ECON2103: Financial Economics Lecture 5

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This week's topics

- Cryptocurrency
- Decentralized
- Bitcoin
- Signature scheme
- Hash functions
- Example with a central bank
- Removing a central bank
- A tamper-proof ledger
- PoW
- Debt vs equity
- Operating earnings
- Financial leverage
- Financial distress
- Debt-to-assets ratio
- Return on assets
- Earnings per share
- Degree of financial leverage
- Increased leverage
- Financial flexibility
- Slack

Source

- “Cryptocurrencies: Protocols for Consensus” by Andrew Lewis-Pye From Notices of the American Mathematical Society Vol 67 No 9

Cryptocurrency?

- The novel feature of Bitcoin as a currency is that it is designed to be *decentralized*.
- "*Decentralized*" means that it runs without using a central bank or any centralized point of control.
- Bitcoin is one example of *Cryptocurrency*.
- Cryptocurrencies are protocols for reaching consensus over a decentralized network of users – There are other applications!

Bitcoin

- The path taken by Bitcoin is to weight users according to their computational power.
- How does it work?
- We need two basic tools: *signature schemes* and *hash functions*.

Signature schemes

- When one user wishes to send a message to another, the signature scheme produces a signature.
- This signature is specific to the message and the user.

Hash functions

- Hash functions take binary strings of any length as input and produce strings of a fixed length as output.
- Hash functions normally produce 256 bit strings.
- The 256 bit output is referred to as the hash of the input string.
- In practice, we will never find two strings that has to the same value.
- If tasked with finding a string that hashes to a value with certain properties, there is no more efficient method than trying inputs to the hash function one at a time and seeing what they produce.

Implementing a centralised digital currency

- Two aims that need to be achieved:
  - Only the owner of the coin can use it;
  - The owner cannot double spend.

Example

- We consider what will happen to a single coin.
- There are three individuals, Frank, Alice and Bob.
- First, Frank owned the coin.
- Second, Alice owned the coin.
- Third, Bob owned the coin.
- The coin records the sequence of owners – ledger (account record).

Example: with a central bank

- A coin is a binary (made up of only two numbers) record identifying the sequence of owners.

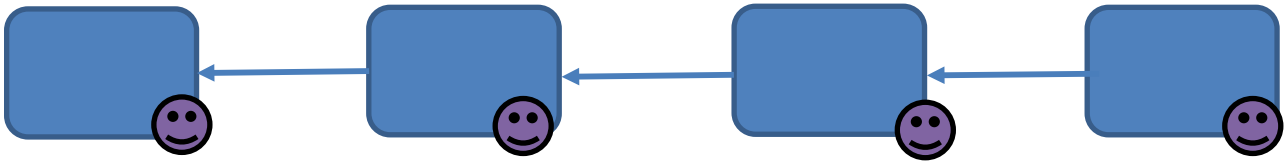
- ☺ indicates “signed.”
- The central bank checks the signature and confirms the record once the signature is verified.

Removing the central bank

- A universal ledger records what happens to all coins.
- A universal ledger records what happens to all coins.
- Each user stores a universal ledger, which is a chain of signed transactions.
- A tamper-proof ledger: We do not want a malicious user to be able to remove intermediate transactions and produce a version of the universal ledger which looks valid.

A tamper-proof ledger

- Each transaction points to the previous transaction.



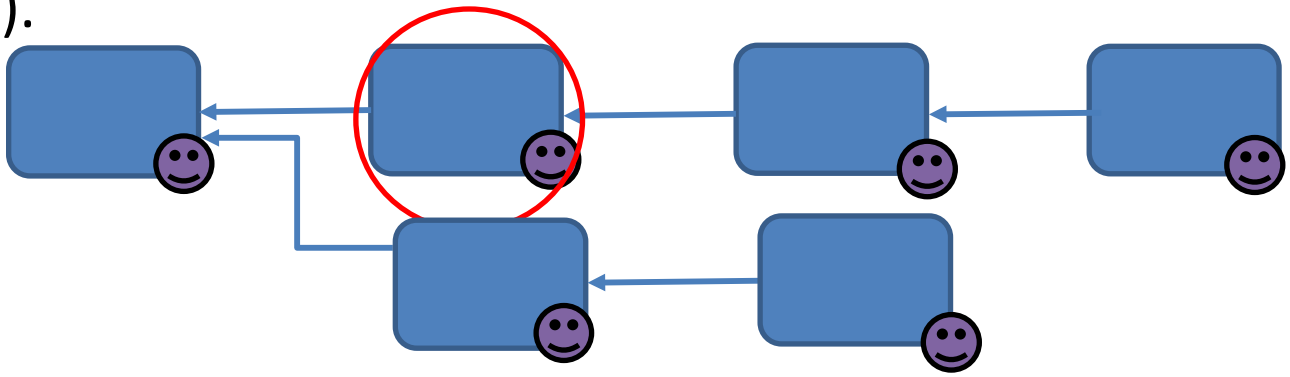
- Each signed transaction includes the hash of the previous transaction as part of its data.
- Because hash values are in effect unique, this hash value serves as a unique identifier.

The key idea: PoW

- We specify a computational puzzle corresponding to each transaction, which is specific to the transaction, and which can be solved only with a lot of computational work.
- The solution to the puzzle corresponding to a given transaction is called a proof-of-work (PoW) for that transaction.
- A transaction cannot be included in the universal ledger, unless accompanied by the corresponding PoW.

Example

- Suppose that Alice wants to reverse the red-circled transaction (*t = 2*).



- Alice has to form a new chain that does not include *t=2*.
- While Alice is building her new chain, the rest of the network combined is working to build the other chain – ***Alice needs more computational power than the rest of the network combined!***

Debt vs equity

- If management elects to finance the firm's operations with debt, the creditors (lenders) expect the interest and principal—fixed, legal commitments—to be paid back as promised.
- Failure to pay may result in legal actions by the creditors.
- If the firm finances its operations with equity, the owners expect a return in the form of dividends, an appreciation of the value of their equity interest (i.e., capital gain), or, as is most likely, some combination of both.

Operating earnings and its implication

- Consider the following three possible outcomes for the firm's operating earnings (i.e., earnings from operations before interest expense) generated by the $100 million invested and any returns on it, and the associated consequences for lenders and owners.

Operating earnings	*Implication for lenders*	*Implication for owners*
More than $10 million	Debt obligation satisfied	Profit generated equal to the operating earnings reduced by $10 million
$10 million	Debt obligation satisfied	No profit or loss
Less than $10 million	Shortfall in required repayment, equals $110 million less the amount of operating earnings generated	Loss equal to the difference between $10 million and the operating earnings generated

Financial leverage and financial distress

- Financial leverage refers to the use of financing that has fixed, but limited, payments.
- Financial distress is the condition where management makes decisions under pressure to satisfy its legal obligations to its creditors—decisions that may not be in the best interests of the company's owners.
- One measure of the extent to which debt figures in the capital structure is the debt ratio:

  Debt ratio = Par value of debt/Market value of equity.

- The greater the debt ratio, the greater the use of debt relative to equity financing.

Debt-to-assets ratio

- Another measure is the debt-to-assets ratio, which is the extent to which the firm's assets are financed with debt:

Debt-to-assets ratio = Par value of debt/Market value of total assets.

- This is the proportion of debt in a company's capital structure.

Capital structure and financial leverage

- The concept of leverage plays a role in affecting the company's financial risk because leverage amplifies the effects of out- comes, good or bad.
- The fixed and limited nature of a debt obligation affects the risk of the earnings available for distribution to the owners.

Example

- Consider a firm that has $20 million of assets, all financed with equity.
- We refer to such a firm as “100% equity financed” or “unlevered.”
- Suppose that there are 1 million shares of stock of this firm outstanding, valued at $20 per share.
- In this case, the equity is $20 million, equal to the value of the assets, and the debt is zero.

Example continued

- Suppose further that the firm's management
  - (1) has identified investment opportunities requiring $10 million of new funds and
  - (2) can raise the funds in one of the following three ways:
- Financing package 1: Issue $10 million equity (500,000 shares of stock at $20 per share)
- Financing package 2: Issue $5 million of equity (250,000 shares of stock at $20 per share) and borrow $5 million with an annual interest of 10%
- Financing package 3: Borrow $10 million with an annual interest of 10%

Return on assets

- Suppose the firm has $4.5 million of operating earnings. We refer to the return that the firm earns on its operating assets as the return on assets (ROA).
- For our hypothetical firm, the ROA is 15% (=$4.5/$30).
- And suppose there are no taxes.
- To illustrate the concept of financial leverage, consider the effect of this financial leverage on the company's earnings per share.

Earnings per share

- The earnings per share (EPS) is the ratio of the earnings available to the owners divided by the number of shares outstanding.
- The EPS for the three financial packages are shown in Table 5.2 assuming a 15% ROA.
- Similarly, different EPS can be computed for different assumptions about the ROA.
- Table 5.3 shows the EPS for each of the three financing packages based on three assumptions about the ROA—15%, 10%, and 5%:

Example

- This example illustrates the effect of debt financing on operating risk (as measured by the variability of operating earnings).
- The greater the use of debt vis-a-vis equity, the greater the operating risk.
- Additionally, by comparing the outcomes for the different operating earnings scenarios—$4.5, $3.0, and $1.5 million—the effect of adding financial risk to the operating risk magnifies the risk to the owners.
- Comparing the results, each of the alternative financing packages shows that as more debt is used in the capital structure, the greater the variability of the EPS.

TABLE 5.1
SUMMARY OF THE CAPITAL STRUCTURE FOR THREE FINANCING PACKAGES

Financing package	*Assets (millions)*	*Debt*	*Equity*	*No. of shares (millions)*	*Debt-to-equity ratio*	*Debt-to-assets ratio*
1	$30	$ 0	$30	1.50	0.0%	0.0%
2	$30	$ 5	$25	1.25	20.0%	16.7%
3	$30	$10	$20	1.00	50.0%	33.3%

TABLE 5.2
EARNINGS PER SHARE RESULTING FROM THREE FINANCING PACKAGES

	Financing package		
	1	2	3
Operating earnings in millions	$ 4.5	$ 4.5	$ 4.5
− Interest expense in millions	0.0	0.5	1.0
= Earnings available to owners in millions	$ 4.5	$ 4.0	$ 3.5
No. of shares in millions	1.5	1.25	1.0
Earnings per share	$3.00	$3.20	$3.50

Earnings per share

- Table 5.3 shows the EPS for each of the three financing packages based on three assumptions about the ROA—15%, 10%, and 5%:

TABLE 5.3
EARNINGS PER SHARE FOR DIFFERENT RETURN ON ASSETS FOR THREE FINANCING PACKAGES

	Financing package		
Assumed ROA	*1 (least leverage)*	*2*	*3 (most leverage)*
15%	$3.00	$3.20	$3.50
10%	$2.00	$2.00	$2.00
5%	$1.00	$0.80	$0.50

Degree of financial leverage

- Another way to view financing effects is to calculate the degree of financial leverage, DFL:

$$DFL = \frac{\text{Earnings before interest and taxes}}{\text{Earnings before interest and taxes} - \text{Interest}}$$

- The DFL for the three financing packages at a 10% ROA, or $3 million in operating earnings, is:

Financial Package	1	2	3
DFL at 10% ROA	1.0	1.2	1.5

- From the above, we can see that financing package 3 has the highest degree of financial leverage.

Increased leverage

- Recall that increased leverage means more debt is used in the capital structure relative to equity, and consequently the greater the volatility of the EPS.

Financial leverage and financial flexibility

- A company with unused debt capacity, sometimes referred to as financial slack, is more prepared to take advantage of investment opportunities in the future.
- The ability to exploit future strategic options is valuable and, hence, taking on debt decreases slack, with the result that the company may not be sufficiently nimble to act on valuable opportunities.

Key points 1

- The capital structure decision is usually analyzed by managing the risks associated with financing decisions while taking a company's business risk as given.
- The cost of capital is the return that must be provided for the use of an investor's funds.
- An optimal capital structure is the mix of financing that maximizes the firm's value.
- If an optimal structure exists it will both maximize firm value and minimize the firm's cost of capital.

- The concept of financial leverage plays a role in affecting investor risk because leverage exaggerates the impacts of either favorable or unfavorable outcomes.
- Financial leverage makes use of additional debt; that is, increased leverage increases the firm’s debt-equity ratio.