7

Futures on Equities

This chapter deals with the special features of futures markets in equity shares, including equity indices (also known as stock futures and stock index futures). The general principles applicable to futures markets are also applicable to futures in equity markets. The *raison d'etre* of equity futures is to enable the hedging of equity positions.

A special and rather unusual feature of the equity or 'stock futures' market in India is that it is increasingly seen not as a supplement to the cash market but as a substitute. The relatively higher volume of trading on the futures markets in India *vis-à-vis* the cash stock market appears to be explained by two main factors.

The first factor is that India's futures market is one of the few that has active futures trading in *individual shares* (single stock futures) rather than in broad stock market indices. This is partly the legacy of the old Indian *badla* system that was an indigenous form of forward trading in individual shares that ended in the late 1990s and was replaced by equity futures. Because there are futures markets in individual shares, the Indian equity futures markets allow speculation on specific companies without basis risk. When only index futures are available, an investor in the stock market cannot really use futures to back his view on an individual company. The Indian market allows speculation on individual shares through futures.

The second factor is margin or leverage. The *cost, extent,* and *ease* of leverage is higher through futures:

- India's credit markets are not as well developed as in, say, the United States. Getting a loan in order to trade on equities is not easy or quick. The 'automatic borrowing' in the futures market (through the fractional margin system) makes things much easier; there is no formal credit agreement nor the attendant transaction costs and time.
- When a speculator borrows from a broker to buy stock and takes a long position with, say, a '2x' (two times) leverage, the broker lends money for half the position to the investor and charges him interest. In the case of stock futures, when a position is opened, only a fraction of the underlying

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amount (generally, one-fifth or so) is blocked as margin in the client's account. No interest is charged for the remaining four-fifths. Therefore, leverage through futures is cheaper.

- It is generally difficult to get more than two times leverage using actual cash stocks, i.e., the investor has to deposit 50 per cent of the cost in advance. On the other hand, the initial margin on futures is typically 20 per cent though it could be lower in some cases. The difference in leverage between stock futures and stock 'spot' can be significant: five times in futures vs. two times in cash. These figures are approximately the same in markets as diverse as India and the US, although high net worth clients can through 'portfolio margining' in the US, access more leverage for direct purchase of stocks. Thus, a short term investor can buy more than twice as many shares with a given amount of money on the futures market than on the spot market.

It should never be forgotten that leverage is a double-edged sword. It amplifies gains and losses too. Higher leverage is not always a benefit.

A third factor is the ease with which equities can be short-sold in the futures market – i.e., one can speculate on an expected decline in prices whereas in the cash market, this is difficult to do.

Portfolio theory

The portfolio theory is derived from the Capital Asset Pricing Model (CAPM) and is widely used for portfolio selection in stock markets. A full discussion of portfolio theory is beyond the scope of this book.

Essentially, portfolio theory takes the view that each asset (say a share of ITC Ltd.) has two components of risk attached to its returns, risk being defined as variability of returns.

One is *alpha* or *non-systematic risk* specific to a share (ITC in this case), which is not correlated to general stock market prices. Events such as new patents, efficiency improvements, boardroom tussles, managerial changes or takeover bids in a company, which do affect the share price, are examples of non-systematic risk affecting the company alone, without affecting the market as a whole. This risk can be avoided by diversifying into other assets.

However, there is a second element, known as *beta* or *systematic risk*, which

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is dependent on the general stock market. Whenever the Indian stock market rises or falls, there is an effect on ITC, the extent of the effect depending on the size of the beta. The beta factor is the sensitivity of the price of a particular share or portfolio of shares to movements in the market index. When the market rises or falls, the particular share or portfolio will also rise or fall, but the extent to which it rises or falls may be less or more than the market as a whole. This proportion is determined by the beta factor. Beta risk cannot be diversified away and hence investors need to be compensated by higher return. The CAPM therefore postulates that there is a trade-off between systematic risk and return. (Empirical evidence for this has been rather weak, however.)

The return that investors would expect in order to hold the shares of ITC would be the return that would fully compensate them for the risks incurred. Investors can earn a risk-free return by investing in government Treasury Bills. If they must be persuaded to hold ITC shares instead, they would expect a proportionately higher return to compensate for the beta (systematic) risk involved in ITC shares. On the basis of the CAPM, for ITC stock, the expected percentage return per year in Indian rupees would be:

$$R_f + \beta (R_m - R_f)$$

Where,

R_f = risk-free interest rate in rupees

β = beta of ITC

R_m = return on the market-as-a-whole

The R_m would be for the whole world's market (percentage return in rupees) if there was full capital account convertibility etc., in India and the rest of the world. For practical purposes now, the 'market-as-a-whole' can be assumed to be just the Indian market.

The actual choice of portfolio by any one individual depends on his degree of risk aversion. A person who wants low risk will buy low beta assets giving a steady return, but his average return over a period will be lower. Another person may go in for a portfolio with a higher average beta risk and reap higher returns over a period, but in any given year, his returns may fluctuate more widely. There could be big losses too along the way.

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Portfolio theory as applied to hedging through futures

The *portfolio theory of hedging* uses the portfolio theory described above as a method of analysing hedging behaviour in futures markets. The portfolio theory of hedging views hedged stocks and un-hedged stocks as two different 'assets' with different betas that can be combined into a portfolio. A fully hedged portfolio is deemed to have lower risk (i.e., lower beta) and lower return. For a hedge involving the basis grade or variety of any commodity for a period co-terminous with the maturity date of a futures contract, there is no risk in hedging: the return from hedging is known exactly in advance (ignoring counter-party risks). Thus, the variance and risk is nil and hedged stocks are a riskless asset. (Single stock futures are an example as they have virtually no basis risk because that very stock is the basis grade; a stock position hedged against the corresponding stock's futures contract is virtually riskless.) In the case of hedging through varieties other than the basis grade, some risk may remain. When a single stock or collection of stocks is hedged against a broad stock market index, some basis risk exists but it is less than for an unhedged position. An unhedged portfolio has the highest risk and return. A partially hedged portfolio would lie in between a fully hedged portfolio and an unhedged portfolio. According to the portfolio theory of hedging, a dealer chooses an 'optimal' hedge ratio based on his degree of aversion to risk.

The portfolio theory is used extensively in investment analysis in the cash market and is generally accepted as a very useful theory for that purpose. However, its utility for analysing hedging through futures markets is debatable, though several researchers used it as a basis for empirical research on futures markets. As Stein,[1] Gray[2] and Williams[3] have pointed out; the conceptual basis for using portfolio theory in assessing hedging behaviour is weak. Firstly, Williams shows that with a small change in the starting point of the portfolio analysis as applied to hedging, the theory breaks down. Secondly, as Stein brings out, the applicability of the theory depends on the existence of a systematic risk in futures prices accompanied by a risk-return trade-off. But several studies have shown that futures prices do not show any such systematic relationship with the general market portfolio, nor is there a risk return trade-off. Even if

1 J. L. Stein, *op. cit.,* 18—22.

2 R. W. Gray, 'Commentary', *Review of Research in Futures Markets,* Vol. 3, 80–81.

3 Jeffrey Williams, *The Economic Function of Futures Markets*, Cambridge University Press.

systematic relationship exists in some markets, this is clearly not a theory that can be applied to the general spectrum of futures trading. Thirdly, from an empirical point of view, a major problem in applying the theory to actual hedging behaviour is the need to know the hedger's risk aversion profile. Some researchers have circumvented this problem in various ways, but the fact remains that this is a major difficulty. Indeed, the authors of this book are inclined to agree with Stein, Williams *et al*, that portfolio theory is not an appropriate approach for the analysis of hedging behaviour in futures markets. It has nevertheless been included in this book for the sake of completeness.

Pricing of equity futures

It was seen in chapter 4 that the relationship between futures and spot prices is based on the interplay of two sets of forces – expectations about the future price and the carrying cost of the asset from the present time to the future date. This leads to the following general relationship for any futures market:

$F \leq S + C - Y$

Where, F= futures price

S = spot price

C = carrying cost for the period t

Y = yield for the period t

Being a financial futures contract where there are no production or consumption discontinuities like harvests or weather related events, expectations are not likely to play a role in determining the futures price and the price will be very close the carrying cost approach. For a financial instrument (unlike commodities) there are negligible exogenous carrying costs (like warehouse rents) which are not directly proportional to the value of the asset. The main or only cost is interest on capital locked up and that is a percentage of the spot price; the carrying cost can be derived directly from the spot price by applying a rate of interest. The yield is a real yield (from dividends) rather than a 'convenience yield' as in the case of commodities. When all of these are taken into account, the relationship becomes as follows:

$F = S + C - Y$

i.e., $F = S + (C - Y)$

i.e., $F = S + S\,(c_t - y_t)$

i.e., $F = S\,(1 + c_t - y_t)$

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Where, S = spot price

C = carrying cost for the period t (absolute amount)

Y = yield for the period t (absolute amount)

c_t = (risk free) interest rate on funds borrowed (opportunity cost) for the time t

y_t = yield rate on the underlying asset for the time t

t = time period involved

The formula above takes only simple interest into account. If it is assumed that the carrying cost and the yield are compounded continuously, then it can be shown mathematically that the formula becomes:

$F = Se^{(c-y)t}$

Where,

$c = r$ = risk free rate of interest per annum

y = dividend yield per annum on the underlying asset

e is a mathematical constant (similar to π) known as Euler's number or the exponential constant (approximately equal to 2.7182818282). As mentioned earlier, approximations to the risk free rate can also be used without major inaccuracy.

Uses of equity futures

Equity futures are of two categories – futures in individual stocks (single stock futures) and futures on a stock market index (stock index futures). Both can be used for speculation as well as for hedging.

Speculation through equity futures

A speculator who expects a particular share to increase in value can buy the futures contract of that share (if it has a futures contract). A speculator who expects a particular share to fall in value can engage in short selling of that share on the futures market. If the speculator's prediction is correct, he will make a profit. If he is wrong, he will make a loss.

On the other hand, if a speculator feels that the stock market as a whole will appreciate but does not specifically want to invest in a particular company, she can buy stock index futures. If she feels the stock market as a whole will fall, she can short sell the stock index futures.

The main advantage to speculating through futures is the higher degree of gearing, as discussed at the beginning of this chapter.

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Hedging through equity futures

Those who have positions in individual shares and wish to hedge them (i.e., lock in to a particular price) without actually liquidating their cash market position can do so by selling single stock futures. This is very similar to hedging in commodities. The only real difference is that shares may yield dividends and this may have to be considered in pricing.

Those having large *portfolios* of individual stocks can approximately hedge by selling stock index futures of those stock indices that largely overlap with their current stock holdings. The exact number of stock index futures to be sold depends on several factors.

The first aspect is the composition of the portfolio (how many different shares of how much value) and the beta of those individual stock holdings with respect to the market. For this purpose, the 'market' can be taken as the premier broad-based stock index. Beta is simply a correlation term. For example, a stock with beta of 1.2 means that when the broad market goes up or down by 1 per cent, then the stock is on average likely to correspondingly go up or down by 1.2 per cent.

The beta of the stock index itself is also relevant when dealing with a narrower index. For example, a sectoral index is narrower in coverage and its beta cannot be taken as one *vis-à-vis* the broad market. When using such an index to hedge, it is necessary to calculate the beta not only of the individual shares and/or portfolio being hedged, but also of the particular stock index used for hedging. The index used for hedging is calculated by statistically regressing its values against the broad market index. For example, to hedge a portfolio of IT stocks by selling CNX IT index futures in India, it is necessary to have the beta of the individual stocks with respect to the NSE, and also the beta of the CNX-IT index *vis-à-vis* the NSE.

When hedging a portfolio, the hedger needs to decide on the target level of volatility (i.e., beta). It should be remembered that a fully hedged portfolio will protect against downside risk, but also prevent any gains from upside risk. A fully hedged stock portfolio (if the hedge is perfectly matched etc.) would have a beta of zero (just like a fully hedged bond portfolio would have a duration of zero, assuming parallel shifts in interest rates across maturities). It would mean that if the stock market moves up or down, the portfolio's value would remain unchanged. A fully hedged portfolio may be appear pointless in theory (since the same result could be achieved by liquidating the portfolio and holding cash) but it may sometimes be necessary for practical reasons relating to taxation, financial reporting etc. It is also a theoretical extreme which helps in understanding the concept. The actual target of portfolio beta values will be based on risk aversion and other factors like tax implications, accounting year-ends etc. Depending on the target beta, the hedger will decide the share of the portfolio to be hedged, ranging from 100per cent to nil.

Optimal hedge ratio

In chapter 4, a general approach to calculating equivalency in any futures market was given, based on the correlation coefficient between the asset being hedged and the futures contract and the standard deviations of the two assets. The formula for the optimal hedge ratio (also known as the minimum variance hedge ratio) given there was,

$$h = \frac{\text{SD of changes in the cash market price of the asset being hedged}}{\text{SD of changes in the futures price}} \times r$$

Where,

h = optimal hedge ratio

SD = standard deviation for a given period

r = correlation coefficient between the SD of the changes in spot price of commodity and SD of the change in futures price

In the case of hedging of a particular share using the futures contract of the stock market index, it can be shown mathematically that the optimal hedge ratio is in fact the same as the beta of the share,

i.e., $h = \beta$

Therefore, the optimal hedge ratio of a single stock for the purposes of hedging using the broad market index is the beta itself.

This ratio must then be adjusted for the size of the portfolio itself. The number of contracts to be traded to achieve the hedge will then be as follows:

$N = h \times P / V$.

Since, $h = \beta$,

$N = \beta \times P / V$

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Or,

$N = (\beta \times P) / (F \times Q)$

Where,

N is the number of future contracts to be bought/sold for hedging,

β is the beta

P is the exposure to be hedged (total portfolio value minus portion to be left unhedged)

V is the value of one futures contract and

$V = F \times Q$ where, F= futures price and Q is the quantity or size of one market lot of futures.

The above formula will work when the underlying of the futures contract is a broad market index which is assumed to have a beta of one (unity). If the beta value of the index is not one, e.g., if a narrower index is the underlying of the futures contract, then:

$N = h \times P / V$

$h = \frac{\beta_s}{\beta_f}$ and so,

$$N = \frac{\beta_s}{\beta_f} \times \frac{P}{V}$$

Where,

N is the number of future contracts to be bought/sold for hedging,

β_s is the beta of the stock to be hedged,

β_f is the beta of the futures index.

However, it is vital to note (and often overlooked) that while the beta value used in the equation should in theory be the expected beta in the future, the beta value actually used is based on *past data* and therefore backward-looking. Therefore attributing precision or great accuracy to these calculations is somewhat pointless. If the future beta is different from the past, the hedge may prove only partial. It is for this reason that some very successful investors like Warren Buffett have mocked such precision.

For this reason, some market practitioners do not use the historical beta values from a simple CAPM model regression. Instead, they use adjusted betas by bringing them closer to one to prevent extremely low or high beta values distorted by relatively recent and non-recurring events. For example, one widely used calculation of an adjusted beta is:

Adjusted Beta = 1/3 +2/3 calculated historical beta.

No doubt, the adjustment may itself result in an imperfect hedge if the market conforms to the past patterns and so such adjustments carry risks of their own.

Roll over and basis risks

Except in the rare case where the portfolio exactly corresponds to the index which forms the underlying of the futures contract, portfolio hedging is essentially a cross hedge. Every cross hedge of one asset through another always has basis risk. If the portfolio of individual stocks that being hedged is not well diversified or not representative in any form of the broader market, portfolio betas become even more meaningless.

As noted earlier in chapter 4, the maturity date of the liquid futures contract may not exactly match the needs of the hedger, and hence hedging may involve the rollover of futures contracts. This carries its own basis risk because the basis may change during the process of rollover.

It should be noted that stock index futures can only be used to hedge the systematic risk in any equity portfolio, not specific or idiosyncratic risks.

The following examples will illustrate some of the ways in which equity futures can be used and the issues discussed above.

Example 7.1:

XYZ Fund has a long-only (i.e., no short positions) portfolio of 20 diversified stocks listed on the NSE) worth Rs. 10 crores. For the next two weeks, the fund manager wants to eliminate general exposure to the stock market risk (or beta risk) because a big policy announcement is expected, and the manager does not want to risk it as the fund's performance this quarter has been good. She could sell all the stocks and convert to cash, but the fund's investment rules do not allow a high allocation to cash, even temporarily. The rules allow taking positions in derivatives such as futures and options so long as they are exchange-traded and liquid. The average beta of her portfolio (based on the previous three-year average) is 1.2 and Nifty is assumed to have a beta of 1 (i.e., it is taken as representing the market as a whole). The Nifty is at 6000 currently. How should she hedge if,

a. she wants to hedge the whole portfolio?

b. she wants to retain risk on 20 per cent of the portfolio while hedging 80 per cent?

Solution

Using the formula $N = \beta \times P / V$, *the number of contracts to be traded is*

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N= (β × P) / (F × Q)

i.e. N=

$$\frac{\beta \times \text{Exposure to be hedged}}{\text{Current value of Nifty} \times \text{Contract size (multiple) for one Nifty futures contract}}$$

The exposure to be hedged = Portfolio value – Exposure remaining unhedged.

a. *In this case, the entire portfolio value is to be hedged. Assuming that the beta value can be taken for the future, to hedge the entire exposure of ₹10 crores, Nifty futures worth 10 × 1.2 = ₹12 crore have to be sold.*

One Nifty futures contract is worth 50 times the index value in rupees. Therefore, the number of contracts to be traded is: $= \frac{12{,}00{,}00{,}000}{6{,}000 \times 50} = 400$

That is, XYZ Fund's manager must short 400 relevant index contracts in order to aim for a short term zero-beta portfolio.

b. *In this case 20 per cent of the exposure, i.e., ₹2 crores is to remain un-hedged. Thus, only ₹8 crores is to be hedged. To hedge ₹8 crores, Nifty futures worth*

₹(8 × 1.2) crores = ₹9.6 crores

have to be hedged. This can be achieved by selling:

$\frac{9{,}60{,}00{,}000}{6000 \times 50}$ *= 320 Nifty contracts.*

Example 7.2

In the above example, since the period was only for two weeks, we assumed the spot price and futures price of Nifty to be the same, and ignored any complications because of dividend yields etc. In a relatively high interest rate environment like India, interest rates have a large influence on pricing. In this example all the facts are as above, except that the target period is two months instead of two weeks. The dividend yield on the Nifty is 2 per cent and the (risk free) interest rate is 12 per cent. For the two-month hedge, the manager decides to use an adjusted beta (with a beta of one having a weight of one-third and the actual beta having a weight of two-thirds) and uses compounding where required. Calculate the number of contracts to be used for hedging.

Solution

To get the number of futures' units to be sold to hedge a long portfolio, we have to divide the value of the portfolio (multiplied by its beta) by the value of the index futures, not the index itself. The question does not give the futures price of the Nifty index. When the index is at 6,000, its futures can be derived from the carrying cost and yield.

$F = S\,(1 + c_t - y_t)$

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Since the carrying cost (interest rate of 12 per cent) is higher than the yield (dividend rate of 2 per cent), C–Y will be positive and the futures price will be higher than the current price because that the interest rate is higher than the dividend yield. In this case, t= 2 months or 2/12 years so

$$\begin{aligned} c_t - y_t &= (12 \text{ per cent } \times 2/12) - (2 \text{ per cent } \times 2/12) \\ &= (10 \text{ per cent} \times 2/12) \\ &= 1.67 \text{ per cent} \end{aligned}$$

Therefore, the futures prices is expected to be

$$F = 6{,}000\ (1 + 1.67 \text{ per cent}) = 6{,}000\ (1.0167) = 6{,}100.2$$

If continuous compounding is used:

$$F = Se^{(c-y)t}$$

i.e., $F = 6{,}000\ (e^{(.12-.02)\ (2/12))}) = 6{,}000\ (e^{(.1)\ (.167)})$

This can be solved manually through logarithm tables (inserting a value of 2.718 for e) or through a scientific calculator and it will be seen that

$F = 6{,}000\ (e^{(.1)\ (.167)}) = 6{,}101.$

The adjusted value of beta,

$\beta = 0.333 + (0.6667 \times 1.2) = 0.333 + 0.8 = 1.133.$

Therefore, the new calculation $N = \beta \times P / V$ *becomes*

$$N = \frac{1.133 \times 10{,}00{,}00{,}000}{6101 \times 50} = 371.4 \text{ contracts}$$

This would be rounded to 371 contracts.

[When compared with Example 7.1 (a), the answer is different because of the change in beta and the change in futures price.]

Example 7.3

A portfolio comprising the shares included in the BSE 30 share index has to be hedged from 1 March to 1 April using Nifty futures. Assume the beta of the Sensex to be 1.1 whereas the beta of the Nifty is .97. The futures contract expiry dates are 18 March and 20 April. What are the alternative ways of hedging and what are the risks remaining?

Solution:

First, the correct equivalency ratio has to be decided upon, considering the correlation and volatility of the BSE Sensex and the Nifty. In this case, the optimal hedge ratio will be as follows:

$$h = \frac{\beta_s}{\beta_f} = \frac{1.1}{.97} = 1.13$$

Once this is decided, there are two ways of achieving the hedge:

a. On 1 March, sell the 18 March futures and then, on 18 March, 'roll over' to the

20 April contract. This rolling over on 18 March will be accomplished by buying back the March futures and simultaneously selling the April futures. On 1 April, the April futures will be bought back to square the transaction. In this case brokerage, transaction taxes etc. will have to be paid twice because two sell-buy transactions are involved.

b. Directly hedge by selling the 20 April contract on 1 March. Then buy back the April futures on 1 April. In this case the 'bid-ask spread' between the sale price and the buy-back price might be greater than in the case of the two separate contracts as the later contract might be less liquid.

Though the net gain or loss on the futures can be expected to be the same the relative costs (brokerage vs. bid-ask spread) have to be weighed in choosing the contract in which to hedge.

As seen in chapter 4, cross hedging inevitably involves some basis risk. Basis in the case of a cross hedge is: spot price of the item being hedged – future price of the contract used for hedging.

The basis risk in this case is that the basis on 1 April (at the time of liquidating the hedge) may temporarily be significantly higher or lower compared to what it 'should' be based on expected correlation between BSE Sensex and Nifty and their respective volatilities or on the basis of interest rates, dividend yields etc. This basis risk may mean that the risk borne on the cash portfolio of BSE 30 shares may be under- or over-compensated in the futures market.