Decentralized Finance

Finance Basics

Instructors: Dan Boneh, Arthur Gervais, Andrew Miller, Christine Parlour, Dawn Song





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THE FINANCE PROBLEM:
Allocate Resources Efficiently across TIME and RISK

<u>Personal Investment</u>:

Build Wealth

Insure against risk

<u>Business Investment</u>:

Start New Projects

Financial markets and contracts enable both

Definitions

Allocate Resources EFFICIENTLY across TIME and RISK

…How should we evaluate an INVESTMENT?

….How should we determine RISK?

…How should we determine EFFICIENCY?

Measuring Investment Success

What was the return?

$$\frac{Change\ in\ Value}{Initial\ Investment}$$

What was the risk?

Standard Deviation of return

Performance relative to a benchmark

Example:

Tomorrow

$1

0.5 → $2 The return is $\frac{2-1}{1}$= 1 or 100%

0.5 → $0.5 The return is $\frac{0.5-1}{1}$= -0.5 or -50%

RISK

A STATE is a description of something that could happen.

Distinguish between two types of states:

1. States that affect everyone

2. States that only affect one or a few people

What is efficiency?

Assume everyone can rank outcomes

The value someone assigns to the outcome in a state is their <u>utility</u>

Assume people prefer more resources to less

Assume people don’t like risk and will pay to avoid it.

Assign probabilities to states and take expectations to value outcomes

Example:

Tomorrow

Today

0.2

System A: 4 utils
System B: 8 utils

0.8

System A: 3 utils
System B: 1 utils

System A: <u>3.2</u>
(4*0.2+3*0.8)

System B: <u>2.4</u>
(8*0.2 + 1*0.8)

How does the Current System Solve the Problem?

- Financial Assets (stocks, bonds, insurance) are contracts that govern when and how real resources are divided up across states of the world.
- The legal system allows these contracts to be enforced.
- Regulators oversee the system

Regulators

- Naïve Investors should not be harmed if they participate.
  - Securities and Exchange Commission (SEC)
    - Disclosure Rules
    - Fiduciary responsibility
- System should not be used by bad actors
  - Know Your Client (KYC), Anti Money Laundering (AML)
- The system should not <u>create its own risks</u>
  - Bank Capital Regulation, Insurance Capital Regulation

Spillovers/Externalities/Market Failures

Externality: Agents' actions benefit or harm others.

- Bank Run: Depositors withdraw cash they don't want because they worry about bank collapse
- Market Breakdown: Beneficial trade does not happen
- Systemic Risk: Distress in one firm spills over to another

Evaluating a Financial System

Costs and benefits we don't observe that still should be evaluated:

1. Trades that don't happen
   - If trades increase utility, not trading is a lost opportunity.
2. Build-up of Systemic Risk
   - System failure is rarely observed but the risk of an event increases over time.
3. Inefficient split of trade benefits.
   - Monopolists distort prices

A Financial System Works Well if:

Goods are allocated to the people who value them the most.

People willingly participate in the system.

Regulators make sure ``spillovers'' are managed in everyone's best interests.

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What is Traded

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Standard Financial Instruments

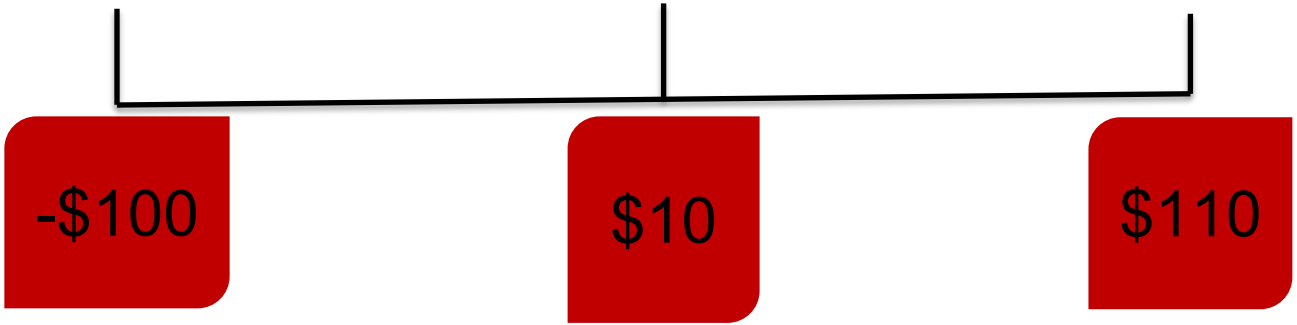
There are a few common financial instruments

- Bonds or fixed income
- Equity or stocks
- Derivatives: e.g., Options
- Time delayed: e.g., Forwards and Futures

All have payoffs defined over **time** and over **states**

Bond: An investment that pays off over time

- A bond or a fixed income security typically pays off a fixed amount every period until the principal is repaid.
- Cash flows of a 10% coupon bond, with a face value of $100 and a market price of $100



Futures and Forwards: Buy now, settle later

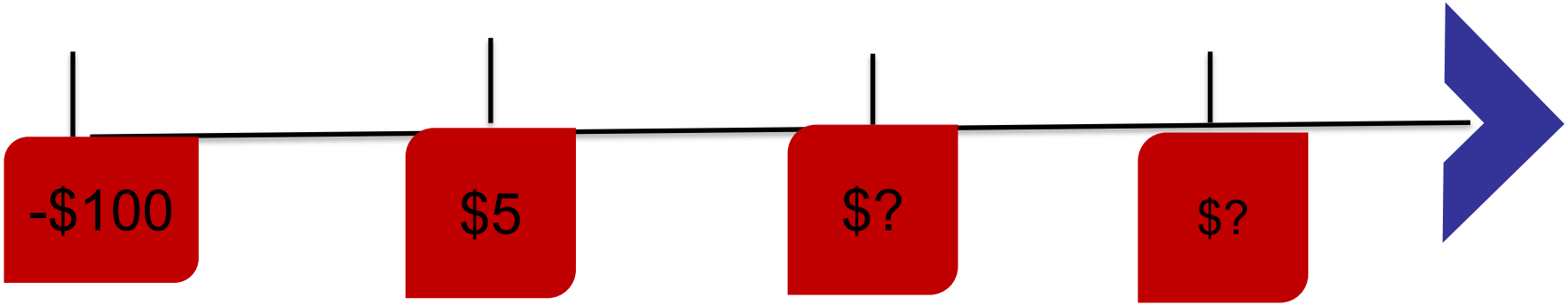
Agree to trade in the future at $P

Trade happens at $P

The market price can move up or down

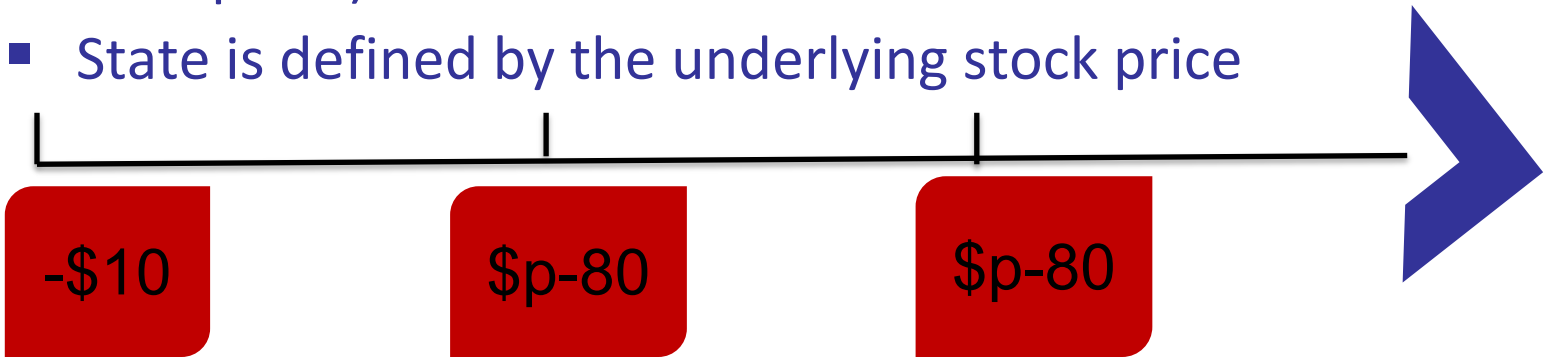
Stock: pays off over time and states

- A dividend payment is usually discretionary and depends on if the company is doing well
- State depends on the company's fortunes
- Cash flows of a stock that costs $100

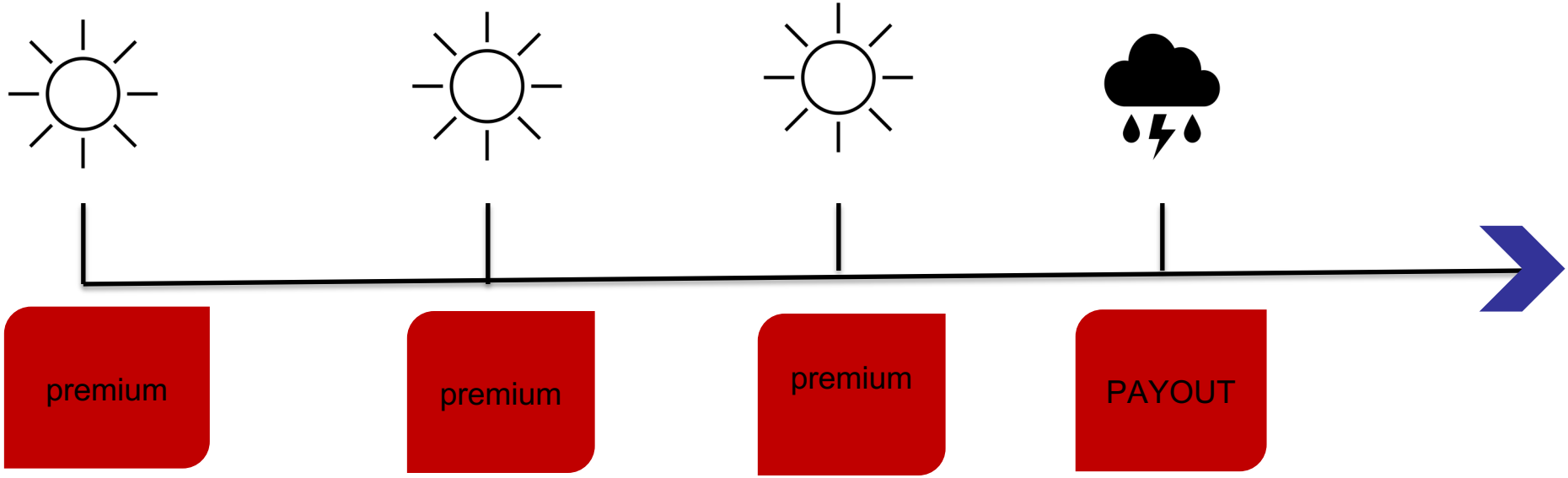


Payoffs Derived from the Stock or Bond Price

- Call Option: Pay $10 for the right to buy a stock for $80
- Payoff at any point is (current price – $80)
- Because this can be negative, you don't have to take it (you have the option)
- State is defined by the underlying stock price



Insurance Pays off Based on a Specific Risk



Where do Financial Assets Come From?

- Stocks and Bonds are sold by firms/organizations that want to raise money for a project.
  - Company sells a bond to pay for a factory

- Financial Institutions bundle existing stocks and bonds and sell them as a package.
  - Exchange Traded Funds (ETF) or Index Funds

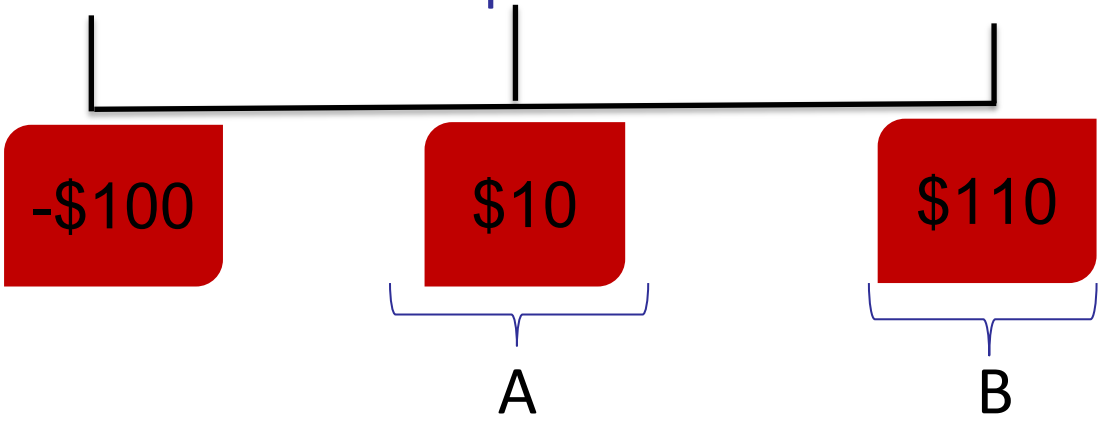
Properties of Financial Assets

Financial Assets are <u>composable</u> ``Value Additivity''
How you divide/add up assets does not affect their value.

Present Value or Price of A + B

Revisiting the Coupon Bond as A and B

- Cash flows of a 10% coupon bond with a market price of $100



Arbitrage Example

Price A= $9, Price of B=$91 but Price of A+B = 101

Arbitrage:
Buy A and B Cost: $9+$91=$100
 Sell bundle AB for for $101
Profit = $1

Arbitrage

Trading assets that gives you a sure profit without exposing you to risk.

Arbitrage trades mean that prices are aligned across markets and aligned across securities

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Who Trades

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Who Trades

Retail Investors/households

Risk Averse: prefer a sure consumption stream over an uncertain one that has the same expected value

Increase Wealth
Hedge Risk

- Hedge Funds and Institutions
  - Sophisticated and informed

- Make Profits
- Private information

Retail Investors

Small relative to the size of the markets

Frequently hold **inefficient portfolios**

- Not properly diversified (too much risk for the return)
- Buy the wrong sorts of assets

Face high trading fees (implicit and explicit)

Trade too much

Hedge Funds and Trading Firms

Sophisticated trading firms.

Frequently take bets

Trade on information

Large enough to move markets (trades affect prices)

Leverage

Leverage: borrow money to invest.

Retail investors borrow through brokerage accounts

Sophisticated investors use derivative securities or complex trading strategies

Both types of investors need to post some form of collateral

Example: Leveraged Stock Investment

Invest $1 of your own money

Borrow $0.50 (assume borrowing rate is 0)

Total Investment is $ 1.5 in the stock.

Suppose that the stock price is currently $1, is equally likely to double to $2, or halve to $0.50

Leverage increases Return and Risk

Outcome	Stock	Loan	Total	Portfolio Return
100%	$3	($0.50)	$2.50	150%
-50%	$0.75	($0.50)	$0.25	-75%

Rehypothecation

Reusing pledged collateral in another transaction.

In the US this is restricted in securities markets

- In margin accounts up to 140% of Debt

ISDA (International Swap Dealer's Association) allows rehypothecation (institutional investors)

- Different rules US/Europe

Complex system

Participants are linked through collateral and payments due.

Challenge for regulators to understand where the

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Overview of Traditional Finance System

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Trading Financial Assets

Customer sends order to a broker

Broker trades in house or sends to a trading floor

Custody and Clearing at the DTCC

US Markets are fragmented

Assets are traded on multiple exchanges and trading venues.

Exchanges and venues compete to provide the best marketplace.

Arbitrageurs align prices across these trading venues "high frequency traders"

Limit Order Markets

	Price	Quantity
	10.3	1,000
	10.2	1,000
ASK	10.1	500
	10.0	
400	9.9	BID
1,000	9.8	
900	9.7	

- Posted orders specify a price and a quantity.
- The more orders that are posted, the easier it is for someone to trade large quantities without moving the price.

Trading Costs

In a perfect world, trade occurs at the fundamental value

Don't observe the fundamental value

$$\frac{Ask + Bid}{2} = midpoint$$

Cost to buy immediately $Ask - midpoint$

Measured $\text{Spread} = Ask - Bid$

Time Lag between Trade and Settlement

- After a price is agreed on, each trade has to be “cleared” and then “settled”
- Process takes time: Change in ownership is not instantaneous.
- Stocks, Bonds etc. in the US take one day to settle (recently changed)
- Time lag gives traders time to either find money to pay or find the security (if they need to).

Central Clearing

- Participants post margins based on trading volume
- Trades netted throughout the day, and margins may be increased.
- Margins provide insurance against any one party failing
- Central Clearing allows for netting of trades (vs gross flows)

RobinHood/Gamestop

- RobinHood had to post margin at the DTCC
- Massive Volume of Trade in one direction
- Called on to post more margin.
- Could not borrow enough.

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Payments: Transferring Value

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Payments

Processing payments is expensive.

- Old estimate (2000) is 3% of GDP to process payments.
- US lags behind many countries.
- Consumers often don’t see the costs.

Current payment methods differ in speed, finality, liability.

Multiple rails that allow value transfer

Money usually performs 3 functions:

1. (Stable) Store of Value.
   - ✓ Does not depreciate quickly
2. Unit of Account
   - ✓ Fees for all goods and services are stated in these terms.
3. Medium of exchange
   - ✓ Easy/safe to use in transactions

Only hold money if at some point someone will accept it for a real good or service.

- Gov't does this by accepting it as tax payments.
- Gov't can also pass rules on 'legal tender'

Only use fiat if the value will remain broadly stable over time (i.e., hold as a store of value until use as a medium of exchange).

- Very important mandate of the central bank to ensure low and stable inflation. (Else, purchasing power falls and fiat is no longer a stable store of value.)

Money is a social institution

Playing Card Money
1685-1728 (front)

Playing Card Money
1685-1728 (back)

Different Types of Money

In a modern economy, three types of money circulate and exchange at par.

1. Physical currency, aka Fiat currency.
   - This is an IOU from Central Bank to Consumers.
2. Central bank reserves.
   - These are an IOU from the Central Bank to Commercial Banks.
3. Commercial bank money.
   - This is an IOU from Banks to Consumers.

Money is a financial asset/liability

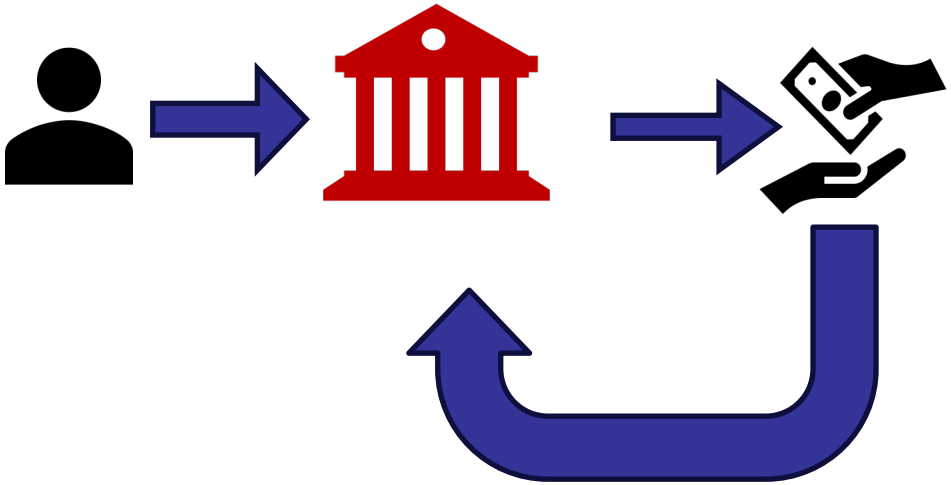
From a consumer's point of view

Most payment methods (aside from cash) are intermediated:

1. Credit/Debit cards
2. Zelle
3. Paypal
4. Money Market Funds

- Not "free"

Banks Create Money



- People Deposit money in banks.
- Banks make loans by creating new bank accounts

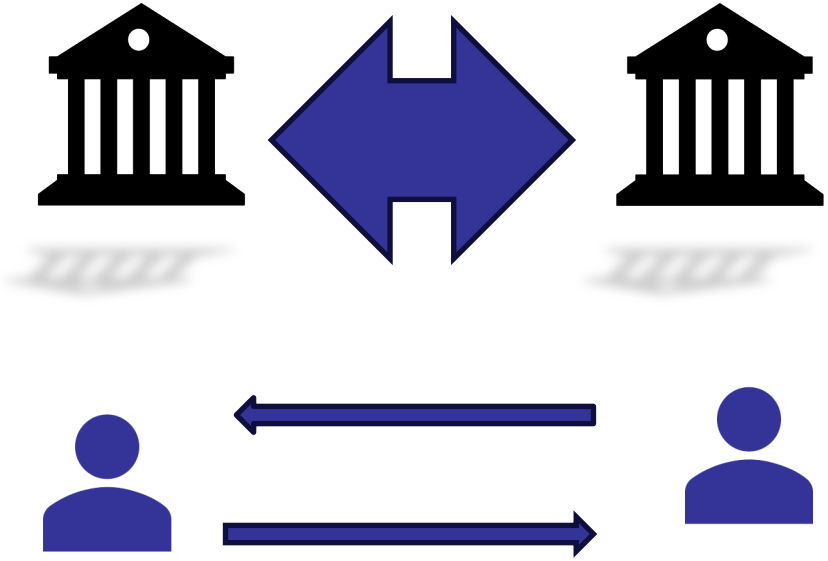
Fractional Reserve Banking

The loans that banks make are valuable assets but, not feasible for everyone to withdraw cash at the same time (there is not enough)

Banks are susceptible to runs

Capital and Liquidity requirements are in place to ensure resiliency.

Interbank payments



- Consumer payments generate liabilities between banks
- Interbank payments are settled through various wholesale platforms

What does/should a bank do?

Banks are a bundle of services

History dependent

Should these services be bundled?

Is it economically rational?