



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

QUANTITATIVE INVESTMENT MANAGEMENT

LECTURE 57

Stock Index Futures – 1

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INDEX FUTURES



THE CAPM MARKET

- The risk of a portfolio can be segregated into two independent components (i) systematic risk (ii) unsystematic risk.
- Systematic risk arises from market randomness.
- Unsystematic risk is intrinsic randomness.
- Systematic risk is non-diversifiable.
- Unsystematic risk is diversifiable.
- Systematic risk is measured by beta.
- Unsystematic risk is measured by the variance of the residual (random) term.



- Beta of a portfolio scales in the same way as return i.e. beta of a portfolio is equal to the weighted average beta of its constituents. Hence, there is conformity between risk and return in this (CAPM) framework.
- The market rewards (prices) only systematic risk.
- It assumes that unsystematic risk can be managed (eliminated) by diversification to any level chosen by the investor.
- Taking an appropriate position in the market index (portfolio) enables the investor to manage the systematic risk (beta) of his portfolio.
- Since the market portfolio is efficient i.e. it has no unsystematic risk, taking a position in the market portfolio does not affect the unsystematic risk of the portfolio.

THE MARKET PORTFOLIO

- **Market portfolio is the universal risky portfolio.**
- **Market portfolio is efficient.**
- **Market portfolio is fully diversified and hence devoid of any unsystematic risk.**
- **The total risk of market portfolio is its systematic risk.**
- **Beta of market portfolio is unity. Why**



BASIC THEORY OF INDEX FUTURES

- Consider Rs V worth of investment in share S . Let the beta of S be β_s .
- Let the beta of another stock M^* be 1.00. Add a short position in Rs $\beta_s V$ worth shares of M^* to the portfolio..
- The beta of the portfolio is $(\beta_s * V - \beta_s V * 1) / (V - \beta_s V) = 0$.
- Thus, we have constructed a portfolio with no systematic risk.



- Now, what happens if $M^* = M$ (the market portfolio) so that (i) $\beta_{m^*} = \beta_m = 1$; but M has only systematic risk i.e. is an efficient portfolio.
- For hedged portfolio: $\beta_p = 0$.
- Hence, systematic risk of portfolio P is still eliminated.



- **What about unsystematic risk???**

- **Unsystematic risk**

$$\sigma_{\text{unsys}}^2 = \sum_{i=1}^N X_i^2 \sigma_{e_i}^2$$

- **Since M does not have any unsystematic risk, it follows that the unsystematic risk of S remains unchanged by the addition of M.**

INFERENCE

- Hence, by taking an appropriate position in a suitable no of units of the market portfolio, the investor has been able to completely hedge the systematic risk of the portfolio while keeping the unsystematic risk unchanged.

PRINCIPLE OF INDEX FUTURES

- Since futures prices and spot prices are expected to move in tandem due to arbitrage, a position in futures on the market portfolio in lieu of spot tantamounts to a similar impact in the portfolio cardinals.
- Hence, use of futures on M will yield similar effects as positions in M itself i.e. **reduce systematic risk and leave unsystematic risk unchanged.**
- Furthermore, futures have the additional advantage of requiring **NO INITIAL INVESTMENT** for taking positions.



STOCK INDEX FUTURES

- Stock index futures are futures contracts on any stock index e.g. S & P BSE SENSEX that constitutes the underlying asset.
- A long/ short position in a SIF is equivalent to taking a long/short position in a futures contract on a portfolio of stocks that is equivalent to the portfolio of stocks constituting the stock index.
- The underlying asset of such futures is the index portfolio or simply the index.
- MTM Settlement on index: $z^*(F_t - F_{t-1})$
- Final Settlement: $z^*(S_T - F_{T-1})$



- A futures contract on a stock market index represents the right and obligation to buy or to sell a portfolio of stocks characterized by the index.
- Stock index futures are cash settled.
- The contracts are marked to market daily.
- Final Settlement: On the last trading day, the futures price is set equal to the spot index level and there is a final mark to market cash flow.



APPLICATIONS OF SIFs

- **Hedging**
- **Speculation**
- **Index Arbitrage**



HEDGING

- **Stock indices constitute well diversified portfolios of stocks. Hence, in such portfolios all idiosyncratic risk (unsystematic risk) of individual stocks gets eliminated and only the systematic risk remains.**
- **Therefore, by taking appropriate positions in SIFs, an investor is able to manipulate and manage the systematic risk of his own portfolio.**



HEDGING

- **Beta Management**
- **Market Risk Reduction**
- **Volatility Management**
- **Investment Management**
- **Locking in the Benefits of Stock Picking**



EXAMPLES OF HEDGING:

REDUCTION OF MARKET RISK

- A pension fund investor holding a diversified equity portfolio perceiving a fall in stock prices can protect value of the fund by taking short positions in the SIFs.
- A fall in the equity prices would lead to a fall in the index and the value of his portfolio and, parallel gains on the future's short position.
- He will thereby substantially reduce his market risk and earn nearly the risk free rate.



- He could also earn the risk free rate by selling all his stocks and holding T-bills. However, this would involve high transactions costs as he sold and then bought back the stocks. Using index futures is far cheaper.



VOLATILITY MANAGEMENT

- If the fund manager having a long portfolio of stocks believes the market would become increasingly volatile over the next 3 months and wished to remove this uncertainty, he could again take a short index futures position to eliminate the market risk.
- At the end of the 3-month period, he could close out his futures position and his stock portfolio would again be subject to market risk.



INVESTMENT

- Suppose you plan to invest cash that you will receive in 3 months time in diversified portfolio of stocks but you are worried that the market will rise over the next 3 months.
- Then you can lock in the known futures price today, by buying (long) stock index futures, and hedge against any future rise in the cash price of the stock.

