Financial Trading

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Lecture 8
Arbitrage

Agenda and objectives of the lecture

- Agenda
  1. Definition and examples of arbitrage.
  2. Economic characterizations of arbitrage.
- Objectives
  1. Be able to construct simple arbitrage trading strategies.
  2. Understand the roles of arbitrageurs in determining prices.

Relevant article

Article 8-A: Bitcoin's Crashing? That Won't Stop Arbitrage Traders From Raking in Millions

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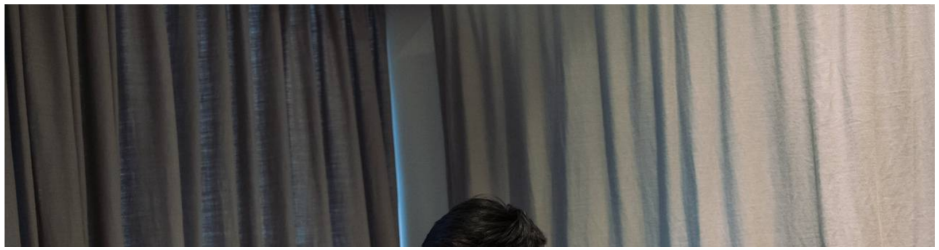
Bitcoin's Crashing? That Won't Stop Arbitrage Traders From Raking in Millions

Cryptocurrency arbitrageurs cash in on wide price disparities between exchanges



Arbitrage: Textbook definition

- Arbitrage arises if an investor can construct a zero-investment portfolio with a sure profit.
- Zero-investment: Since no net investment outlay is required, an investor can created arbitrarily large positions to secure large levels of profit.
- In a well-functioning market (efficient market) such profitable arbitrage opportunities will quickly disappear as a result of supply and demand pressure.
- Note that arbitrage involves
  1. Pricing mistake
  2. No own capital
  3. No risk

Arbitrage: An example

Maple bacon donut:

1. 1 donut @ \$1.5 a piece
2. 2 pieces of bacon @ \$0.50 a piece
3. 3 spoons of maple syrup @ \$.25 per spoon
4. no other cost for making or selling a donut; competitive market for donut and its ingredients

- What would you do if the current price of the maple bacon donut is \$5?
- What would you do if the current price of the maple bacon donut is \$1.5?
- What is no-arbitrage price of maple bacon donut?

Arbitrage: An example

Value of stocks in 1 month:

Stock	Recession	Normal	Boom
A	12	7	15
B	8	13	5
C	9	9	9

If all of these stocks cost \$8 today, are there any arbitrage opportunities?

Arbitrage: An example (cont.)

Value of stocks in 1 month:

Stock	Recession	Normal	Boom
A	12	7	15
B	8	13	5
C	9	9	9

If all of these stocks cost \$8 today, are there any arbitrage opportunities? Consider the following strategy:

Long/Short	Portfolio	Cash flow today	Cash flow in one month
Short	2C	\$16	-\$18
Long	A+B	-\$16	\$20
		\$0	\$2

This opportunity should not persist in competitive capital markets!

Arbitrage (cont.)

- In practice the initial investment may not be zero and the profit may be risky. Hence, we may use the term speculative arbitrage.
- Arbitrageurs trade correlated assets. They buy what is cheap and sell what is expensive.
- The difference in prices is called the basis or arbitrage spread.
- The individual positions are called legs.
- The arbitrage portfolio is called the hedge portfolio.
- Imagine that the hedge portfolio is an instrument.
- Arbitrageurs buy and sell the hedge portfolio.
- Any trading strategy can be applied to the hedge portfolio.

Arbitrage (cont.)

- Returns are correlated when they depend on common fundamental factors.
- A long position in one asset and a short position in a correlated asset reduces volatility due to common factors.
- Hedge portfolios usually are less risky than their individual elements.
- Arbitrageurs make money if the basis closes.
- In a pure arbitrage, some physical or institutional process closes the basis.
- Some pure arbitrages are almost risk free.
- In a speculative arbitrage, instrument-specific fundamental factors may prevent the basis from closing.

Arbitrage: An example

Consider a futures contract to purchase a non-dividend-paying stock in 3-months. Assume the current stock price is \$40 and the 3-month risk-free interest rate is 5% per year continuously compounded. Suppose the futures price is \$43. Is there an arbitrage opportunity?

- Arbitrageur borrows \$40 at the risk-free rate of 5% per year. Buy one share and short a futures contract to sell one share in 3 months.
- After three months, the arbitrageur delivers the share and earns \$43 dollars.
- Her costs are $\$40e^{0.05\times 0.25} = \$40.50$.
- The arbitrageur profits \$43-40.50 = \$2.50 per share.

Arbitrage opportunity (with futures price \$43) works so long as the price is above \$40.50.

Arbitrage: An example (cont.)

Consider a futures contract to purchase a non-dividend-paying stock in 3-months. Assume the current stock price is \$40 and the 3-month risk-free interest rate is 5% per year continuously compounded. Suppose the futures price is \$39.5. Is there an arbitrage opportunity?

- Arbitrageur shorts one share at \$40.
- She invests the \$40 in the risk-free investment at the 5% rate.
- Arbitrageur then takes a long 3-month futures contract.
- She earns in 3-months $40e^{0.05\times 0.25} = \$40.50$.
- At the end of the three months she takes delivery of the share in the long contract and closes out the short position for a gain of \$40.5 - 39.50 = \$1.

Arbitrage opportunity (with futures price \$39.50) works so long as the price is below \$40.50.

Arbitrage: An example (cont.)

Arbitrage opportunity (with futures price \$39.50) works so long as the price is below \$40.50.

Futures price = \$ 43	Futures price = \$39.50
Action now	*Action now*
Borrow \$40 at 5% for 3 months	Short 1 unit of asset to earn \$40
Buy 1 unit of the asset	Invest \$40 at 5% for 3 months
Enter into futures contract to	Enter into a futures contract to
sell asset in 3 months for \$43	buy the asset in 3 months for \$39.5
Action in 3 months	*Action in 3 months*
Sell asset for \$43	Buy asset for \$39.50
Use \$ 40.50 to repay the loan with interest	Close short position
	Receive \$40.50 from investment
Profit realized = \$2.50	Profit realized = \$1

Arbitrage: An example

- If the price of oil in Rotterdam is less than the price of oil in New York (less the cost of shipping to New York), buy Rotterdam oil and sell New York oil.
- Ship oil from Rotterdam to New York.
- Shippers are the natural arbitrageurs.
- In practice, Persian gulf oil already on board ship is simply rerouted.

Risks involved in speculative arbitrage

- Fundamental risk,
- Noise trader risk,
- Implementation cost.

Fundamental risk:

- Arbitrageurs may identify a mispricing of a security that does not have a close substitute that enables riskless arbitrage.
- If a piece of bad news affects the substitute security involved in hedging, the arbitrageur may be subject to unanticipated losses.

Speculative arbitrage: Pairs trading

- A pairs trading strategy employs two nearly identical securities in the arbitrage process.
- If the prices of two securities depend on common factors, their returns should be correlated.
- The correlation will not be perfect if the prices also depend on firm-specific factors.
- If one security price rises and the other does not, either
  - the common factors may be mispriced or
  - the firm-specific factors have changed.
- If the common factors are mispriced, either
  - the first price will fall or
  - the second price will rise.
- Pairs traders speculate on common factors mispricing.
- A notable pairs trader was hedge fund Long-Term Capital Management.

Fundamental risk: An example

- Suppose Coke and Pepsi traditionally trade at a similar valuation, a P/E of 10.
- Suppose for some reason Coke has become very expensive at 20 $\times$ earnings, while Pepsi remains at a 10 $\times$ multiple.
- The arbitrageur would go long Pepsi, and short Coke. When the multiples converge to historical equality, at some point in the future, the arbitrageur would realize gains.
- But what if Pepsi declined to a 5 $\times$ multiple and Coke increased to a 30 $\times$ multiple for the next 5 years?
- The arbitrageur is exposed to the fundamental risks of each security.

Risks involved in speculative arbitrage: Noise trader risk

- Fundamental risk,
- Noise trader risk,
- Implementation cost.

Noise trader risk:

- Noise traders may limit arbitrage.
- Once a position is taken, noise traders may drive prices farther from fundamental value, and the arbitrageur may be forced to invest additional capital, which may not be available, forcing an early liquidation of the position.

Noise trader risk: Example

- 2011 bankruptcy of MF Global.
- Long term capital management.

Risks involved in speculative arbitrage: Implementation costs and other consideration

- Fundamental risk,
- Noise trader risk,
- Implementation cost.
- Short selling is often used in the arbitrage process, although it can be expensive due to the "short rebate," representing the costs to borrow the stock to be sold short.
- In some cases, such borrowing costs may exceed potential profits. If short rebate fees are 10% or 20%, then arbitrage profits must exceed these costs to achieve profitability.
- Another consideration to the arbitrage process relates to limits imposed by variations in performance, and how they affect money manager incentives.

Risks involved in speculative arbitrage: Implementation costs and other consideration

- Consider the pressures produced by "tracking error," or the tendency of returns to deviate from a benchmark.
- You have a job investing the pensions of 100,000 firemen. You have a choice of investment strategies. You can invest in:
  1. Strategy A: A strategy that you know (by some magical means) will beat the market by 1% per year over 25 years. You also know that you will never underperform the index by more than 1% in a given year.
  2. Strategy B: An arbitrage strategy that you know (again by some magical means) will outperform the market, on average, by 5% per year over the next 25 years. The catch is that you also know that you will have a 5-year period where you underperform by 5% per year.
- Which strategy do you choose? If you are a professional money manager, the choice is obvious: you choose A.
- Why choose A? It a bad strategy relative to B.

Relevant article

Article 8-B: Ultrafast Trading Costs Stock Investors Nearly $5 Billion a Year, Study Says

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Ultrafast Trading Costs Stock Investors Nearly $5 Billion a Year, Study Says

U.K. regulator's study says 'latency arbitrage' imposes a small but significant tax on investors

RECOMMENDED VIDEOS

Relevant article

Article 8-C: Some Investors Find Stability in SPACs

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Some Investors Find Stability in SPACs

Mania for blank-check companies and subsequent selloff has created what some see as an alternative to short-term bonds

Questions for class discussion

- What limits arbitrage profits?
- Why don't arbitrage opportunities exist for long periods of time?
- Does arbitrage destabilize prices? Does it increase volatility?