsoft and Google have high bond ratings, with Microsoft slightly higher.

Value	Microsoft	Google
Morningstar Credit Rating	AAA	AA
Amt Outstanding	$16.9 Bil	$3.0 Bil
Debt/Assets	10.58%	5.31%

Based on the ratings, the bond market appears to favor more experienced borrowers, since from a debt load perspective, Google has better standing. Google's entire bond issue is encompassed in just three bonds with the longest maturation in 2021. It's also interesting that all three mature on May 19.

Duration

Duration is calculated the weighted average of the present values of all future cash flows. It can be represented by the following equation (ref), where PV is the present value.

$$Duration = \frac{1 \times PV(C_1)}{PV} \frac{2 \times PV(C_2)}{PV} \frac{3 \times PV(C_3)}{PV} \cdots \frac{T \times PV(C_T)}{PV}$$

Calculations like this are easily done in Excel. For this exercise I chose bonds that mature in 2016 and payout semi-annually for both Google and Microsoft.

Microsoft bond duration

Coupn				2.500%			
Par				$1,000.00			
Maturity				2/8/2016			
Frequency				semi-annual			
Discount rate				2.38%			
Coupon	1	2	3	4	5	6	Total
Date	8/8/2013	2/8/2014	8/8/2014	2/8/2015	8/8/2015	2/8/2016	
Payment	$25.00	$25.00	$25.00	$25.00	$25.00	$1,025.00	
PV(Ct)	$24.42	$23.85	$23.30	$22.76	$22.23	$890.09	$1,006.64
PV(Ct)/PV	0.0243	0.0237	0.0231	0.0226	0.0221	0.8842	
Duration	0.0121	0.0237	0.0347	0.0452	0.0552	2.6527	2.8236

Google bond duration

Coupon	2.125%
Par	$1,000.00

Coupon				2.125%			
Maturity				5/19/2016			
Frequency				semi-annual			
Discount rate				2.04%			
Coupon	1	2	3	4	5	6	Total
Coupon Date	11/19/2013	5/19/2014	11/19/2014	5/19/2015	11/19/2015	5/19/2016	
Payment	$21.25	$21.25	$21.25	$21.25	$21.25	$1,021.25	
PV(Ct)	$20.83	$20.41	$20.00	$19.60	$19.21	$904.71	$1,004.75
PV(Ct)/PV	0.0207	0.0203	0.0199	0.0195	0.0191	0.9004	
Duration	0.0104	0.0203	0.0299	0.0390	0.0478	2.7013	2.8486

Based on the data above, the duration for the Google bond is higher than for the Microsoft bond, however the difference is slight. You can download the original spreadsheet here: corporate-finance-project-bond-duration

DuPont Analysis for Microsoft and Google

Return on Assets (ROA) and Return on Equity (ROE) are two standard measures used to evaluate the health and future prospects of a company. This type of analysis was introduced in the 1920s, being employed by the DuPont corporation. It algebraically splits ROE into three different measures

- Profit margin
- Turnover
- Leverage

This is accomplished by starting with the ratio of net income to equity

$$ROE = \frac{NetIncome}{Equity}$$

Then multiplying by assets and sales, like this

$$ROE = \frac{NetIncome}{Equity} \times \frac{Assets}{Assets} \times \frac{Sales}{Sales}$$

Some shuffling and we can get the three items listed above

$$ROE = \frac{NetIncome}{Sales} \times \frac{Sales}{Assets} \times \frac{Assets}{Equity}$$

Variation

Some authors prefer to normalize out taxes and interest in the ROA and ROE equations, so that in place of net income they instead use after-tax interest plus net income.

$$ROE = \frac{After-taxinterestNetIncome}{Equity}$$

DuPont Analysis for Google

Assets	96,692.00
Equity	75,473.00
Net income	11,193.00
Interest Expense	85.00
Tax rate	16.58%
After-tax interest	70.91
After-tax interest + Net Income	11,263.91
ROA	11.6%
ROE	14.9%

DuPont	
Sales	53,499
profit margin	21.1%
turnover	55.3%
leverage	128.1%

DuPont Analysis for Microsoft

Assets	134,105.00
Equity	76,688.00
Net income	16,406.00
Interest Expense	405.00
Tax rate	22.85%
After-tax interest	312.46
After-tax interest + Net Income	16,718.46
ROA	12.5%
ROE	21.8%
DuPont	
Sales	76,012.00
profit margin	22.0%
turnover	56.7%
leverage	174.9%

Observations

Profit margin and turnover are roughly the same for both companies. However, Microsofts total Assets are greater than Google’s by about 40%. That significantly increases Microsoft’s leverage position. The higher ratio for leverage may shed some light on my previous analysis showing that Microsoft has a higher bond rating and a higher debt load to bonds.

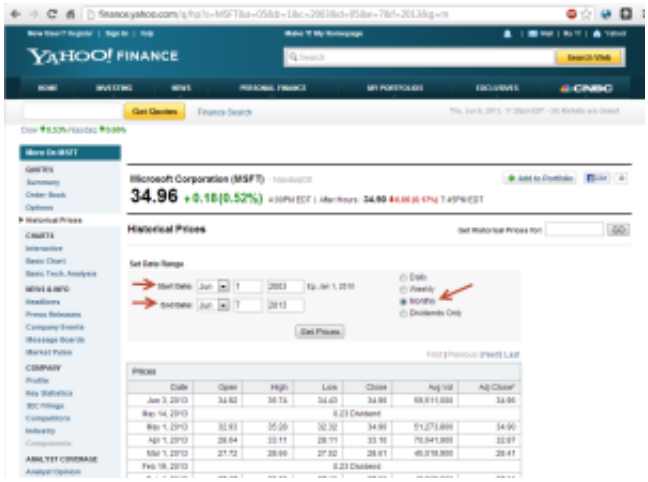
Beta analysis by period for MSFT & GOOG

A review of the monthly rates of return for Google and Microsoft for two successive five year periods allow me to calculate the beta, ß, for each period. Recall that ß is calculated under the Capital Asset Pricing Model (CAPM) as follows:

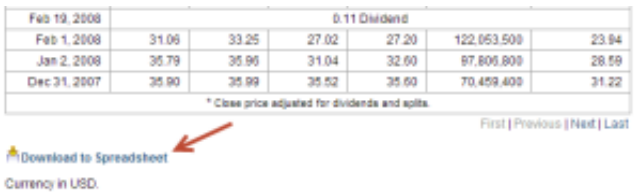
$$r - r_f = \beta(r_m - r_f)$$

Getting the data

It was easy to download the data on yahoo finance. Once there, I was able to set the time period of interest and frequency as shown here (click to enlarge).



Once you have the set of data that interests you, scroll down to the bottom and download the data, as shown here.



Note that in order to calculate the ß in Excel, you need the market comparison data as well. In order to get that I change my search to ^DJI with the same period and frequency as shown above. However, I noticed that they don't provide a download option for that data. Since the data is shown in tabular format, you can copy and paste it directly in to Excel. Don't forget to click Next until you have grabbed all the necessary pages.

Google data only went back to 2004, so the analysis for the second five year period for Google has fewer data points than the same analysis for Microsoft.

Setup in Excel

I setup a workbook with three sheets, one for MSFT, one for GOOG and the last for DJI, or market data. Since I wanted to get two success five year periods, I added an empty line at the five year mark. I hid all but the date, closing price and adjusted closing price on each sheet.

Adjusted closing price

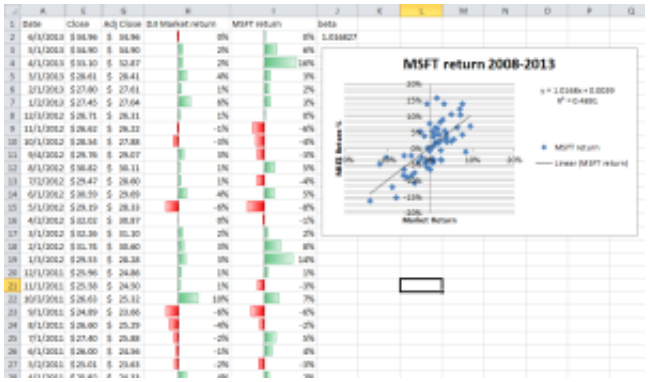
In order to get the most accurate historical view of return rate, I used the adjusted closing price to calculate my monthly return.

Formatting

I then display the market data side by side with the stock specific return rate on each page. Excel conditional formatting made it easy to show movement graphically. That graphical view is a good sanity check while reviewing the formulas.

Scatter plot

Finally I inserted a scatter plot and used Excel's built in linear mapping to show the ß line and calculate R-squared. Note that I also calculated ß using the SLOPE formula and provided the stock return as *y* and the market return as the independent variable *x*. This obviously agrees with the slope intercept form shown on the scatter plot.



ß stability and estimates

Here's a summary of the data resulting from the analysis described above.

Time period	Company	Beta	R^2
2008-2013	MSFT	1.0168	0.4891
2003-2008	MSFT	0.8911	0.1381
2008-2013	GOOG	0.9526	0.3101
2003-2008	GOOG	1.2223	0.0564

As can be seen in the data, the ß was not perfectly stable between periods. However, that doesn't mean it was drastically different. The difference is more pronounced for Google than for Microsoft.

Example

Let's look at a quick example. Given a market premium of 7%, a risk free rate of 4% and using the beta from each five year period, we end up with a 2% difference between rates that should be used (see CAPM equation for ß above).

Beta period	Rate r
rate ß 2008	12.556%
rate ß 2013	10.668%

The difference in *r* becomes more drastic as the market premium increases, but rises linearly with changes to the risk free rate.

Conclusion

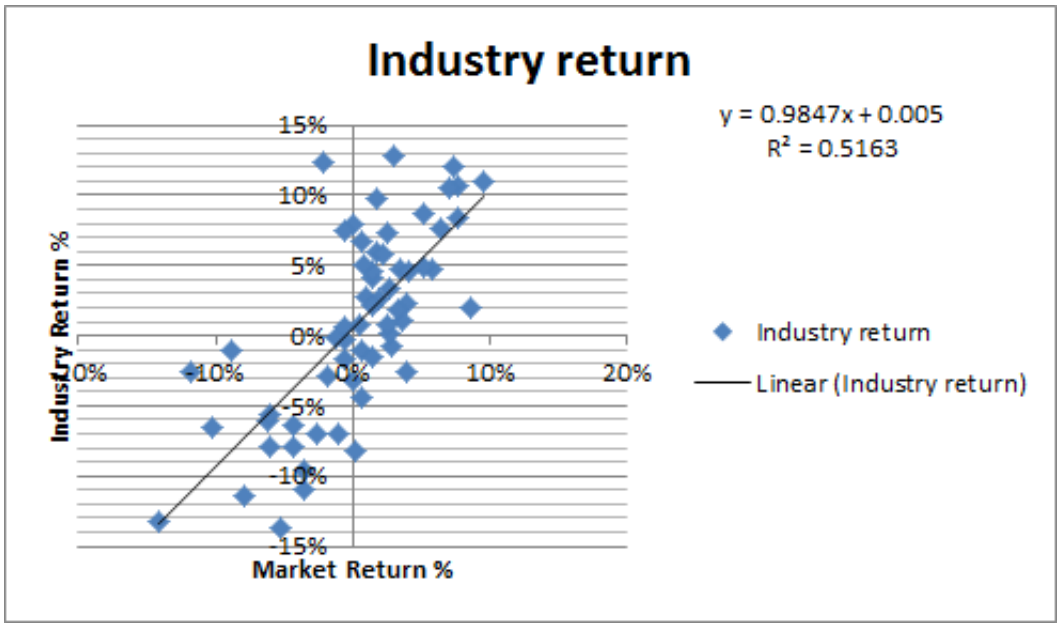
While history provides a good data point and may be used to project into the future, there are risks when using old data. When it comes to risk, there are downsides to both overestimating and underestimating. When precision like that can make the difference between dropping or executing a project, it pays to include other analysis beyond just historical review.

Resources

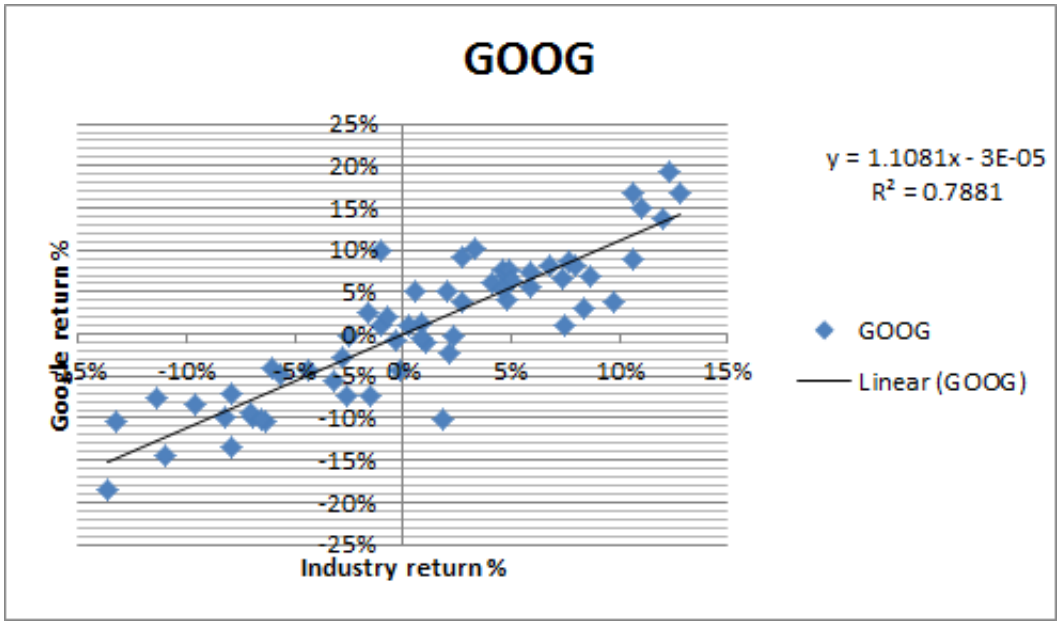
Download the beta and CAPM spreadsheet to see how I put it together.

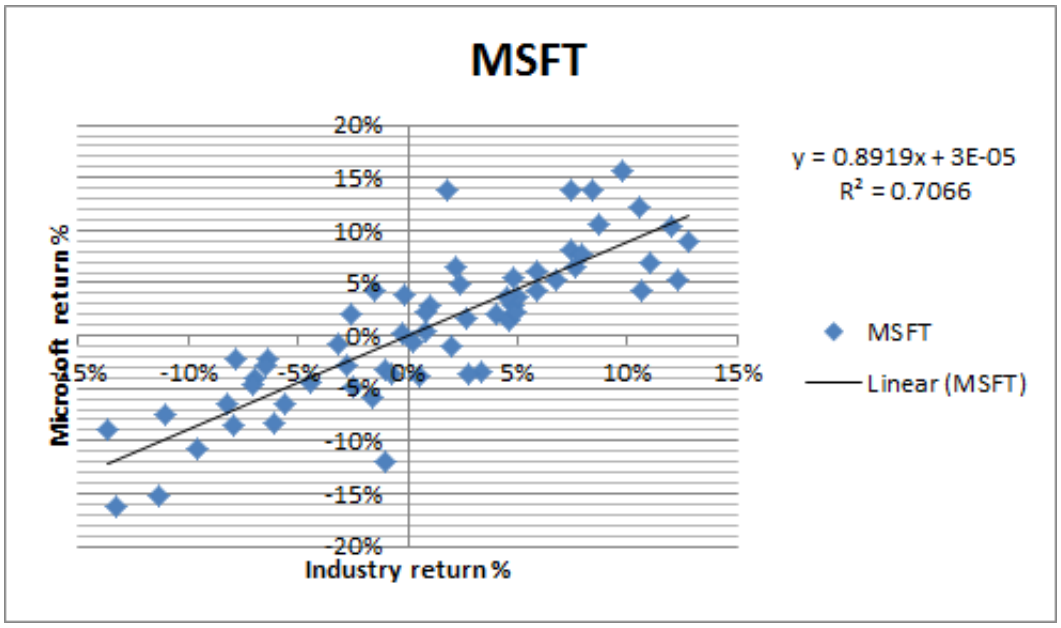
Beta analysis for Software Industry

Previously I calculated the beta (ß) and r-squared (R^2) for Google and Microsoft relative to the market (DJIA). There are cases where it's more useful to know how a company does relative to its peers or as part of a portfolio. Using the monthly values from that previous work, I compiled and 'industry' or 'portfolio' average of returns. That provided me with a ß and R^2 for the industry.



As shown above, the software industry (my sample of GOOG and MSFT) has a ß=0.9847 and an R^2=0.5163 relative to the market (DJIA). While that's interesting, it's also worth observing the ß and R^2 of each company relative to the industry.





This table summarizes the observations in the plots shown above

Company	Beta-market	Beta-industry	R^2-market	R^2-industry
MSFT	1.0168	0.8919	0.4891	0.7066
GOOG	0.9526	1.1081	0.3101	0.7881

Some observations are less useful due to the small sample of only two companies. For example, the ß values are proportionally distant from the industry. This is because the industry is made up of a sample of those two companies only. The R^2 for the industry are very similar and both show

better fit to data than the industry comparison.

CAPM

Recall that the cost of equity, r_e, can be obtained using the Capital Asset Pricing Model as follows:

$$r_e = r_f \beta (r_m - r_f)$$

Using this and the data above, we can calculate the average cost of equity for the industry as represented by Google and Microsoft. We'll use r_f=0.1 and r_m=6.2. That gives us:

$$r_e = 0.10.9847(6.2 - 0.1)$$

$$r_e = 6.1067\%$$

With the current economic state, the risk free rate has little impact on the equity rate. The beta for the industry relative to the market is also very tight, which reduces risk with respect to the market.

Financing Proportions for Google & Microsoft

It’s often useful to understand how a company makes financing decisions, and where funds for investment originate. While financing decisions may not be a good indicator of likely growth or profit, they may be an effective indicator of company health.

One way to segment this analysis is

- Internal funds
- Net equity issues
- Net borrowing

Gather the data

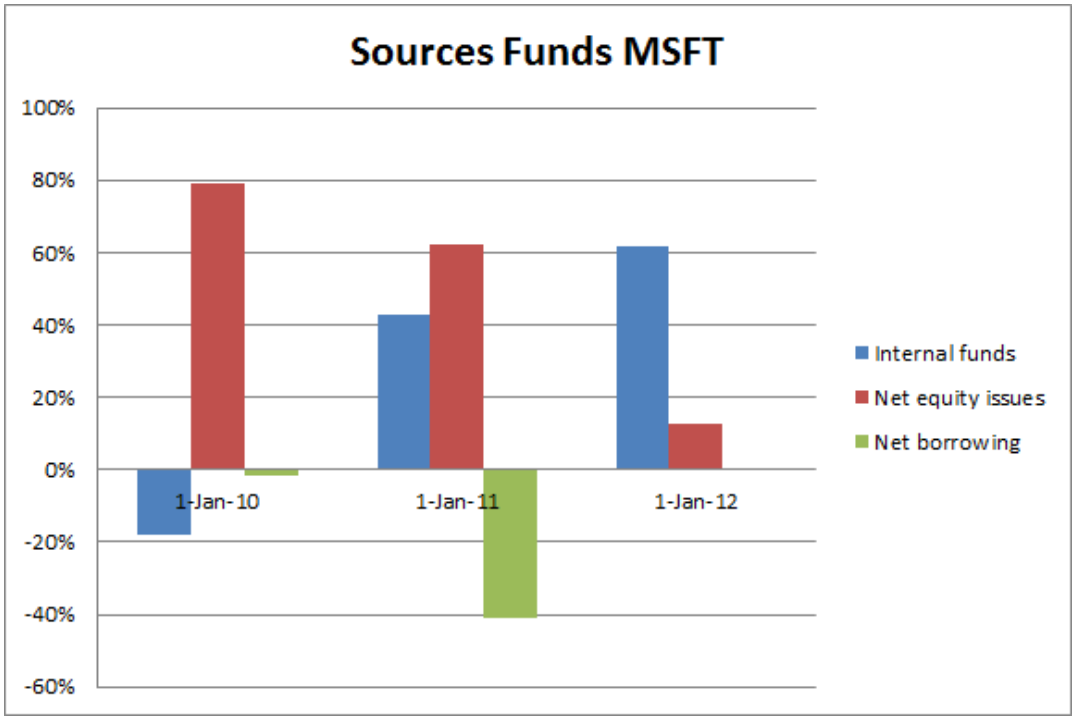
The data for this type of analysis is available on http://finance.yahoo.com. After searching for your desired company, click “Cash Flow” under “Financials”. Using that I found the cash flow details for Google and Microsoft.

Net borrowing is listed directly. Net equity issues are listed as “Sale Purchase of Stock”. In order to get the amount of investment that came from internal funds (plowback), I take the “Total Cash Flows From Investing Activities” and subtract away Dividends, Sale Purchase of Stock and Net Borrowings. I can then get the proportions by dividing each of these by the total investing amount.

I used the standard three years shown on the cash flow statement for this analysis.

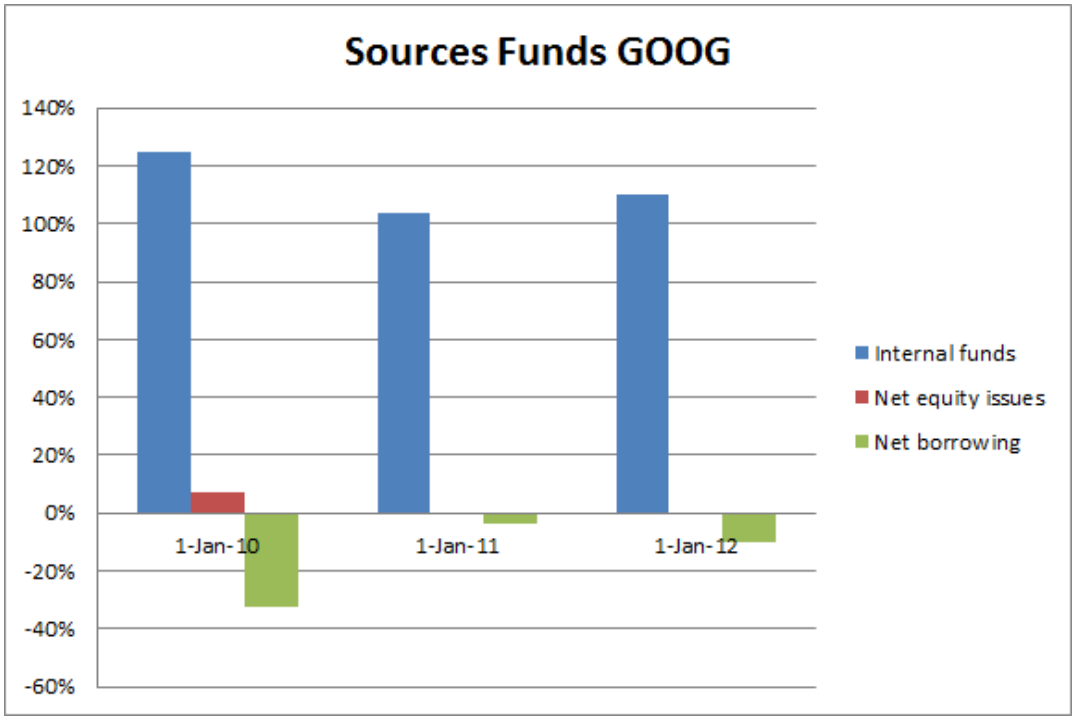
Microsoft funding sources

Period Ending	29-Jun-10	29-Jun-11	29-Jun-12
Internal funds	-18%	43%	62%
Net equity issues	79%	62%	13%
Net borrowing	-2%	-41%	0%



Google funding sources

Period Ending	30-Dec-10	30-Dec-11	30-Dec-12
Internal funds	125%	104%	110%
Net equity issues	8%	0%	0%
Net borrowing	-32%	-4%	-10%



Review

Based on the last three years it is observed that Microsoft much more frequently resorts to issuing stock and borrowing than Google. Also, the majority of the investment made by Google is from internal funds, even to the extent of investing savings from previous periods. They even purchased back some stock in one period to achieve a net positive equity issue.

Here's the original spreadsheet if you want to see how I arrived at the numbers above: Sources of funds for Google and Microsoft.

Value of Call Options for Microsoft and Google

Options are a device that allows an investor to hedge potential losses for a cost. A **call option** gives the purchaser the right, but not the obligation, to buy a stock at a given price. A **put option** gives the purchaser the right, but not the obligation, to sell a stock at a given price. The counter party to the agreement has the obligation to either sell or buy (call and put) at the agreed price if the option is exercised.

The exercise date is always in the future, and the further an option is in the future, the more it will cost. How much more depends on the exercise price, interest rates and the volatility of the stock. To give you an idea, here's some data from Microsoft and Google showing the call option prices going four months into the future. I obtained this data from Yahoo! Finance for Microsoft and Google.

To make monthly analysis more relevant, I've included only the call options that have been traded for a given strike price in each of the four months analyzed. I also collapsed recent trade prices for options with the same strike price in some cases.

Call Option Pricing

Microsoft

The stock price at the time these options values were captured was **$34.54**.

_	July, 2013	August, 2013	September, 2013	October, 2013	_
Strike	Last	Last	Last	Last	stdev (annual)
$29.00	$5.69	$4.50	$5.35	$5.77	1.743
$30.00	$4.81	$4.75	$4.80	$4.85	0.123
$31.00	$3.66	$3.85	$3.80	$4.09	0.537
$32.00	$2.77	$2.88	$2.97	$3.22	0.575
$33.00	$1.88	$2.20	$2.32	$2.55	0.837
$34.00	$0.77	$1.41	$1.66	$1.85	1.413
$35.00	$0.16	$0.86	$1.13	$1.33	1.533
$36.00	$0.25	$0.50	$0.70	$0.99	0.939
$37.00	$0.09	$0.24	$0.43	$0.63	0.702
$38.00	$0.03	$0.12	$0.28	$0.43	0.530
$39.00	$0.01	$0.03	$0.15	$0.27	0.361
$40.00	$0.02	$0.04	$0.08	$0.16	0.186
$41.00	$0.01	$0.02	$0.05	$0.11	0.135

Google

The stock price at the time these options values were captured was **$880.37**.

_	July, 2013	August, 2013	September, 2013	October, 2013	_
Strike	Last	Last	Last	Last	stdev (annual)
$700.00	$180.87	$179.00	$216.00	$186.00	51.831
$750.00	$135.10	$144.67	$127.40	$151.80	32.104
$770.00	$103.50	$113.90	$104.20	$126.00	31.591
$780.00	$102.73	$105.50	$122.00	$108.20	25.675
$800.00	$73.12	$87.90	$91.80	$94.40	28.519
$805.00	$81.22	$81.20	$114.04	$91.52	46.438
$810.00	$69.64	$74.90	$80.90	$109.00	52.622
$820.00	$59.15	$71.77	$91.20	$94.50	50.059
$825.00	$58.00	$59.00	$96.80	$74.90	54.452
$830.00	$52.00	$56.80	$65.00	$80.90	38.027
$835.00	$49.60	$54.10	$87.60	$83.40	58.769
$840.00	$45.90	$56.63	$61.00	$71.01	31.222
$845.00	$41.16	$53.10	$81.10	$60.53	50.314
$850.00	$39.80	$42.50	$58.00	$64.70	36.089
$860.00	$29.94	$43.37	$46.50	$52.90	29.026
$865.00	$33.60	$40.80	$48.90	$49.55	22.632
$870.00	$30.28	$37.00	$41.90	$47.40	21.835
$875.00	$28.80	$34.70	$39.60	$48.10	24.491
$880.00	$27.90	$32.44	$37.10	$45.90	23.069
$885.00	$24.20	$29.30	$36.20	$43.50	25.175
$890.00	$18.00	$24.00	$34.00	$41.20	30.959
$895.00	$19.60	$25.40	$26.30	$46.80	35.680
$900.00	$18.00	$22.05	$29.20	$35.60	23.355
$905.00	$17.93	$20.00	$26.20	$32.20	19.357
$910.00	$16.16	$16.50	$25.80	$33.70	25.181
$915.00	$12.70	$16.45	$23.20	$28.50	21.086
$920.00	$11.12	$16.39	$22.55	$27.60	21.549
$925.00	$9.10	$12.90	$19.70	$29.00	26.193
$930.00	$8.80	$11.20	$19.40	$31.80	31.135
$935.00	$7.38	$10.90	$13.60	$22.20	18.967
$940.00	$6.41	$11.19	$16.80	$23.20	21.726
$945.00	$5.40	$8.70	$15.50	$21.60	21.654
$950.00	$5.10	$7.20	$14.10	$19.40	19.643
$955.00	$4.00	$7.80	$14.20	$16.40	17.146
$960.00	$6.50	$5.61	$10.10	$21.90	22.511
$965.00	$5.80	$5.00	$17.80	$21.50	25.113
$970.00	$2.85	$4.90	$8.30	$16.90	18.591

_	July, 2013	August, 2013	September, 2013	October, 2013	_
$975.00	$1.60	$4.20	$7.50	$12.70	14.360
$980.00	$1.93	$4.40	$12.07	$11.80	15.492
$985.00	$1.25	$6.30	$6.10	$12.20	13.444
$990.00	$1.99	$4.10	$10.70	$10.00	12.942
$995.00	$0.85	$6.80	$7.40	$10.20	11.795
$1,000.00	$2.25	$2.80	$4.20	$8.40	8.347
$1,010.00	$0.80	$4.90	$6.30	$7.50	8.751
$1,020.00	$0.35	$1.15	$6.20	$7.10	10.325
$1,030.00	$0.25	$3.10	$2.51	$7.20	8.690
$1,040.00	$0.20	$0.97	$1.90	$4.80	6.037
$1,050.00	$0.15	$0.58	$1.55	$4.30	5.593
$1,060.00	$0.29	$0.55	$3.50	$3.70	5.523
$1,070.00	$0.10	$0.60	$2.25	$2.85	3.929
$1,080.00	$0.15	$0.35	$2.60	$2.75	4.211
$1,100.00	$0.30	$0.40	$0.60	$2.00	2.380

Black-Scholes formula

The Black Scholes formula is a sophisticated statistical mechanism that can help project options prices. I can be [written simply as](#)

$$Valueofcalloption = [delta \times shareprice] - [bankloan]$$

Where

$$delta = N(d_1),$$

$$shareprice = P,$$

$$bankloan = N(d_2) \times PV(EX),$$

and,

$$d_1 = \frac{log[\frac{P}{PV(EX)}]}{\sigma\sqrt{t}} \frac{\sigma\sqrt{t}}{2},$$

$$d_2 = d_1 - \sigma\sqrt{t},$$

N(d) is the cumulative normal probability density function, EX the exercise price, t the number of periods to exercise date, P the price of stock today and σ the standard deviation.

Black-Scholes values

The authors of the textbook have provided some Excel based resources to help explore these devices. For standard deviation I'll use the values above for the strike price nearest the stock price at the time I captured the data. In this case it was 34.54 and 880.37 for Microsoft and Google Respectively. That same valuation will be used for the standard deviation. Due to the super low interest rates right now, I'll use an interest rate of 1%.

Microsoft calculated call option price

The expected call value option for Microsoft is $0.16. The low value is due in part to the low standard deviation (low volatility). Here you can see how the calculations shaped up:

BLACK-SCHOLES OPTION VALUES

INPUTS:	
Stock price (P)	34.54
Exercise price (EX)	35
Interest rate, percent (r)	1
Is this rate compounded annually (A) or continuously (C)?	a
Maturity in years (t)	1
Annual standard deviation, percent (σ)	1.533
Equivalent continuously compounded rate, percent	1.00
INTERMEDIATE CALCULATIONS:	
PV(EX)	34.6535
d1 = log[P/PV(EX)]/σ√t + σ√t/2	-0.2063
d2 = d1 - σ√t	-0.2216
N(d1) = delta	0.4183
N(d2)	0.4123
OPTION VALUES:	
Call value = N(d1) x P - N(d2) x PV(EX)	0.16
Put value = Call value + PV(EX) - S	0.27

As you can see in the table of data above, the current call options for Microsoft range between $0.16 and $1.33. The Black-Scholes formula was accurate. However, it's difficult to say whether the Black-Scholes formula predicted a phenomenon that would have been naturally ocurring, or if everyone trading options today uses a Black-Scholes calculator to determine what to pay for a call option.

Google calculated call option price

Google's call option price reflects the higher standard deviation with a value of $85.05. Here are the details of that calculation:

BLACK-SCHOLES OPTION VALUES

INPUTS:	
Stock price (P)	880.37
Exercise price (EX)	880
Interest rate, percent (r)	1
Is this rate compounded annually (A) or continuously (C)?	a
Maturity in years (t)	1
Annual standard deviation, percent (σ)	23.069
Equivalent continuously compounded rate, percent	1.00
INTERMEDIATE CALCULATIONS:	
PV(EX)	871.2871
d1 = log[P/PV(EX)]/σ√t + σ√t/2	0.1603
d2 = d1 - σ√t	-0.0704
N(d1) = delta	0.5637
N(d2)	0.4719
OPTION VALUES:	
Call value = N(d1) x P - N(d2) x PV(EX)	85.05
Put value = Call value + PV(EX) - S	75.97

In this case the calculated call option value of $85.05 is much higher than the currently trading $24-$46 dollars. When I look further out there are some options trading at about a year and a half go as high as $66.10. It may seem that the calculated volatility doesn't line up with the market's current perception for Google.

Perceived Volatility

It's pretty obvious that the higher volatility for Google doesn't reflect the market's perception of volatility. In fact, rather than 23.069, a standard deviation of between 9 and 12 would produce a value more true to the currently trading prices than what is shown above.

This may also suggest that there is more risk, but that the market is choosing, for whatever reason, to look past it.

Resources

In the analysis of this data I created a python script to take a few months of call options data and

derive the unique set of data shown above. I also use this Excel spreadsheet to sort and calculate the standard deviation.