Lecture

IAQS | INSTITUTE OF ACTUARIAL & QUANTITATIVE STUDIES

Class: TY BSc

Subject : Risk Management & Investment Management - II

Chapter: Unit 3 Chp 1

Chapter Name: Investment Indices

Topics to be covered:

1. Construction of indices
2. Weighted arithmetic indices
3. Chain-linking
4. Total return indices
5. Yield adjustment
6. Unweighted arithmetic indices
7. Geometric indices
8. Uses of indices
9. Relevance of indices
10. Fit for purpose

Topics to be covered:

11. FTSE UK Index Series
12. Dow Jones
13. Standard & Poor's
14. NASDAQ
15. Indian Indices
16. Volatility Indices
17. FTSE Global Equity Index Series
18. Morgan Stanley Capital International Indices
19. UK Bond indices
20. International bond indices
21. Property Indices

1 Construction of indices

- An investment index represents the relative changes in the share/stock prices of the constituent companies or stocks which make up the index. The various methods of averaging those relative price changes are dealt with further.

- Investment indices have a wide variety of uses in investment and asset management.

- There are many investment indices in use throughout the world, with each index having it's own particular purpose and use. Each index will be constructed using certain eligibility criteria to determine the constituent companies from time to time.

2 Weighted arithmetic indices

- Most investment indices are calculated on a weighted arithmetic average basis. The general formula being:

$$I(t) = K \frac{\sum_i W_i \frac{P_{i,t}}{P_{i,0}}}{\sum_i W_i}$$

- Where:
- $I(t)$ is the capital index at time t
- $P_{i,t}$ is the price of the i^{th} constituent at time t
- $P_{i,0}$ is the price of the i^{th} constituent at time 0-the last time at which there was a capital change
- W_i is the weight applied to the i^{th} constituent
- K is a constant related to the starting value of the index at time 0.

2 Weighted arithmetic indices

- For investment indices, the weights used are the market capitalisations of the constituents, usually the market capitalisations of the constituents at time 0.
- The weights are updated each time the number of shares issued by a constituent company changes and continuity is maintained by "chain-linking" the index on the new capital to that of the previous index.
- It is now becoming common practice to restrict the weights to reflect the level of "free float" of shares available for purchase, thereby eliminating strategic holdings.
- The **free float** of a share is the proportion of the shares that are freely available for purchase on the open market. It therefore excludes shares that are held for strategic purposes-eg by holding companies in subsidiaries – and are thus highly unlikely to be sold.

3 Chain-linking

- The chain-linking process is set up so that:
  - The index reflects the new market capitalisation of the constituents
  - The index value is not disturbed by the change in capital structure of it's constituents.

- This is appropriate because if the aim of the index is to reflect the investment performance of it's constituents, then the index value should change only in response to that investment performance and not in response to injections or withdrawals of funds into or out of the market itself.

- After allowing for chain-linking, the formula for the investment index then becomes:

$$\boldsymbol{I(t) = \frac{\sum_i N_{i,t} P_{i,t}}{B(t)}}$$

- Where:
  - $N_{i,t}$ is the number of shares issued for the i^{th} constituent at time t
  - $B(t)$ is the base value, or divisor, at time t
  - $B(t)$ is obtained from $B(t-1)$ through the chain-linking process

Question 1

A new index is to be constructed in a share market that contains just two shares, in Companies A and B. At the starting date of the index, time 0, there are 100 shares in each company. Company A shares are priced at 3, whilst Company B shares are priced at 1.

(i) What is the market capitalisation at time 0?

(ii) What are the weights to be used in the above formula?

(iii) What value of the constant K is required if the index is to have a starting value of $I(0) = 100$?

(iv) What is the value of the index at time 1 if the share prices have by then increased to 3.2 and 1.1 respectively?

Solution

At time 0, the starting date of the index:

$$N_{A0} = 100,\ N_{B0} = 100,\ P_{A0} = 3,\ P_{B0} = 1$$

where N_{it} is the number of Company i shares at time t.

(i) ***Market capitalisation at time 0***

This is equal to: $N_{A0}\,P_{A0} + N_{B0}\,P_{B0} = 100 \times 3 + 100 \times 1 = 400$

(ii) ***Weights in the formula***

For each share the weight is equal to the opening market capitalisation, thus:

$$w_A = N_{A0}\,P_{A0} = 100 \times 3 = 300$$

$$w_B = N_{B0}\,P_{B0} = 100 \times 1 = 100$$

Solution

(iii) ***Value of the constant K***

For the opening value of the index $I(0)$ to be 100, we require that:

$$I(0) = 100 = K\frac{\left(300\times\frac{3}{3}+100\times\frac{1}{1}\right)}{(300+100)}$$

ie K must be equal to 100.

(iv) ***Index value at time 1***

$$I(1) = 100\times\frac{\left(300\times\frac{3.2}{3}+100\times\frac{1.1}{1}\right)}{(300+100)} = 107.5$$

4 Total return indices

- In many cases, a measure of the total return, including income received, is required on an investment class. To provide this measure, a total return index is calculated from the capital index. Total returns can be calculated using ex-dividend adjustments or yield figures.

XD adjustment

- The ex-dividend or XD adjustment represents the amount of income that has been received since the start of the year by the capital value index.

- To allow for the effect of investment income, it is necessary to make assumptions about the time that the income is reinvested and whether it is reinvested net or gross of tax.

4 Total return indices

- An allowance may also be required for the expenses of reinvestment.

- Assuming that the dividend or interest payment is reinvested back in the index on the ex-dividend date, and that is it is added to the current market capitalisation, the corresponding increase in the index value would be the investment income divided by the base value, that is:

$$\boldsymbol{xd_{i,t} = N_{i,t} \frac{D_{i,t}}{B(t-1)}}$$

- Where:
  - $D_{i,t}$ is the dividend per share declared by the i^{th} constituent at time t (net or gross, as required);
  - $B(t-1)$ is the divisor at the close of business on the previous day after allowing for any capital changes.

- The XD adjustment is the accumulated total of each constituent over the calendar year as each constituent company declares a dividend. It is returned to the value zero at the beginning of the year and a new accumulation is started.

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4 Total return indices

- Thus, the XD adjustment in respect of any share *i*, which reflects the total dividends declared by Company *i* over the year to date is given by:

$$\boldsymbol{XD_{it} = \sum_{t} xd_{it}}$$

- Finally, the XD adjustment for the index itself is found by summing over all of the individual company XD adjustments to obtain:

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4 Total return indices

- To create a single index that incorporates both capital and income, we need to combine the capital index with the XD adjustment. The total return from $t-1$ to t is:

$$\boldsymbol{TR} = \frac{\boldsymbol{I(t) - I(t-1) + XD(t) - XD(t-1)}}{\boldsymbol{I(t-1)}}$$

- This implicitly assumes that:
  - Dividends are subject to the rate of tax (if any) assumed in the calculation of the index
  - There are no expenses or losses incurred in reinvesting the dividends.

4 Total return indices

- The figure calculated using the above expression is sometimes referred to as the **holding period return,** which is more generally defined as:

$$\frac{\boldsymbol{P_1 + d}}{\boldsymbol{P_0}} - \mathbf{1}$$

- Where:
  - P_0 and P_1 are the values of the investment at the beginning and end of the period
  - d is the income generated by the investment over the period.

4 Total return indices

- The holding period return is sometimes used an approximation to the internal rate of return, but is inaccurate because it fails to allow for the fact that in practice part of the total return comes from the reinvestment of the income (d).

- However, by linking successive holding period returns together we can generate a total return index series. Thus. the total return index value at time *t* is related to the total return index value at time *t-1* as follows:

$$\boldsymbol{TRI(t) = TRI(t-1)\ x\ \left[\frac{I(t) + XD(t) - XD(t-1)}{I(t-1)}\right]}$$

4 Total return indices

Alternative formula

- The formula to obtain a total return index at time **t** is:

$$\boldsymbol{TRI(t) - TRI(t-1)\frac{I(t)}{I(t-1) - [XD(t) - XD(t-1)]}}$$

- Where:
  - $TRI(t)$ is the total return index;
  - $XD(t)$ is the value of the accumulated XD adjustment at time *t*.

- The total return between time *a* and *b (b>a)* is then given as:

$$\boldsymbol{\frac{TRI(b)}{TRI(a)} - 1}$$

4 Total return indices

- If ex-dividend adjustments are published separately the approach illustrated in this section can be used to calculated the total return using any desired assumptions for reinvestment frequency and tax rates. Care has to be taken to allow for the fact that the XD figures are reset to zero at the year end.

- Thus, the formula used is that derived previously, namely:

$$\boldsymbol{TRI(t) = TRI(t-1)\ \mathrm{x}\ \left[\frac{I(t) + XD(t) - XD(t-1)}{I(t-1)}\right]}$$

- ie the capital gain plus the income, divided by the starting value.

- Because of the small size of the XD adjustment relative to the capital index the difference between the two approaches is rarely of any practical significance.

- If a published total return index is used, care should be taken to ensure that the tax and reinvestment assumptions used in the calculation of the index are understood.

5 Yield adjustment

- For many published equity indices ex-dividend adjustments are not available but figures for the net dividend yield on the index are. The yield figures can then be used to estimate the dividend income over the period in order to calculate total return. The income received over the 12 months prior to time t (measured in index points) is:

$$I(t) \text{ x } y_t$$

- where yr is the dividend yield at time t. and at) is the value of the index at time t.

- The income received over shorter periods can be estimated by taking the relevant proportion of the annual amount but this will only give an approximation to the true value as income is not generally received uniformly over the year.

- Having estimated the income in this way. a total return index series can then be calculated as described above.

6 Unweighted arithmetic indices

- An unweighted, or price-weighted, arithmetic index is the arithmetic average of the relative price changes of the constituents. It is unsuitable as a benchmark for dynamic institutional portfolios.

- Although such indices are rather crude and generally inappropriate for performance measurement work. several of the world's most famous indices are constructed using this method eg. the Dow Jones Industrial Average. the Nikkei 225.

7 Geometric indices

- A geometric index is based on the geometric mean of the relative price changes of the constituents. The geometric index with n constituents is:

$$K\left(\prod_i \frac{P_{i,t}}{P_{i,0}}\right)^{\frac{1}{n}}$$

- where K is the index value at time 0, usually taken as 100.
- An unweighted geometric index is easy to calculate as only price data is required. It gives an indication of short-term price movements, but is totally unsuitable as a benchmark for investment strategy or portfolio investment measurement.
- For example, if the price of one constituent falls to zero, then so does the index. Hence, constituents need to be changed, when necessary, to avoid this happening.

8 Uses of indices

The uses to which indices can be put include:

- A measure of short-term market movements
- Providing a history of market movements and levels.
- As a tool for estimating future movements in the market, based on past trends.
- As a benchmark against which to assess the investment performance of portfolios.
- Valuing a notional portfolio.
- Analysing sub-sectors of the market.
- As a basis for index funds that track the particular market.
- To provide the basis for the creation of derivative instruments relating to the markets or a sub-section of the market.

8 Uses of indices

In particular for government bond indices:

- A standard against which yields on other fixed interest investments can be assessed.
- Approximate valuation of a fixed interest portfolio.
- Providing a picture of general yield structures of fixed interest investments.
- Yield indices allow comparison to be made with yields on ordinary shares as a measure of the yield gap between bonds and equities.

9 Relevance of indices

Indices are thus relevant to all stages of the asset management process.

- The investor's investment objectives may be specified with reference to one or more indices — eg track or outperform a particular index.

- Indices can be used in the development of the appropriate portfolio to best achieve those investment objectives — by helping us to predict the future possible returns on a particular investment market or sector.

- Indices can be used to value the portfolio and can provide a benchmark against which to monitor its performance — as part of monitoring the investment experience.

10 Fit for purpose

- When using any index it is vital to ensure that the index chosen is fit for purpose. In particular where an index is used to model a real world situation, it is important to ensure that the constituents of the index are a good match for the real world situation being modelled.

- This is particularly true when using indices compiled by commercial institutions. Such indices may have been established primarily for the sponsoring institution's internal purposes, and later put into the public domain as a marketing tool.

- One example is that corporate bond indices produced by UK merchant banks often have a greater exposure to debt from financial institutions than does the bond market as a whole. Using such an index without care during the bond market turmoil in 2008-2009 could have generated significant model risk.

11 FTSE UK Index Series

- This is a series of indices covering the whole quoted UK equity market. All the indices used to be calculated on a weighted arithmetic average basis with the market capitalisations as the weights. As such they may be suitable for performance measurement purposes.

- From June 2001 the weightings of all FTSE constituents were altered to reflect the availability of stock in the market. Where the actual "free floats' is 5% to 15%, this percentage (rounded up to the next whole number) is used. Otherwise weightings are in bands according to the next higher of 20%, 30%, 40%, 50%, 75% and 100%.

- The free float weighting of a share is the proportion of the company's equity that is available for trading by the public. It therefore excludes any strategic holdings by holding companies in subsidiary companies.

11 FTSE UK Index Series

- In addition to the capital and total return index numbers:
  - average net dividend cover
  - actual dividend yield
  - price earnings ratio
  - ex-dividend adjustment

- are given for each of the indices in the series.

- The dividend cover and dividend yield are based on the most recent year's profits and declared dividend figures respectively, updated for interim changes and for any statements by companies forecasting future earnings and dividends. A euro index value is also computed.

11 FTSE UK Index Series

- The FTSE 100 index is based on the 100 largest companies in the UK equity market and covers about 80% of the market by value. It is calculated every minute, is the most widely quoted of the FTSE UK Index Series and is used as the basis for derivatives contracts.

- The FTSE All-Share Index covers about 98% of the market by value and is calculated and updated every minute.

- The other FTSE indices include:
  - FTSE 250
  - FTSE 350
  - FTSE SmallCap
  - FTSE Fledgling
  - FTSE Aim.

12 Dow Jones

- This is the best known and most widely quoted of the New York Indices.

- The Dow Jones Industrial Average, commonly known as the Dow Jones index, is made up of 30 shares. It is an unweighted arithmetic index. It is therefore unsuitable for performance measurement calculations.

- It provides a quick guide to shares in the industrial sector, but it is not representative of the American equity market as a whole. It is, however, very widely reported.

- It is a very crude index because:
  - it is based on only 30 shares
  - there is no weighting by market value.

12 Dow Jones

- The basic principle of calculation is that you add up the share prices of all the constituents and divide by 30. Therefore, if the price per share of the company with the most costly share rises by 10%, it will have a disproportionate impact on the index —even if the company happens to be the smallest of the thirty companies.

- The divisor does get adjusted to reflect capital changes such as scrip issues. Consequently, the divisor now bears no resemblance to 30. However, the basic principle of summing the prices of the thirty shares and dividing by a constant remains.

13 Standard & Poor's

- The Standard & Poor's Composite Index, sometimes known as the S&P 500, is a weighted arithmetic index. Its constituents are 500 leading companies in the USA representing a broad cross-section of all sectors of the market.

- It is often suitable to use for performance measurement of a fund's portfolio of USA equities.

- Both the S&P 500 and the Dow Jones Industrial Average are used as the basis for stock index futures.

14 NASDAQ

- There are a number of other relatively comprehensive US equity indices such as the MISD,4Q (National Association of Stock Dealers Automated Quotations).
- The NASDAQ composite index includes all common stocks (ie ordinary shares) traded on the NASDAQ market and currently includes about 5,000 different stocks.
- There are various sub indices for different industrial sectors. which reflect the large number of technologically based companies that are quoted on NASDAQ.
- In addition there are indices for the NASDAQ 100 (largest non-financial companies) and the NASDAQ Financial 100 (largest financial companies).
- The NASDAQ 100 is also used as the basis for stock index Futures.

15 Indian Indices

NIFTY 50

- The NIFTY 50 is the flagship index on the National Stock Exchange of India Ltd. (NSE). The Index tracks the behavior of a portfolio of blue chip companies, the largest and most liquid Indian securities. It includes 50 of the approximately 1600 companies listed on the NSE, captures approximately 65% of its float-adjusted market capitalization and is a true reflection of the Indian stock market.

- The NIFTY 50 covers major sectors of the Indian economy and offers investment managers exposure to the Indian market in one efficient portfolio. The Index has been trading since April 1996 and is well suited for benchmarking, index funds and index-based derivatives.

- The NIFTY 50 is owned and managed by India Index Services and Products Ltd. (IISL). IISL is India's first specialized company focused on an index as a core product.

15 Indian Indices

BSE SENSEX

- S&P BSE SENSEX, first compiled in 1986, was calculated on a 'Market Capitalization-Weighted' methodology of 30 component stocks representing large, well-established and financially sound companies across key sectors.

- The base year of S&P BSE SENSEX was taken as 1978-79. S&P BSE SENSEX today is widely reported in both domestic and international markets through print as well as electronic media. Since September 1, 2003, S&P BSE SENSEX is being calculated on a free-float market capitalization methodology.

- The growth of the equity market in India has been phenomenal in the present decade. Right from early nineties, the stock market witnessed heightened activity in terms of various bull and bear runs. S&P BSE SENSEX has captured all these happenings in the most judicious manner.

- One can identify the booms and busts of the Indian equity market through S&P BSE SENSEX. As the oldest index in the country, it provides the time series data over a fairly long period of time (from 1979 onwards). Small wonder, the S&P BSE SENSEX has become one of the most prominent brands in the country.

16 Volatility indices

- The above indices all measure the performance of equities in price or total return terms. Another form of equity indices measures the volatility of equities, and such indices are typically used as an indication of the market perception of risk.

- The most well known volatility index is the Chicago Board Options Exchange Volatility Index, commonly known as the VIX. This is essentially a weighted average of prices for a range of 30 day expiry put and call options on the S&P 500 index.

- Intuitively, the level of the index, which is quoted in annualised percentage terms, is the risk neutral expectation of the volatility on the S&P index over a 30 day period.

- The composition of VIX is quite sophisticated and uses the prices of options to calculate the implied volatility. Specifically, a higher option price implies greater volatility. other things being equal. Despite the sophistication, its predictive power is similar to that of simpler measures. such as observations of past volatility

17 FTSE Global Equity Index Series

Construction

- The FTSE Global Equity Index Series covers over 8.000 securities in 48 countries and captures around 98% of the world's equity markets in terms of investible market capitalisation.

- The index is divided into Developed, Advanced Emerging and Secondary Emerging segments.

- The indices are weighted arithmetic indices. From June 2001 the weightings of constituents reflect "free float", as above. This applied to all new constituents from the beginning of 2000.

17 FTSE Global Equity Index Series

Coverage

- Index numbers are shown for each country in US dollar and local currency terms. The local currency index gives a measure of the underlying performance of the particular market, and the dollar currency index shows performance adjusted for movements in the currency concerned.

- In addition to the indices in respect of each country, there are indices in respect of market type and region, for example, the FTSE Developed All Cap Index. Finally, there is a FTSE All-World Index comprising the Large/Mid-Cap aggregate of around 2,700 stocks from the Global Equity Series.

- The indices also include the gross dividend yield and a total returns index for each country.

17 FTSE Global Equity Index Series

Uses

- Stocks not available to foreign investors are not included in the indices. This is not the case for most local indices.

- So the Global Index Series are often more suitable for performance measurement purposes than local indices.

- They also have the advantages of consistency between countries and are easier to obtain than some local indices.

18 Morgan Stanley Capital International Indices

- These are a widely used series of international equity indices covering both developed and emerging markets. They are calculated on a market capitalisation weighted arithmetic basis and total returns are published both gross and net of withholding tax.

- The MSCI ACWI (All Country World Index) Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed and emerging markets. As of May 2015, the MSCI ACWI consisted of 46 country indices, comprising 23 developed and 23 emerging market country indices.

19 UK Bond Indices

- The FTSE Gilts Index Series include price and yield indices. Conventional gilts and index-linked gilts are treated separately. and indices are produced for a variety of different terms.

- The price indices are weighted average indices based on market capitalisations and dirty prices. For each category of the price indices, the information given includes the:
  - index number
  - accrued interest
  - XD adjustment for the calendar year to date

20 International Bond Indices

- Establishing a suitable benchmark for a bond portfolio can be more complicated than for a portfolio of equities. as bond portfolios are often constructed subject to specific constraints such as duration or credit rating. Many different series of international bond indices are produced. mostly by brokers.

- International bond indices include the FTSE global bond index series and the Markit iBoxx fixed income indices. Investment banks. such as Barclays Capital, Merrill Lynch. Saloman and JP Morgan. also produce bond indices.

- **Credit derivative indices** allow investors access to standardised credit default contracts on many different securities. The main families of CDS index are **iTraxx** and **CDX.**

21 Property Indices

- Property price indices are very difficult to maintain because:
  - there is little reliable, up-to-date price data for properties at any one moment
  - properties tend to be very heterogeneous.

- The problems involved with obtaining market values for property include:
  - Each property is unique.
  - The market value of a property is only known for certain when the property changes hands.
  - Estimation of value is a subjective and expensive process.
  - Valuations will be carried out at different points in time.
  - Sales of certain types of investment property are relatively infrequent.
  - The prices agreed between buyers and sellers of properties are normally treated with a degree of confidentiality.

21 Property Indices

- **Portfolio-based properly indices** measure rental values, capital values or total returns of actual rented properties, split according to size, regional spread and sector weighting (office, retail , etc).

- **Barometer properly indices** aim to track movements in the property market at large by estimating the maximum full rental values of a number of hypothetical rack-rented properties.

- **IPD** is a leading index provider for commercial property indices.