

MBA Teaching Note 10-01 Measuring Market Movements with Stock Indexes

Rarely does a day pass when one fails to hear how the stock market is performing or has performed during the day's trading session. Market movements are covered on all major news web sites and are mentioned in virtually all television and radio news programs. These market movements are summarized in the form of an index or measure that reflects the level of stock prices of a defined combination of stocks. Such a measure provides a relatively consistent way of quantifying how the market behaved over a period of time.

These measures are often called indexes (sometimes "indices") but not all of them are truly indexes. An index is a measure of the value or price of something relative to some pre-defined base value. For example, the Consumer Price Index (CPI) is a measure of the combined prices of a defined basket of goods and services, but the index number itself does not tell us what these goods and services cost at a given point in time. It tells us what these goods and services cost relative to what they previously cost. Suppose you construct a new CPI in an attempt to measure the cost of your monthly food consumption. You define a combination of food items that you purchase each month. Let's say their cost is \$500 right now. This point in time is called the base period. You then establish the index by setting its value at 100. Note that this is not \$100 but just simply the number 100. The following month that same combination of food items costs \$502.50. Your index value is now $(\$502.50/\$500)*100 = 100.50$. The change in the index value, from 100 to 100.50, is the same percentage change, 0.5%, as the change in the cost of the food items. Neither figure, 100 and 100.50, is the actual cost of the items, but the relationship between 100 and 100.50 determines the rate of change in the actual cost of the items.

In a similar manner, a stock market index does not tell us the values of the stocks. It tells us their values at a point in time relative to their values at a previous point in time. That said, however, at least one index, the celebrated Dow Jones Industrial Average (DJIA, the "Average," or just "the Dow") is not at all an index. In practice, however, the Dow is usually referred to as an index and there is little harm in doing so.

Two General Types of Indexes

There are two general classes of indexes: those in which the prices of the component stocks are simply added up and divided by the number of stocks and those in which the market values of the stocks are added up and divided by their market values at the base period. The latter is truly an index, while the former is not. There are a few complicating factors to consider, however, before understanding how these measures are constructed, and we will go over those here.

First, let us define a set of stocks that we will include in an index. We show below their (hypothetical) names, prices, and number of shares on days 0 and 1. Day 0 is the day on which we construct the index or the base period.

Name	Day 0		Day 1	
	Price	# of shares	Price	# of shares
ABC	\$28.00	1,000	\$26.56	1,000
DEF	\$54.00	400	\$55.25	400
GHI	\$25.00	1,500	\$24.75	1,500

We will first construct a price-weighted index like the DJIA. We will call this our Price-Weighted-3 index (PWI3). Such an index is created by simply adding up the prices and dividing by the number of stocks. Its value on day 0 is

$$PWI3_0 = \frac{\$28.00 + \$54.00 + \$25.00}{3} = 35.67.$$

On Day 1 its value is

$$PWI_3_1 = \frac{\$26.55 + \$55.25 + \$24.75}{3} = 35.52.$$

Thus, from Day 0 to Day 1, the market experienced a percentage decline of 0.42%.¹

Now let us construct the second type of measure, a value-weighted index. We first establish the base period market value of the stocks. This is the total market value of all of the component stocks at the base period. The market value of each stock is obtained by multiplying the price by the number of shares. Thus, the total market value on the base day, Day 0, is

$$\frac{(\$28.00 * 1,000) + (\$54.00 * 400) + (\$25.00 * 1,500)}{3} = \$87,100.$$

Thus, if an investor purchased all of these stocks on Day 0, it would cost \$87,100. Keep in mind, of course, that no investor could purchase all of the shares of all of the component stocks, but this based period market measure is simply supposed to accurately reflect what these companies are worth in totality. This aggregate market value becomes the base value. The index value on Day 0 is arbitrarily set at any number. Common base index values are numbers like 10 or 100. Let us use 100. Thus, the value of our Value-Weighted-3 index (VWI3) on Day 0 is

$$VWI3_0 = \left(\frac{(\$28.00 * 1,000) + (\$54.00 * 400) + (\$25.00 * 1,500)}{\$87,100} \right) * 100 = 100.$$

From this point forward, the value-weighted index is computed by inserting the market value of the stocks into the numerator, dividing by the \$87,100 base value, and multiplying that result by 100. Thus, on Day 1, the index is at

$$VWI_1 = \left(\frac{(\$26.56 * 1,000) + (\$55.25 * 400) + (\$24.75 * 1,500)}{\$87,100} \right) * 100 = 98.49.$$

Thus, we see that the index has fallen in value from 100 to 98.49, a decrease of 1.51%. Note that this change does not equal the percentage change in the price-weighted index. In fact, it is several times the percentage decrease in the price-weighted index. Indeed, these two measures do not reflect the same thing, and they can even move in opposite directions. The price weighted index is most heavily influenced by the highest priced stocks, while the value-weighted index is most heavily influenced by the largest companies, as measured by total market value.²

Stock Splits and Changes in Capitalization

A complicating factor in the construction of stock indexes is what to do when there are changes in the number of shares brought about by stock splits. When a stock splits, each shareholder receives new shares according to the defined split ratio. So, for example, if there is a 2-for-1 split, each shareholder is given one additional share for each share he owns. Thus, in a 2-for-1 split, there will then be twice as many shares outstanding. The company itself is not larger or more valuable because of the split. It is just a division of ownership into smaller pieces. Thus, the stock price will fall proportionately. For a 2-for-1 split, the price should fall in half. Of course, when the stock splits, there may be other information that occurs simultaneously that drives the price up or down relative to its split price. An index must properly measure these other factors and not be biased by the pure effect of the split on the stock price.

¹ $(35.52/35.67) - 1 = 0.0042.$

²The highest priced stock is DEF, but in terms of market value, it is the smallest company. From Day 1 to Day 2 stocks ABC and GHI both decreased, while DEF increased. The increase in DEF was more heavily weighted in the price-weighted index. Thus, its increase had a greater impact in offsetting the price decreases of ABC and GHI, resulting in only a small price decrease in the overall index. For the value-weighted index, however, the greatest impact was attributed to the largest company, GHI, and also to the second-largest company, ABC, both of which went down. DEF went up in value but it is the smallest company. Thus, it had less of an effect in offsetting the declines in ABC and GHI.

Price-weighted indexes handle this problem by adjusting the divisor. Thus, in our example, to construct the price-weighted index, we would ordinarily divide by three since there are three stocks. If we continue to divide by three, however, the sharp drop in a stock price resulting from a split will bias the index. Consider the following information, which reflects a 2-for-1 split on Day 3 for ABC.

	Day 3	
Name	Price	# of shares
ABC	\$13.65	2,000
DEF	\$52.75	400
GHI	\$26.15	1,500

Note that the split would cause the price of ABC to fall from its Day 2 price of \$26.56 to half of that, \$13.28. Without adjustment, the split would cause the value of the index to fall quite dramatically from 35.52 to

$$PWI_{3_2}(\text{unadjusted}) = \frac{\$13.65 + \$52.75 + \$26.15}{3} = 30.85.$$

Thus, the index would show a sharp decline of 13.1%. It should be clear that this result is a biased measure of what happened. The split had no economic value, but it drives the index down substantially.

The standard approach to adjusting for this bias in a price-weighted index is to change the denominator. We start by asking a simple question: if nothing of economic value occurred to the prices of these three stocks, what divisor would leave the index unchanged, taking into account that the split stock falls to exactly one-half its previous value? Since the index was at 35.52, we determine what divisor would leave the index unchanged if the stock prices were \$13.28 (the price of ABC divided by the split factor), \$55.25, and \$24.75, the latter two being the prices of DEF and GHI on Day 2. We see that the divisor would be

$$\frac{13.28 + 55.25 + 24.75}{35.52} = 2.6261.$$

Thus, we compute the prices on Day 3 forward using a divisor of 2.6261. Now, using this divisor and the actual Day 2 prices, the price-weighted index value on Day 2 is

$$PWI_{3_2} = \frac{\$13.65 + \$52.75 + \$26.15}{2.6261} = 35.24.$$

This number now reflects a 0.79% increase, which is clearly a more accurate measure of what happened.

This type of adjustment is also used when a stock is replaced, which occurs sometimes due to such events as mergers, spin-offs, and bankruptcies. Such an adjustment ensures that the index properly reflects what it is intended to reflect: changes in economic value. So, if the index is supposed to reflect U. S. companies, but one of its components becomes predominately foreign-owned, the index producer might decide to replace it with a pure U. S. company. In that case, the new company's price will be entered into the formula in the same manner that the split price is entered. A new divisor is found such that the entry of the new company does not change the value of the index. Of course, from that point forward, the new company could perform in a substantially different manner from the old company, but that is a separate issue.³

A value-weighted index does not have to be adjusted in order to accommodate the price change arising from a stock split. Since the numerator contains the price times the number of shares, a proportionately lower price times an equally-proportionately higher number of shares

³There have indeed been many changes to indexes such as the Dow. There have been almost 50 changes in the Dow components.

leaves the market value of a stock unchanged. Thus, our value-weighted index on Day 2 is calculated as

$$VWI_1 = \left(\frac{(\$13.65 * 2,000) + (\$52.75 * 400) + (\$26.15 * 1,500)}{\$87,100} \right) * 100 = 100.60.$$

This is a percentage increase over Day 2 of 2.14%. Note, again, that the price-weighted and value-weighted indexes give a much different picture of what happened.

Price-weighted indexes give greater weight to the higher priced stocks, while value-weighted indexes give greater weight to the stocks with greater market value, i.e., the larger companies. It is almost universally agreed that value-weighted indexes more accurately depict market movements. Larger companies should logically have a greater impact on the market; hence, their movements should carry heavier weight.

There are a few other types of indexes, where the weighting is done based on other factors, such as market performance. Some indexes are equally-weighted, whereby it is assumed that an equal amount is invested in each stock on the base day. The problem with equally-weighted indexes, however, is that they remain equally-weighted only so long as prices change.⁴ Once the price of any component stock changes, the index is no longer equally-weighted. It is safe to say that value-weighted indexes make up about more than 90% of all indexes, with price-weighted indexes and other weighting schemes making up the rest.

The Dow Jones Industrial Average

The most well-known price-weighted index and indeed the most well-known of all indexes, is the Dow Jones Industrial Average, which was developed by Charles Dow in 1896 with an initial set of 11 stocks. More stocks were gradually added until 1928, when it reached its permanent level of 30 component stocks. Over the years, there have been various changes to the Average including both stock splits and component changes, and, as a result, the divisor has been lowered numerous times. The current divisor can be obtained near the top of the page called “Market Data” in the “Money and Investing Section” (Section C) of *The Wall Street Journal*.

The Dow is truly an average, as described above. It is not weighted by the sizes of the companies, though all of the companies are quite large. The Dow was originally intended to consist of “industrial” or traditional manufacturing firms, reflecting the heavy-industry focus of the U. S. economy nearly a hundred years ago. Since that time, however, the economy has changed to a more service-oriented one, and the Dow now consists of numerous companies that are not at all “industrial,” such as Disney, McDonalds, Bank of America, and Wal-Mart.⁵

The Dow is probably one of the worst measures of U. S. stock market performance, but nonetheless, is the most widely quoted. The reason the Dow is a poor measure is in fact because it is an average and does not reflect the relative sizes of the companies. As noted, a price-weighted average is literally weighted by the prices of the component stocks. Hence, stocks with the largest prices carry the greatest weights even though they may not be the largest companies. Another reason the Dow is such a poor indicator is that it consists of only 30 stocks. Thirty stocks may well have been quite representative of the U. S. market many years ago, but it is certainly not today. While it is true that these 30 stocks are extremely large companies, there are simply too many other companies to ignore.

Let us look at how the Dow is computed and see how to interpret a change. On Thursday, November 18, 2010, the Dow closed at 11,181.23. The divisor was 0.132129493. Thus, the sum of the prices of the 30 stocks is found as follows. First, we have the general

⁴One other weighting scheme that has been used is geometric weighting, in which prices are multiplied instead of added and the n^{th} root (assuming n stocks) is taken, instead of dividing by n . Geometric indexes have never been successful, however, one reason of which is that it is not possible to actually reproduce the index as a portfolio.

⁵The current list of Dow stocks can be found at <http://finance.yahoo.com/q/cp?s=DJI+Components>.

formula for the average on any arbitrary day t , the prices of each of the thirty stocks, $S_{1t}, S_{2t}, \dots, S_{30t}$, and the divisor for that day, d_t :

$$DJIA_t = \frac{\sum_{i=1}^{30} S_{it}}{d_t}$$

Filling in what we know:

$$11,181.23 = \frac{\sum_{i=1}^{30} S_{it}}{0.132129493}$$

Thus, the sum of the prices is

$$\sum_{i=1}^{30} S_{it} = (11,181.23)0.132129493 = 1,477.37$$

To put this in perspective, the average price of a component stock is, therefore,

$$\bar{P}_t = \frac{\sum_{i=1}^{30} S_{it}}{30} = \frac{\$1,477.37}{30} = \$49.25$$

Now, let us look at what happened the following day and provide an interpretation. The Dow increased by 22.32 to close at 11,203.55, an increase of 0.2%. The new average price would also clearly increase by the same 0.2% to.

$$\bar{P}_t = \frac{\sum_{i=1}^{30} S_{it}}{30} = \frac{(11,203.55)0.132129493}{30} = \frac{\$1,480.32}{30} = \$49.34$$

This is an increase of nine cents a share. Is this large? While it does not sound large, nine cents a share is a substantial amount of money for the equity of a large company. Also, if a stock increased 0.2% every day, it would amount to about a 50% increase over a year.⁶ Unfortunately, many observers and news commentators do not report the percentage change in the Dow but only the unit change. It is the percentage change that matters.

For better or for worse, the Dow is the most widely followed measure of stock market activity, a result of the company's long-standing status as the leading provider of information on the financial markets. For example, the company's leading publication, *The Wall Street Journal*, has been published since 1889, is the most well-known financial newspaper in the world, and the company has widely promoted the Dow through the *Journal*. The company has also been extremely successful in getting the Dow out and keeping it in the public eye through television and radio. For many years, the Dow was virtually the only measure of the stock market, and it naturally became widely reported by the news media, which needs a short and simple way to communicate how the market performed. Numerous books have been written about "beating the Dow" and when the Dow hits certain threshold levels, such as 10,000, there are always major news stories. As a result, the Dow has firmly established itself as an accepted measure of the market, without regard to its numerous defects.

Dow Jones also produces similarly constructed averages of 20 transportation and 15 utility stocks as well as an overall composite average of all 65 stocks (30 industrial, 20 transportation, and 15 utility). These averages are not followed closely, however, and Dow Jones does not emphasize them. The company itself, through a subsidiary called Dow Jones Indexes,

⁶That is, with 250 trading days in a year, $0.002(250) = 0.5$, or 50%.

produces thousands of indexes, measuring markets around the world.⁷ Most of these indexes are value-weighted.

The S&P 500 Index

Standard and Poor's (S&P) created their index of 500 stocks in 1957.⁸ Its original value was set at 10. The base period that determines the denominator in the index was an average of the prices and shares of the component stocks over the period 1941-43. Thus, with N_{it} representing the number of shares of stock i on day t , the index is computed as follows:⁹

$$S \ \& \ P500_t = \left(\frac{\sum_{i=1}^{500} S_{it} N_{it}}{\sum_{i=1}^{500} S_{i,1941-43} N_{i,1941-43}} \right) 10.$$

Obviously there have been changes in the component stocks as some firms go bankrupt and others merge and become part of other companies. When that happens, S&P replaces the stock with a new stock and adjusts the denominator so that the replacement of the stock does not change the index. Thus, the denominator reflects not only the base value in 1941-43 but also changes as a result of new component stocks.

To put the S&P 500 in perspective, it closed at 1,207.43 on November 19, 2010, a period roughly 53 years since its origin. Thus, the compound rate of return is

$$\left(\frac{1,207.43}{10} \right)^{1/53} - 1 = 0.1433,$$

or 14.33%.

The S&P 500 is unquestionably the most widely accepted index by professional money managers. It not only is used to determine how the market performed but also as a benchmark for how a particular manager or portfolio performed. The manager's portfolio is compared to the S&P 500, adjusted for any risk differences, and the portfolio is deemed to have out- or under-performed the S&P 500. More than \$1 trillion of institutional investment money is benchmarked to the S&P 500.

Other Indexes

Although the S&P 500 and the Dow Jones Industrial Average are the most widely quoted indexes, the Nasdaq Composite Index is also highly visible. Indeed, on most web sites and business television networks, the Nasdaq is quoted as frequently as are the Dow and S&P 500. This value-weighted index covers all of the more than 3,000 stocks on the Nasdaq exchange.

Another leading index provider is the Frank Russell Company. Russell has specialized in broad-based indexes, such as their Russell 1000, Russell 2000, and their combined Russell 3000 indexes. Russell has also been innovative in developing in style indexes, which determine their components stocks based on size (large-cap), mid-cap, small-cap), and style (value, growth).¹⁰

⁷Dow Jones Indexes was a subsidiary of the Dow Jones Company until 2010, at which time it was sold to the Chicago Mercantile Exchange, a leading future exchange. Dow Jones retains some investment interest in Dow Jones Indexes and considerable influence over the Dow Jones Industrial Average.

⁸The origins of the index go back to the 1920s with an index of 90 stocks called the Standard & Poor's Composite, which itself evolved from an earlier index created by economist Arthur Cowles.

⁹In recent years, S&P changed the number of shares to reflect shares traded, which is called *free float*. This measure removes from the computations shares that are unlikely to trade, such as shares held by the insiders and founders.

¹⁰Value stocks are those that are considered relatively inexpensive, while growth stocks are stocks considered relatively expensive. While determining whether a stock is inexpensive or expensive is what investing all boils down to, Russell and other index providers use relatively simple schemes, such as dividing the market into two set of stocks based on PE (price-to-earnings) ratios. High PE stocks are considered expensive and low PE stocks are considered inexpensive, a process that also dictates changes in

There are also a handful of other index providers. All in all, the index world produces possibly as many as 10,000 indexes. These measures reflect movements in various markets around the world, parsed and sub-divided by such factors as capitalization, investment style, and level of dividend.

Investing in Indexes

One of the main results of portfolio analysis is that diversification is beneficial for investors. The investment industry has responded by creating numerous ways to invest in broadly diversified indexes. Mutual funds that replicate indexes have been around since the 1970s. In the last 20 years, we have seen the creation of a new type of product called the *exchange-traded fund* or *ETF*. These instruments are technically securities, and not mutual funds, but they can be traded like securities. Most mutual funds are considered open-ended, meaning that shares can be redeemed and issued. When you buy a mutual fund, you place an order with the fund and you pay the value of the shares at the closing of the day. Likewise, if you sell shares, you receive the closing value of the shares at the end of the day. This value is called the *net asset value* and represents the value of the fund's securities divided by the number of shares outstanding.¹¹ ETFs allow you to trade shares all during the day in the underlying portfolio, which is often a stock index. The ETF provider accumulates dividends and pays them out, usually on a quarterly basis. There are a handful of other differences. It is very important that you know what ETFs are, because they represent a huge portion of the financial instruments that exist in our markets today.

the index from time to time, and these companies do so on a regular and well-known basis. S&P and Dow Jones also divide their indexes into other indexes based on growth/value, capitalization, and other factors.

¹¹What we just described is called an open-end fund. There is another type of mutual fund called a closed-end fund that issues a fixed number of shares. These shares can be bought and sold like stocks. Closed-end funds are fading in popularity, being supplanted by ETFs.