Tracking the Dow

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Plan

Lecture notes

The Stock Market

What are stocks? A stock is a share in a company, or part of a company. That is, the people who own the stock of a company are the owners of that company. If you own stock in a company you can work out what share of the company you own by dividing the number of shares you own with the number of shares there are. So if you buy 10 shares out of 1000 the company has issued, you own 1% of the company.

Get the annual report for some company – Google? – and use real figures here, for total number of shares outstanding, stock price. Maybe get two companies, one of which pays dividends.

Why might you buy stock?

Owning stock in a company gives you the right to vote on issues regarding the company, such as who is on the board of directors. Typically, the more stock you own, the more votes you have (and the more power you have to influence decisions the company makes). But this is not why most not why most everyday investors buy stock.

If you buy stock and the price goes up you can sell your stock and make a profit.

That's what most people think about these days when they think about stocks. What other reason might there be? In the good old days (whenever that was) companies were in business to make a profit. Then the board of directors would

divide some of the profits among the shareholders – these are called dividends. (Some of the profit they might keep in the company, to reinvest in new machinery and the like.)

This still happens, although much of the business of some companies is to find ways to make their stock prices grow, because ...

Why does a company sell stock?

Companies sell stock in order to raise money to improve their operations – perhaps to build new factories, or invest in research – so as to make more money later. (They also borrow money from banks for the same purposes.)[1]

What's the stock market? This is the public system in which stocks are bought and sold. Many different stocks, from a wide variety of companies, are bought and sold in the United States (and around the world) each day. This activity is an important part of the United States economy, but it is a lot of information.

What's the Dow Jones Industrial Average? This is an *index* created to measure the performance of stocks representing the major industries in the United States. It can be seen as a representation of the performance of the entire stock market, and it is a very widely quoted figure. It curently consists of 30 companies, and the Dow Jones Industrial Average is calculated using the prices of all 30 stocks. [2]

Can you buy a share of the Dow Jones Index? Not really, but you can buy shares of the companies that the Dow monitors. Does the Dow really measure the health of the economy? It is a number and we like numbers, and its easy to say that the Dow going up means the economy is going well. The problem is that anytime you want to use one number to describe a complicated phenomenon, there are bound to be inaccuracies.

On January 1, 1975 the Dow stood at $632. On January 1, 2007 it was $12474.

At `http://www.analyzeindices.com/dow-jones-history.shtml`. you can download the complete day by day history of the value of the Dow. We've extracted the values for January 1 for each year from 1975 to 2006, and put the results in the spreadsheet `http://www.cs.umb.edu/~eb/m114/lectureNotes/1129/dowjonesJan.xls`

[1] When startup companies sell stock for the first time the founders often get rich quickly – cf Google.

[2] Originally the Dow was calculated as the mean of the stock prices. Now the calculation is a bit more complicated, although it does use the sum of the 30 stock prices.

Saving versus investing

Question: Would you have been better off putting your money in a savings account or a CD (a Certificate of Deposit)? Suppose you invested $632.04 in January 1975 in the stocks tracked by the Dow. Using the information we have about the growth of the Dow over time, we see that money would grow to $10,847 today. What interest rate would you need to earn in a savings account or in a CD to match this? What will happen 5 years from now?

There is another issue here that we cannot so easily address: risk. There is a certain risk involved in investing in stocks. You may lose money (if you pick the wrong stocks, if the market goes down). If you have a savings account, there is not much risk (most accounts are insured by the federal government). On the other hand, you won't make much money. A lottery ticket is an exceedingly risky investment. The stock market has some risk, certainly not as much as the lottery. In terms of investing in stocks to save for retirement, the general wisdom is that the younger you are, the more risks you can take. That's because the stock market has historically done well over long stretches of time, and so you will have time to absorb and bounce back from any declines. As you approach retirement, it's better to opt for safer investments (bonds, for example), as you will not have much time to bounce back from a large loss.

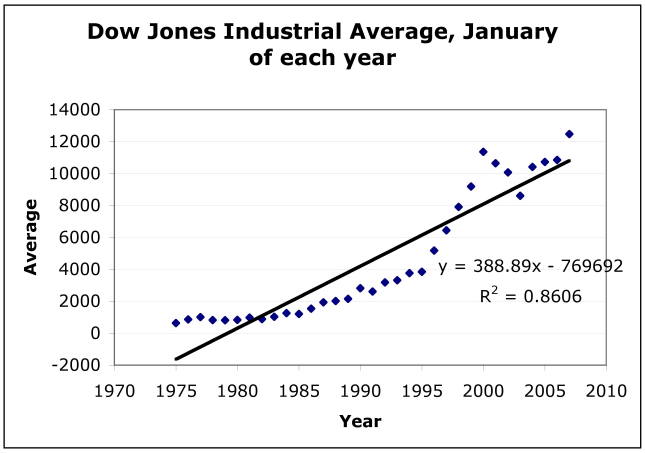
Exponential regression

Let's go back to the question of where our money would have grown more: in a savings account, or in the Dow. To answer this question, we really need to know the rate at which the Dow grew since 1975. The spreadsheet `http://www.cs.umb.edu/~eb/m114/lectureNotes/1129/dowjonesJanAnalysis.xls` shows the Dow Jones Averages along with a graph of the data. The second graph features a curve that fits the data quite well, called an exponential regression curve (Excel calls it an exponential trendline). We also graphed (in pink) a curve showing how the original $632.04 would change if we had invested it in a savings account at 10% interest. You can see that the exponential trendline and our savings curve (which is also exponential) are quite close to each other (and to the data) until about 2005, or about 30 years after the beginning time. Then the exponential regression model begins to dominate.

How did we build these curves? How well do they model the data? The process, and the interpretation, is very similar to what we did with linear trendlines. We will go through it step by step, using the `http://www.cs.umb.edu/~eb/`

`m114/lectureNotes/1129/dowjonesJan.xls` spreadsheet. You can always refer back to the dowjonesJanAnalysis spreadsheet to remind yourself of where we are going.

Open up the dowjonesJan.xls spreadsheet and graph the data using a scatter plot. From the graph we get a good picture of the behavior of the Dow since 1975. It increased consistently, in fact fairly quickly, for about 25 years. Then it declined but seems to have increased again. Let's start very simply and put a linear trendline onto this data. Remember that to do this you click on any of the points on the graph, then go to Chart and click on "Add Trendline". Then click on the Options tab and click on appropriate boxes to show the equation and the R^2 value. Here is the picture:



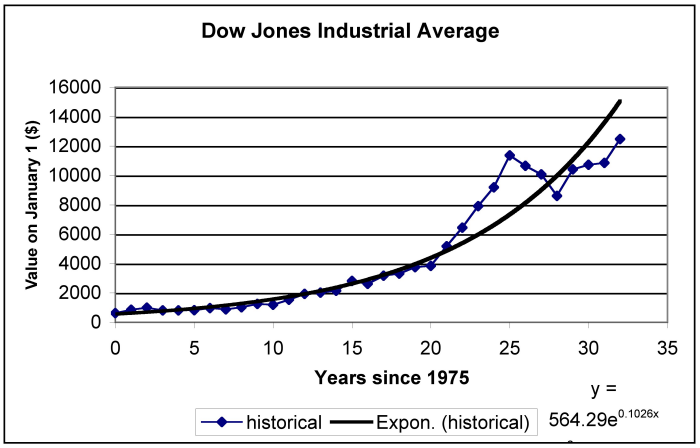
By taking the square root of 0.8606, we find that $R = 0.9277$. This seems to be a fairly good fit, although we can see that the data points don't follow a very linear pattern. Can we find a better model? Yes, if we try a different type of trendline. Before we do this, it would help if we made one adjustment to the data. The initial value (or vertical intercept) for the linear trendline is -769692. What does that mean? It means that in the year 0, the value of the Dow was $\$ - 769692$. This doesn't really make any sense. Not only was the Dow not around in the year 0, but it's not reasonable for it to have a negative value. Excel is calculating this value for the vertical intercept because it is using the actual year (1975, etc.) to construct the linear equation. We are not really interested in the actual year; we are really interested in the amount of time that has passed. Therefore, it is just as easy to look at the years since 1975 when we draw the graph and find the best-fit functions. What we gain is that the equations are more reasonable and also easier to work with.

To make this change, we have to add a column into the data table. The best approach is to insert a column in between the Year column and the DJIA column. To do this, highlight the second column, then go to Insert and click on "Column". Excel should put in a new column in between the two existing data columns. Now we need to fill in this column. You can do it by hand, but as you may realize by now Excel has a way to do it for you. Click on the first cell in this column and type in the formula

$$= \text{A11-1975}$$

When you hit return, Excel should calculate 0 for that cell. Now copy and paste this into the remaining cells in this column and Excel will automatically calculate the years since 1975 for each cell. Now you can highlight this new column along with the DJIA data and build a new graph.

Now make a scatter plot of the "Years since 1975" column and the DJIA column. Click on one of the points on the graph and insert a trendline. This time, click on "Exponential" in the window that opens, then click on the Options tab and click the boxes to show the equation and the R^2 value. The graph looks like this:



The R-value for this curve is $R = 0.9816$, indicating that this regression curve is a much better fit for the data than the linear model we made. You can see this from the graph: the curve follows the data points fairly closely.

We still have not answered our original question about putting money in savings accounts (or CDs) versus investing in the Dow. As we noted earlier, we need

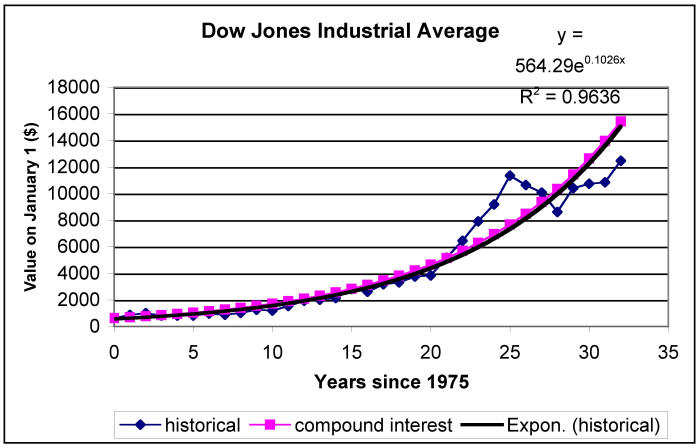
to know the interest rate for the savings vehicle in order to make a good comparison. We will see soon that the exponential regression function has a constant relative change. For now let's try to build an exponential curve that matches this, by using Excel to experiment with interest rates.

We assume that we are investing $632.04 in an interest bearing vehicle (probably a CD since no savings account pays that much). We will put in a new column, column D, giving the value of this savings account. Put your interest rate in cell D7; we'll try a 10% interest rate for our first estimate. Then fill column D with the result of exponential growth, with the interest rate in cell D7 so we can change it easily. (This is a review of Tuesday's class.)[3] We put $632.04 in cell D11, then entered the following formula into cell D12.

```
=$C$11*(1+$D$7)^B11
```

The dollar signs that we put on either side of C and D are used to make those references absolute. In other words, Excel will always refer to those cells, even if we copy and paste the formula into the rest of column D.

Now we can create a new chart with our 10% growth estimate. As we observed before, it matches the exponential regression curve fairly well. We could adjust the interest rate to see if we can get an even better match. If you try 10.5%, as shown below, you'll see that the match is very close.

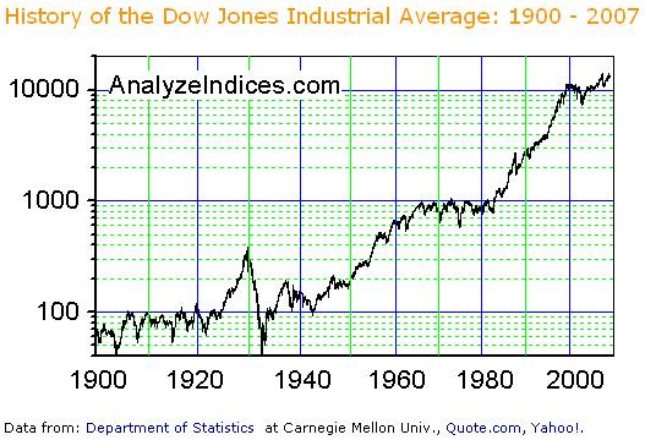


[3] We do this with the formula, not recursively by computing each line from the previous line. That reinforces the algebra. But the recursive way is a more common idiom in Excel.

A longer term view

An article in today's it Boston Globe talks about recent volatility in the stock market. You can read it at `http://www.boston.com/business/globe/articles/2007/11/29/in_roller_coaster_market_an_urge_to_jump_off?mode=PF` [4] One interesting quote that refers to what we discussed earlier about safe and risky investments: "But investors who are selling their stocks and leaving their money in cash face an opportunity risk, professionals warned. 'They can sabotage their investment by getting out when things look bad and waiting too long to get back into the market,' Swanson said." This article highlights the strong connection between the stock market and the overall economy (or people's perceptions of the overall economy).

As a last graph, let's look at some longer-term historical data about the Dow. This graph shows the behavior of the Dow from 1900 to 2007. The growth looks exponential even though the scale is logarithmic![5] You can clearly see the bubble in the 1920's followed by the 1929 stock market crash.



[4] "Volatile" appears in a page one headline, too: Republican presidential debate turns volatile.

[5] Too bad we don't have time to study logarithmic scales – or do we, with Excel?