



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

QUANTITATIVE INVESTMENT MANAGEMENT

LECTURE 3 Financial Risk

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DERIVATIVES Contd/...



OPTION CONTRACTS

- **Option contracts are contracts whereby the holder of the option acquires a right to buy/sell a certain asset by/on a certain date for a certain price.**
- **The seller of the option has the obligation to honor the option if the holder decides to exercise the option. He has no discretion.**
- **Option contracts that give a right to the holder to buy (sell) the underlying asset are called calls (puts).**

BASIC TYPES OF OPTIONS

- **Call Options**
- **Put Options**
- **European Options**
- **American Options**



SWAPS

- **Swaps are private agreements between two parties to exchange cash flows in the future according to a pre-arranged formula. They can be regarded as a portfolio of forward contracts. Common swap contracts are**
- **Interest Rate Swaps (IRS)**
- **Currency Swaps**

RISK & ARBITRAGE



THE DEFAULT FREE BOND

- Consider an investment in a one-year government T-bill for say INR 95 today.
- Assume that the T-bill will be redeemed by the government at INR 100 at the end of one year.
- Assume that this redemption value is certain i.e. there is no probability of default as to the receipt of the redemption proceeds.
- Since there is no probability of default, there is no default risk.



RISKFREE ASSET

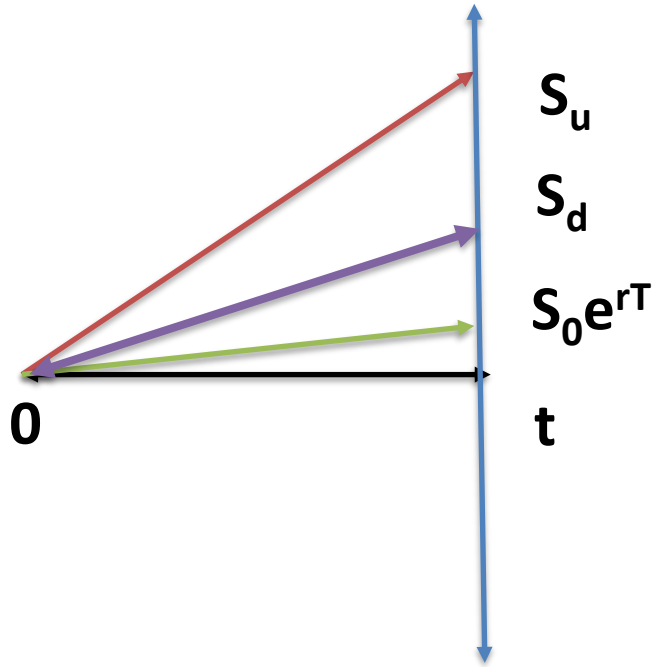
- A riskfree asset is an asset which has a precisely determined future value with no possibility of default i.e. the future value of the asset is absolutely certain.
- A risky asset is an asset which is not riskfree i.e. it is an asset whose future value is not certain.

RISK & FLUCTUATIONS

- There can be uncertainty about the future value of an asset,
- only if there exists the possibility of the asset taking more than one value at that future date
- i.e. if there is any possibility of fluctuation in the value of the asset.

PROPOSITION 1

- It must necessarily be that the worst return out of the spectrum of possible returns that a risky asset can provide at a given future date is less than that of a riskfree bond.



Let $S_0e^{rt} < S_d = S_0e^{\mu t} < S_u$.

Thus, our riskfree return is less than the worst possible return μ on the risky asset.

By no arbitrage, this is not possible.

- Hence, it must necessarily be that the worst return out of the spectrum of possible returns that a risky asset can provide at a given future date is less than that of a riskfree bond.

PROPOSITION 2

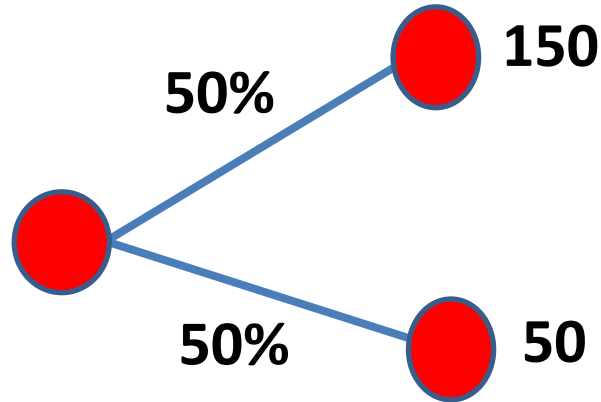
- The expected return on a risky asset must necessarily be greater than or equal to that of a riskfree asset.
- Because rational investors view riskiness as an undesirable attribute of a security, a risky asset will call for a greater expected return than a riskfree asset.

RISK & PROBABILITIES

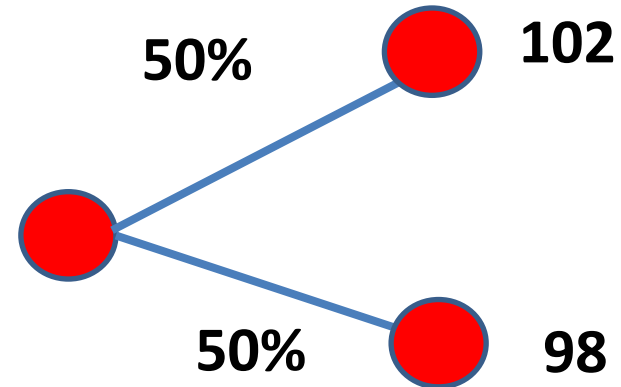


RISK & DISPERSION

BOND X



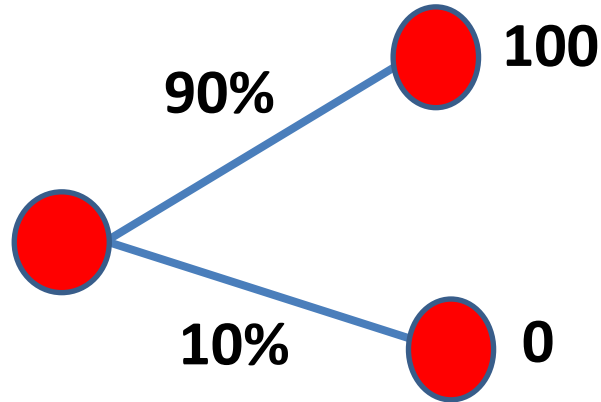
BOND Y



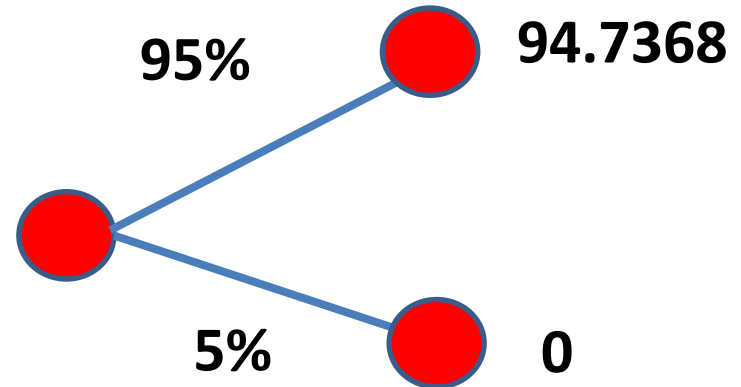
Indeed, higher the dispersion, higher the risk.

RISK & PROBABILITIES

BOND X



BOND Y



Risk depends on the relative probabilities of the various values.

- Thus, the RISK of an investment depends on:
- The dispersion
- The relative probabilities
- of the possible values of the investment in the final state.
- In other words, the risk of an investment is reflected in the probability distribution of the possible final values of the investment.
- The essence of a probability distribution is captured by its mean and variance.

RISK vs UNCERTAINTY

- In the case of risk, the possible outcomes are known and the probability distribution governing them is known. The actual outcome will only be known after the experiment.
- Uncertainty is characterized by incomplete knowledge of possible outcomes or unknown probability distributions of known possible outcomes.
- In both cases, preferences are defined across chance distributions of outcomes.
- For risk, these chances are taken to be objective, whereas for uncertainty, they are subjective.



- Consider betting with a friend by rolling a die. If one rolls at least a four, one wins INR 30. If one rolls lower, one loses INR 30.
- If the die is unbiased, one's decision to accept the bet is taken with the knowledge that one has a 50% chance of winning and losing. This situation is characterized by risk.
- However, if the die has an unknown bias, the situation is characterized by uncertainty.
- The latter applies to all situations in which one knows that there is a chance of winning and losing but has no information on the exact distribution of these chances.

RISKINESS, PRICE & RETURN

- Part of the information the market has about an asset is its riskiness.
- Thus the riskiness is already included in the price, and
- Because rational investors view riskiness as an undesirable attribute of a security, riskiness will reduce the price.
- Thus, the price of a risky asset taking into account its riskiness must be lower than that of a risk-free asset.
- Indeed, greater the riskiness, lower the price.

**RISKINESS
&
DISCOUNT
RATE**

t=0

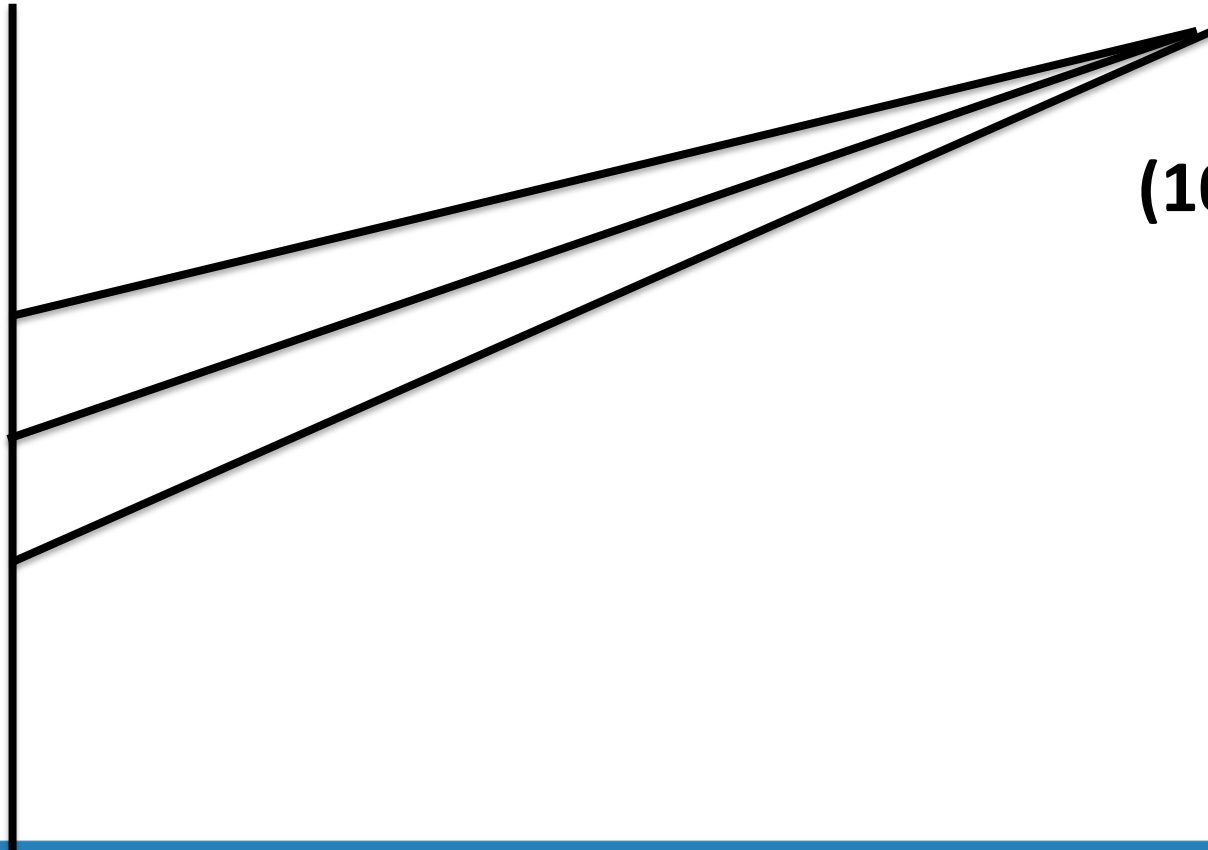
t=1

F(92)

L(86)

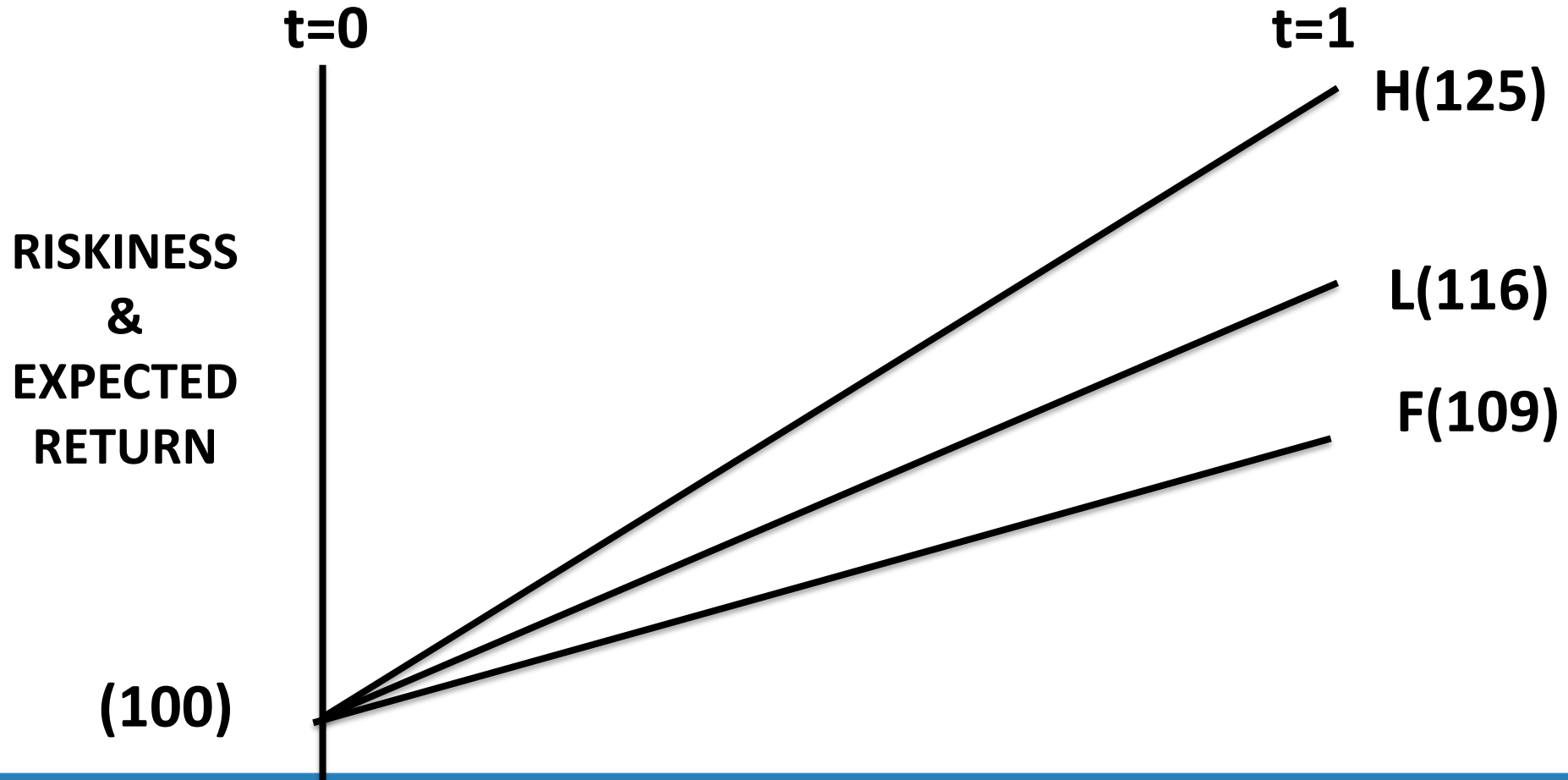
H(80)

(100)



DISCOUNT RATE & RISKINESS

- Thus, an asset's price i.e. its present worth reflects the value it is likely to have in the future reduced by a factor depending upon its riskiness called the discount rate.
- *For Asset F: $r_F = \frac{100-92}{92} = 8.69\%$*
- *For Asset L: $r_L = \frac{100-86}{86} = 16.28\%$*
- *For Asset H: $r_H = \frac{100-80}{80} = 25.00\%$*



- This means that for equally priced assets now, in a year from now we can expect the risky asset to be worth more than the less risky one.
- So increased riskiness means greater returns, but only on average - it also means a greater chance of losing money.