

Financial Economics

Lecture 07. Principles of Risk Management

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Schedule

- What is risk?
- Risk management
- Risk management process
- Portfolio theory

Corporate bond is riskier than Government bond

- A zero-coupon bond with FV of \$1,000 and maturity of 1 year
- Do not know which state will be

	Good state (25%)	Normal State (50%)	Bad state (25%)
Government bond	\$1,000	\$1,000	\$1,000
Corporate bond1	\$1,000	\$1,000	\$0
Corporate bond2	\$1,000	\$500	\$0

- Risk: $R_g < R_{c1} < R_{c2}$
- The higher the risk, the higher the return: $P_g > P_{c1} > P_{c2}$

What is risk?

- An unrealized event is uncertain for an observer at a given time if he/she does not know its outcome at that time
- Risk is uncertainty that “matters” to the observer
 - You plan to hold a party but the number of guests is not uncertain
 - It is a risk if you need to prepare food for them
 - It is not a risk if it is a take-your-own-food party
 - There may be uncertainty without risk; there must be uncertainty if there is a risk

What is risk?

- You manage a commercial concert and have a choice between two contracts for the concert hall
 1. Pay the hall owner \$2 for each ticket sold
 2. Pay a specified lump sum \$100 for the hall
- “Ticket sales” is the “risk that matters”
 - While each fan may be certain about attending or not attending, management is not fully informed, and is at risk because
 - If sales are in fact higher than $N^*=50$, it pays more if it selected choice 1
 - If sales are in fact lower than $N^*=50$, it pays more if it selected choice 2

Strategies for controlling risk

- **Research:** do research to determine the number of fans and the percentage of fans who will attend
 - There is a cost associated with collecting information, but information enables one to make better-informed decisions
 - Information is often collected incrementally, and a decision is made at each step whether to continue collecting further information

Strategies for controlling risk

- **Insurance or options:** for a fee, obtain the right to select between contract 1 and 2 at a later date
 - The right take an action when information becomes clearer can be valuable
 - In this case, the option is the right to delay selection of the exact contractual terms
 - The obligation to rent the hall might be a good quid pro quo for the option

Risk aversion

- Risk aversion
 - A measure of an individual's willingness to pay for a reduction in exposure to risk
 - Example: which do you prefer,
 - A fixed payment of \$50 v.s. A lottery with a probability of 50% winning \$100 and 50% getting 0?
 - A fixed payment of \$45 v.s. A lottery with a probability of 50% winning \$100 and 50% getting 0?
 - A fixed payment of \$40 v.s. A lottery with a probability of 50% winning \$100 and 50% getting 0?
 - A fixed payment of \$35 v.s. A lottery with a probability of 50% winning \$100 and 50% getting 0?

Upside-downside

- Each contract has an *upside* and a *downside*, depending on the variable that controls the “risk that matters”
 - Upside: favorable outcome
 - Downside : unfavorable outcome
- E.G. Pay the hall owner \$2 for each ticket sold
 - Upside: $\text{sales} < 50$, then the rent $< \$100$
 - Downside: $\text{sales} > 50$, then the rent $> \$100$

Upside-downside

- Some risks are more complex. A computer manufacturer that
 - Underestimates demand will lose current sales and market share
 - Overestimates demand will own an inventory with a market price that is being eroded by rapid technological obsolescence
- *Any* deviation is unfavorable

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Risk management

- The process of formulating the benefit-cost trade-offs of risk reduction and deciding on the course of action to take (including the decision to take no decision at all).
- The appropriateness of a risk-management decision should be determined using only the information available when the decision was made
 - No one is perfect foresight
- We should avoid coloring our judgment of an earlier decision with facts known after the decision
 - Skill or luck?

Risk management

- “Preserve your options”
 - A decision that preserves the ability to make in-flight corrections (at a small cost) over one that disposes of that ability characterizes a well-made decision
- “Know when to buy a vowel”
 - A decision that was based on timely and carefully purchased information characterizes a well-made decision

Risk exposure

- If you face a particular kind of risk because of the nature of your job, business, or pattern of consumption you have a particular *risk exposure*
- Example:
 - If you are temporary worker, your exposure to the risk of a layoff is relatively high
 - If you are a farmer, you are exposed both to the risk of a crop failure and to the risk of a decline in the crop price

Risk exposure of households

- Sickness, disability, & death risks
- Unemployment risk
- Consumer-durable asset risk
- Liability risk
- Financial asset risk

Risk exposure of firms

- Input/output channels
 - Strike, boycott, embargo, war, safety, supply/ demand
- Loss of production facilities
 - Fire, legislation, civil action, strike, nationalization, war
- Liability risk
 - Customer, employee, community, environment
- Price risks
 - Input, output, foreign exchange, interest
- Competitor risk
 - Technology, intellectual property

Risk exposure of the government:

- Major calamities
 - Weather, forest fires, riots
- Guarantees
 - Small business loans, mortgages, student loans, crop prices
- Interventions
 - Bank failures, strategic firm failures, crop failures, medical coverage

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The risk-management process

- Risk identification
- Risk assessment
- Selection of risk-management techniques
- Implementation
- Review

Risk identification

- Figure out what the most important risk exposures are for the unit of analysis, be it a household, a firm, or some other entity.
- Households or firms are sometimes are not aware of all risks to which they are exposed
 - A person who has never missed a day of work because of illness or injury may give little thought to the risk of disability.
- There may be some risks for which a person buys insurance coverage, but does not have an exposure
 - May single people who have no dependents buy life insurance
- Effective risk identification requires that one take the perspective of the entity as a whole and consider the totality of uncertainties affecting it.
- It is a good idea to have a checklist that enumerates all of the entity's potential exposures and the relations among them.

Risk assessment

- The quantification of the costs associated with the risks that have been identified in the first step.
 - Illness is common risk exposure to most people.
 - How likely is that someone of certain age, gender and health status get sick?
 - How much is the cost of treatment?
 - Requires specialized skills
 - Actuaries: insurance
 - Investment counselors: investment portfolio

Selection of risk-management techniques

- Risk avoidance
 - Not to be exposed to a particular risk
 - Not always feasible
- Loss prevention and control
 - Actions taken to reduce the likelihood or the severity of losses. Can be prior to, concurrent with, or after a loss occurs.
- Risk retention
 - Absorbing the risk and covering losses out of one's own resources, e.g., precautionary savings.
- Risk transfer
 - Transferring risk to others
 - Selling risky assets to others or buying insurance
 - Taking no action to reduce risk and relying on others to cover your losses

The underlying principle is to minimize the costs of implementation.

Review

- Management of risk should be an ongoing systematic activity because risk exposure changes
 - New risk exposures may arise,
 - Information about the likelihood and severity of risks may become more readily available,
 - Techniques for managing them may become less costly
- Maintaining flexibility will enable you to react more appropriately to change
 - Term life insurance with an annual renewable term is more flexible than policies without this clause

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Portfolio theory

- Quantitative analysis for optimal risk management
 - Portfolio theory selects from a set of (usually divisible) risks by optimizing risk-return
 - Consumption and risk preferences are exogenous
 - It is sometimes possible to devise a strategy that reduces the risk of all contracting parties
 - E.G., Sellers and buyers

Harry Markowitz (August 24, 1927 – June 22, 2023)

- Professor of Finance at the University of California, San Diego (UCSD)
- Won the 1990 Nobel Memorial Prize in Economic Sciences
- Pioneering work in modern portfolio theory
- seminal theory of portfolio allocation under uncertainty, published in 1952 by Journal of Finance
- diversification can lower the portfolio's risk for a given return expectation
- essential to the development of the Capital Asset Pricing Model (CAPM)
- In 1954, he received a PhD in Economics from the University of Chicago
- a thesis on the portfolio theory
- Milton Friedman argued his contribution was not economics

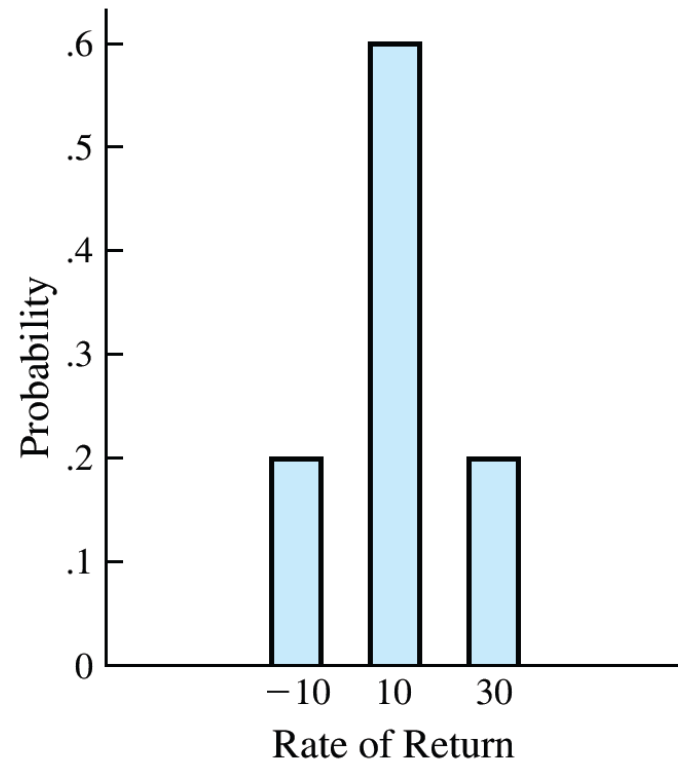


Probability distributions of returns

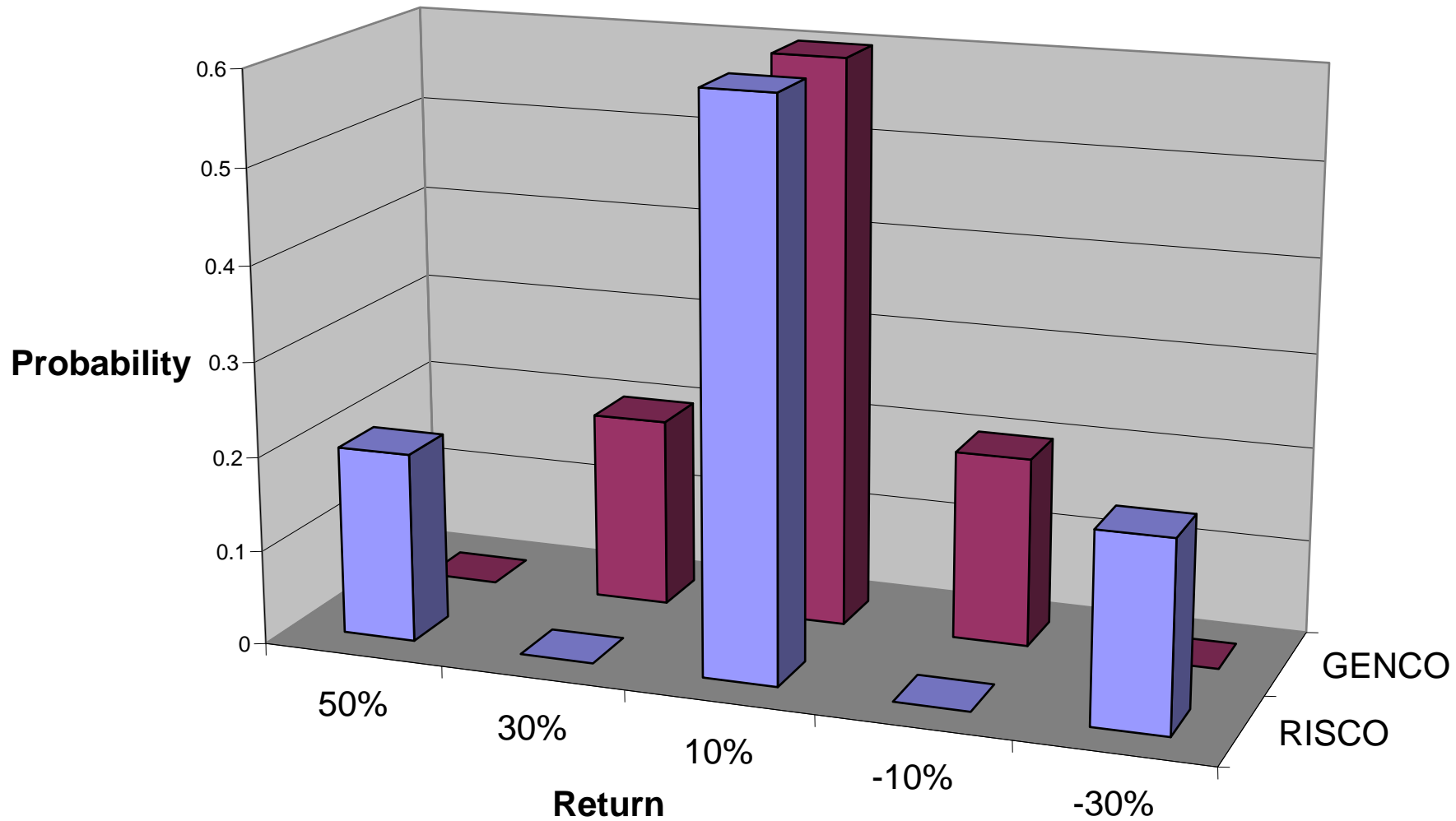
- Assume that there are two stock available, GENCO and RISCO, and each responds to the state of the economy according to the following table

State of Economy	Return on RISCO	Return on GENCO	Probability
Strong	50%	30%	0.20
Normal	10%	10%	0.60
Weak	-30%	-10%	0.20

Probability distribution of returns for genco



Probability distributions of returns



Observation

- Both companies have the same expected return, but there is considerably more risk associated with RISCO
- A stock's volatility is larger/risk is higher/standard deviation is larger
 - The wider the range of possible outcomes
 - The larger the probabilities of those returns at the extremes of the range

Mean: expected rate of return

$$\mu_r = E[r] = P_1 r_1 + P_2 r_2 + P_3 r_3 + \dots P_n r_n$$
$$= \mathbf{P} \cdot \mathbf{r}$$

$$= \sum_{i=1}^n P_i r_i$$

$$\mu_{r_{GENCO}} = 0.2 \times 0.3 + 0.6 \times 0.10 + 0.2 \times (-0.10)$$

$$\mu_{r_{GENCO}} = 0.10 = 10\%$$

Also :

$$\mu_{r_{RISCO}} = 10\%$$

Standard deviation: risk

$$\sigma_r = \sqrt{E[(r - E[r])^2]}$$

$$= \sqrt{P_1(r_1 - \mu_r)^2 + P_2(r_2 - \mu_r)^2 + \dots + P_n(r_n - \mu_r)^2}$$

$$= \sqrt{\sum_{i=1}^n P_i(r_i - \mu_r)^2}$$

$$\sigma_{r_{GENCO}} = \sqrt{0.2 \times (0.30 - 0.10)^2 + 0.6 \times (0.10 - 0.10)^2 + 0.2 \times (-0.10 - 0.10)^2}$$

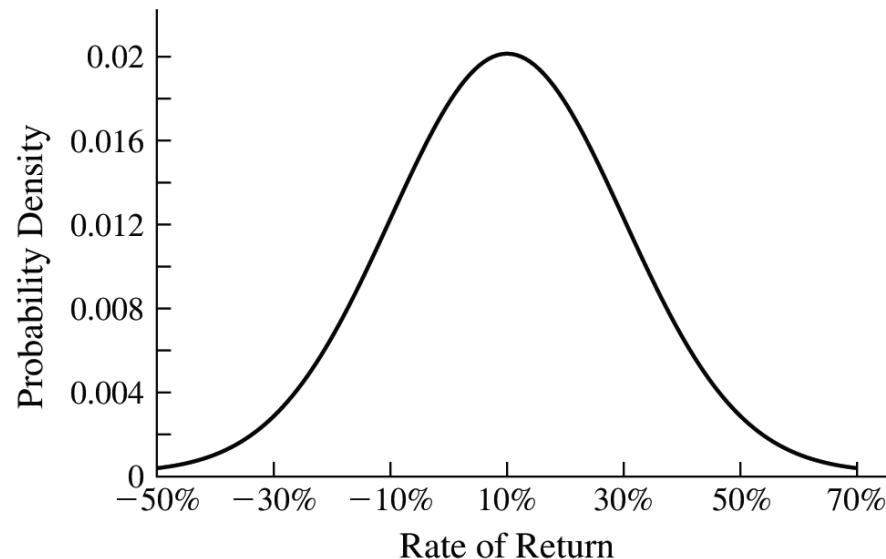
$$\sigma_{r_{GENCO}} = \sqrt{0.016} = 0.1265$$

Also :

$$\sigma_{r_{RISCO}} = 0.2530$$

Continuous probability distribution

- In the real world, the range of stock returns is not limited to a few numerical values
- Instead, the stock returns can be virtually any number
 - Continuous probability distribution
- The most widely used: normal distribution



Normal distribution

- Normco's has an expected return of 10% and a standard deviation of 0.1265
- VOLCO also has an expected return of 10%, but has a standard deviation of 0.2530

Distribution of Returns on Two Stocks

