FINM3405 Derivatives and Risk Management

Week 1: Introduction to derivative markets

Dr Godfrey Smith

July 19, 2024

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Other useful concepts

- Present value: Law of finance
- Arbitrage: Law of one price

Course admin

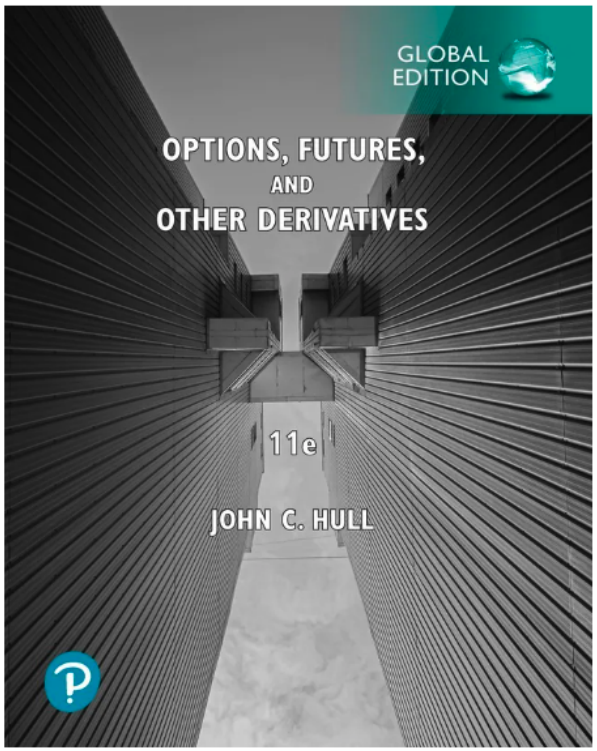
Lecturer and course coordinator:

- Dr Godfrey Smith: Undergrad finance, 2000s in industry, left during GFC, Master of Science and PhD in pure maths (UQ), in industry since 2015 as a mathematician and machine learning engineer.
- Office hours: Mondays 11am to and after lecture, room 39-309.
- Email: finm3405@business.uq.edu.au.
- Please direct all course admin and assessment enquiries to me.

Course admin

Course materials:

- Lecture notes and Echo360 recordings provided on Blackboard.
- Tutorial questions and solutions also provided on Blackboard.
- Supplementary readings will also be provided for tome topics.
- Textbook: Hull's Options, Futures, and Other Derivatives, 11ed:



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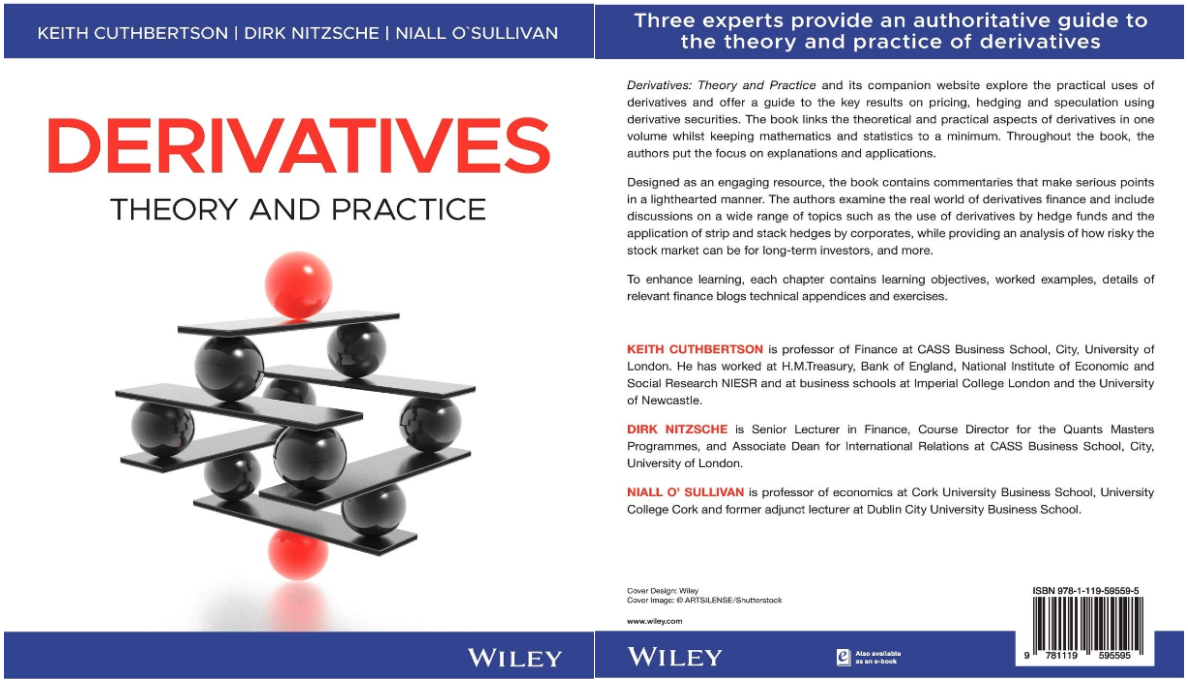
For an alternative perspective, I recommend the the following book which is available in softcopy from the UQ library website:

- Nitzsche, Cuthbertson, O'Sullivan, Derivatives: Theory and Practice.

It's not compulsory but some students may find the relevant chapters useful and helpful, and they're written at about the same level as Hull.



Course admin

Course communication:

- Blackboard announcements.
- Email: finm3405@business.uq.edu.au.
- In person: During tutorials and consultation times.
- Online: Microsoft Teams course site is also set up.
  - I will check it daily.

Course admin

Assessment:

Category	Assessment task	Weight	Due date
Paper/ Report/ Annotation, Reflection	Team Project Team or group-based	30% (Report 25%; Reflection 5%)	Report 4/10/2024 11:00 pm Reflective Piece - Individual 8/10/2024 11:00 pm Peer Assessment - Individual 8/10/2024 11:00 pm
Examination	In-Semester Exam Identity Verified In-person	20% Individual	In-semester Saturday 31/08/2024 - 14/09/2024
Examination	Final exam Identity Verified In-person	50% Individual	End of Semester Exam Period 2/11/2024 - 16/11/2024

More details will be provided in due course, but:

- Start forming your Team Project groups of 4 students now!

Introduction to derivatives

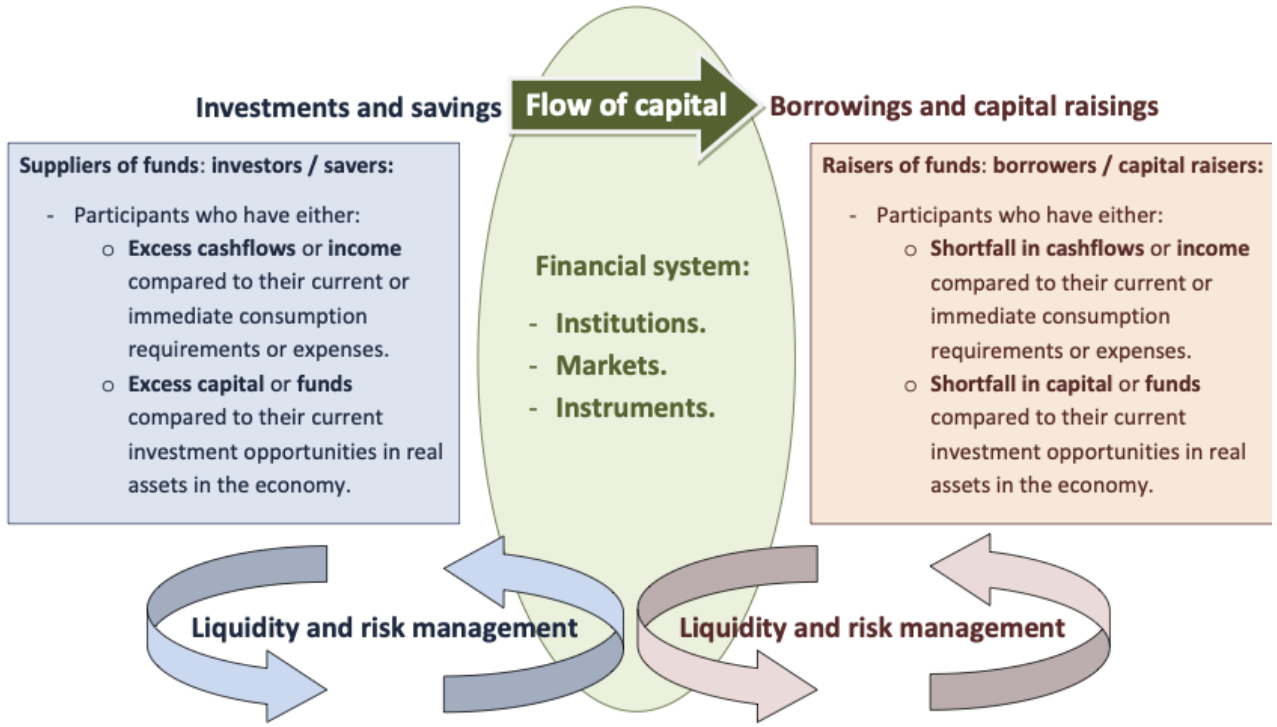
This week we give a broad overview and outline of derivative securities and their markets. We introduce the basic contracts and look at the relative sizes of derivative security markets, including comparing OTC vs exchange traded markets, which motivates the specific derivatives we focus on in the course. We then look at some basic uses of derivative securities and finish with refreshing the central concepts of present value and arbitrage, concepts we draw upon throughout the course.

- Readings: Chapters 1 and 2 (and chapter 10) of the textbook.

Function of the financial system

Derivative securities facilitate the management of risks that arise when:

- The financial system performs its core function of transferring savings and investment funds to long-term investments in real assets.
- Businesses simply go about their usual day-to-day trading activities.

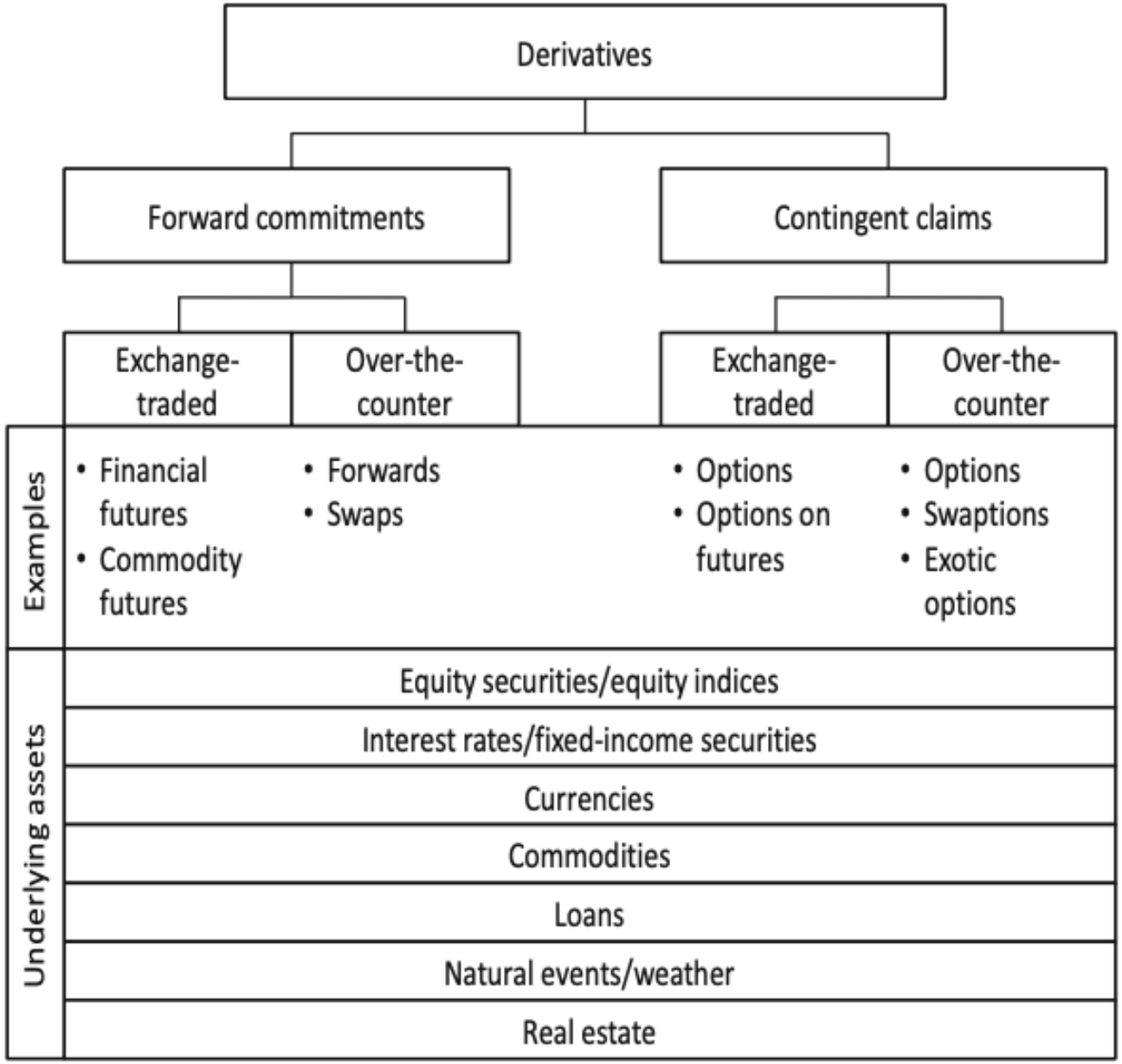


Vanilla derivatives and payoffs

A **derivative** security is a contract between two or more **counterparties** specifying one or more future transactions that are dependent on (are "derived" from) other **underlying assets**.

- **Futures and forwards**: Contracts obligating the parties to trade the underlying asset for an agreed price on a future date.
- **Options**: Contracts giving one party the right but *not the obligation* to trade the underlying asset for an agreed price in the future.
- **Swaps**: Contracts involving the exchange or "swapping" of future cashflow obligations or risk exposures between the parties.

Vanilla derivatives and payoffs



Vanilla derivatives and payoffs

- Derivative securities can be negotiated directly between parties OTC, or standardised contracts traded on **trading venues**:
  - Traditional exchanges, multilateral trading facilities (MTF) in Europe, and alternative trading systems (ATS) in the US.
- Underlying assets include physical assets, financial securities or instruments, financial market indices or other variables, currencies, commodities, energy, other derivatives, etc.
- The underlying assets can be physically deliverable in the contract, or the derivative security can be cash settled with no physical delivery of the underlying asset ever taking place.

We now give a brief description of the above basic classes of derivatives: futures/forwards, options and swaps.

Futures and forwards

Futures and **forwards** are contracts obligating two parties to trade an agreed quantity of the underlying asset for an agreed **contract price** K on an agreed future date T (the **maturity date**).

The basic difference between futures and forward contracts is:

- Futures are standardised contracts traded on trading venues.
- Forwards are negotiated between the parties in OTC markets.

The party agreeing to buy the underlying asset is said to be taking a **long** position. The party agreeing to sell the underlying is said to be **short**.

Futures and forwards

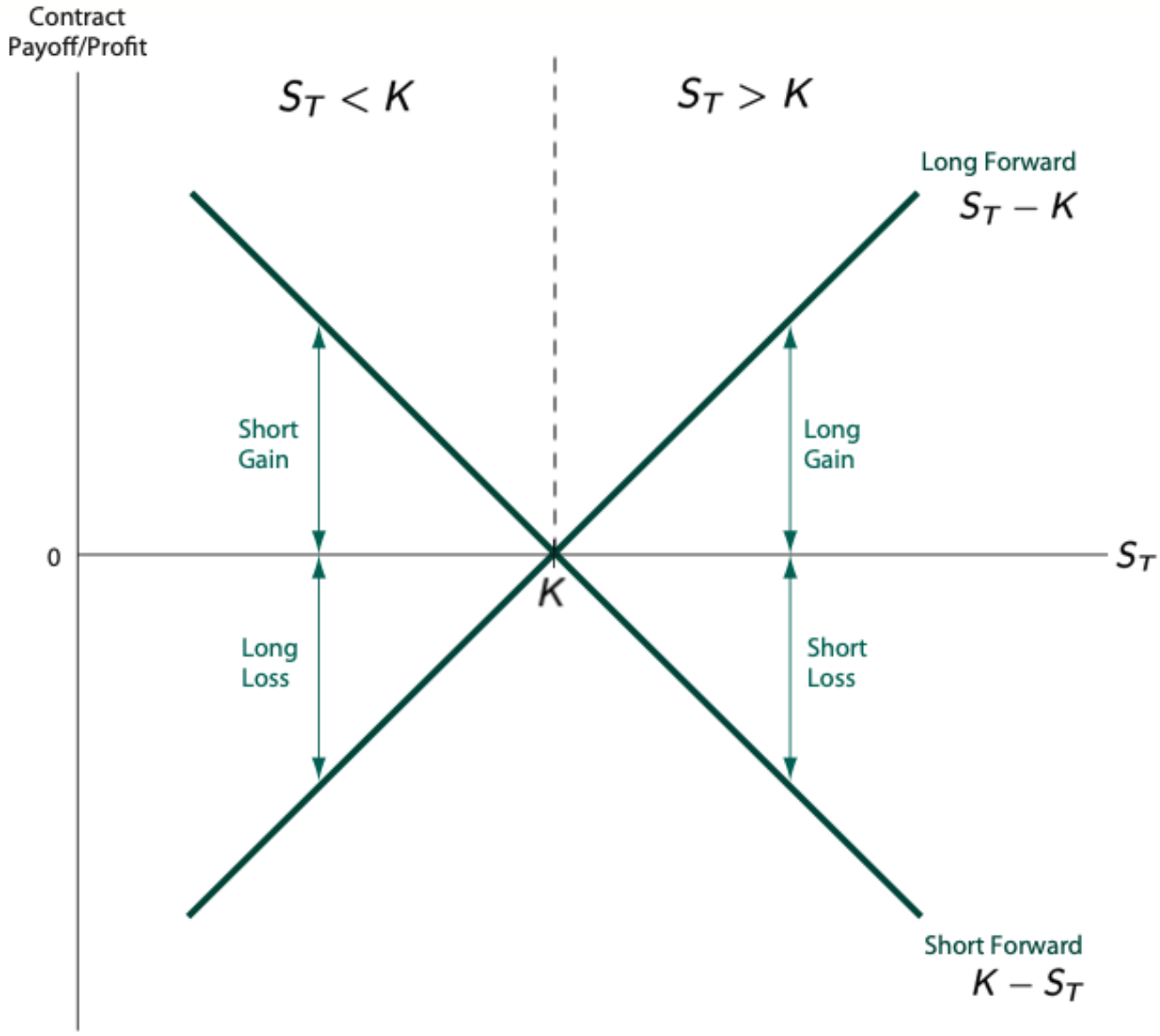
At maturity T, the long party buys the underlying asset for K. If $S_T > K$ at maturity, then the long party has benefited by the amount $S_T - K$. But if $S_T < K$ at maturity then the short party, who sells the underlying asset for K, has benefited by the amount $K - S_T$.

- Hence, the **payoffs** to the long and short parties are:

$$\text{long payoff} = S_T - K \qquad \text{and} \qquad \text{short payoff} = K - S_T.$$

We plot these payoffs graphically as follows:

Futures and forwards



Options

There's two basic types of option contracts, namely call and put options:

The holder of a European **call** option has the *right but not the obligation* to buy an agreed quantity of the underlying asset for an agreed **strike price** K on an agreed future date T (**expiry**).

The holder of a European **put** option has the *right but not the obligation* to sell an agreed quantity of the underlying asset for an agreed **strike price** K on an agreed future date T (**expiry**).

Note that an **American** option gives the holder these rights to exercise an option at any point up and including the expiry date T.

Options

The holder of an option is also called the **taker**, and is said to be **long**.

The other party to the contract is called the **writer** and said to be **short**.

> The writer has "no rights" and is "at the mercy" of the holder if the holder decides to exercise the option at expiry (European options) or anytime up to and including expiry (American options):

- Call option: The writer must sell the underlying asset if the taker exercises their right to buy it.
- Put option: The writer must buy the underlying asset if the taker exercises their right to sell it.

Options

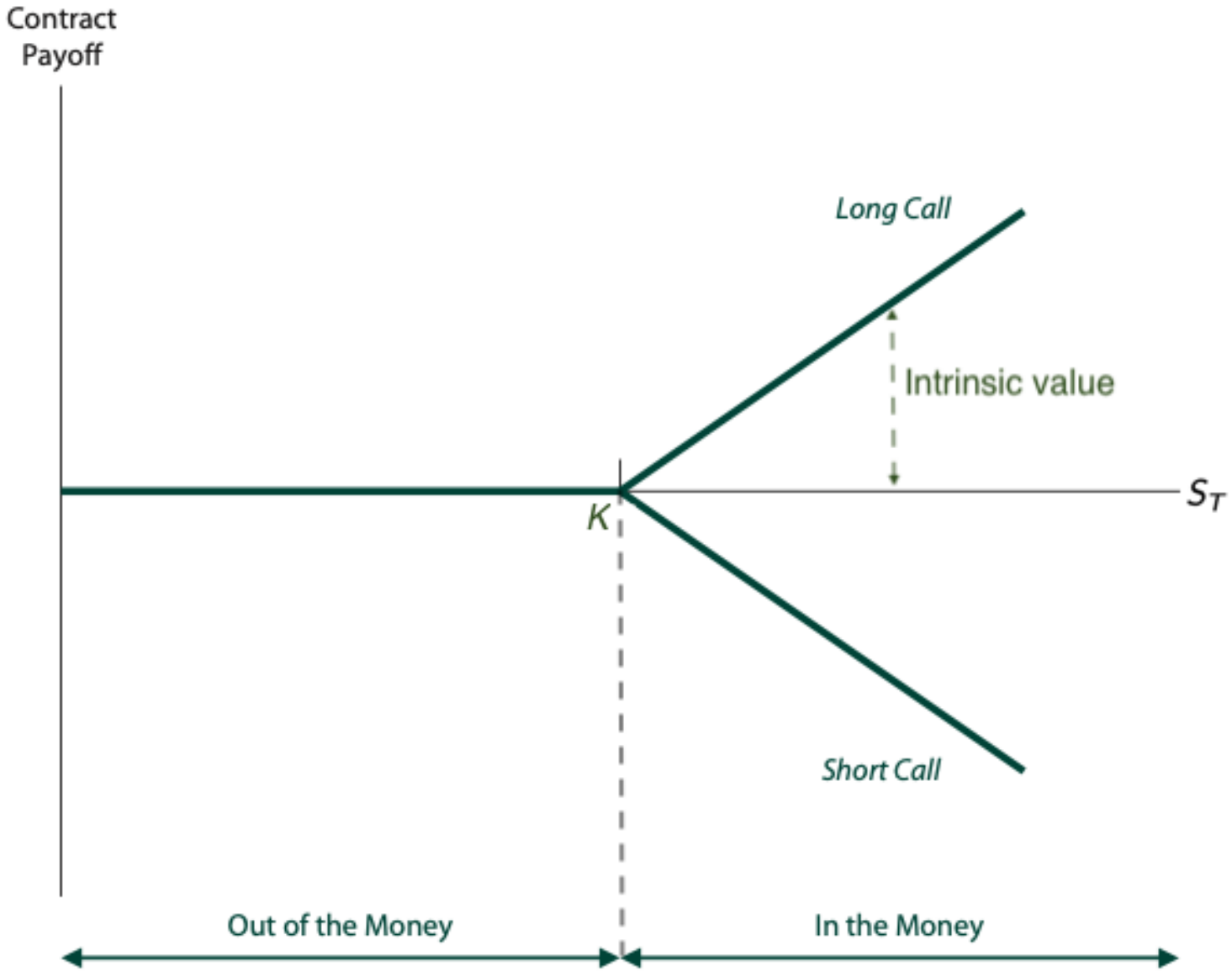
At expiry T, the call option holder has the right but not the obligation to buy the underlying asset for K. If $S_T > K$ at expiry, then the holder has benefited by the amount $S_T - K$ and will exercise the option. But since the holder has no obligation to exercise the option, if $S_T < K$ at expiry, then the holder doesn't exercise it and simply lets it expire worthless.

- Hence, the European **call holder's payoff** at expiry is

$$\text{call holder payoff} = \max\{0, S_T - K\}.$$

The call writer's payoff is the negative of this.

Options


Contract
Payoff
Long Call
Intrinsic value
S_T
K
Short Call
Out of the Money
In the Money

Options

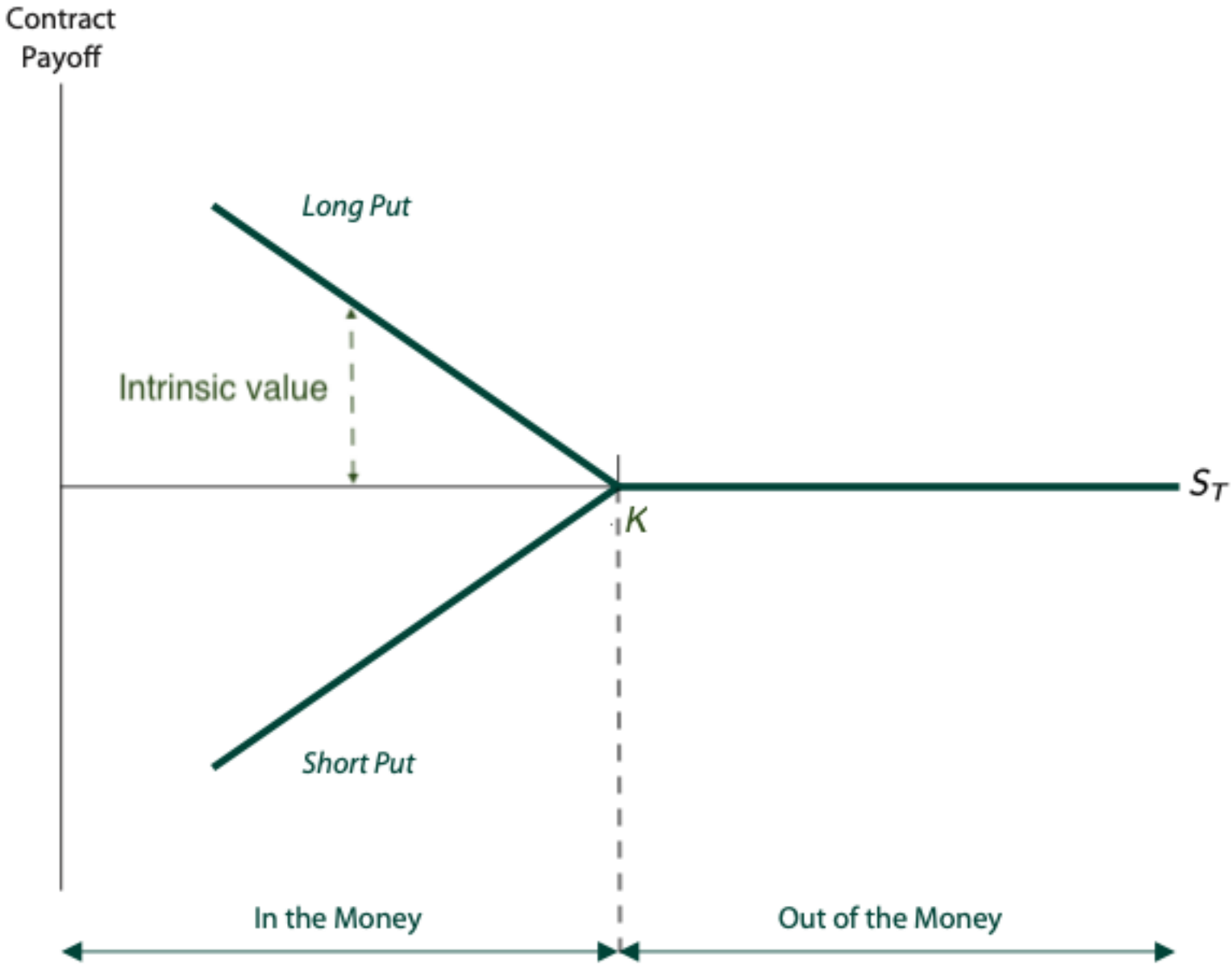
At expiry T, the put option holder has the right but not the obligation to sell the underlying asset for K. If $S_T < K$ at expiry, then the holder has benefited by the amount $K - S_T$ and will exercise the option. But since the holder has no obligation to exercise the option, if $S_T > K$ at expiry, then the holder doesn't exercise it and simply lets it expire worthless.

- Hence, the European **put holder's payoff** at expiry is

$$\text{put holder payoff} = \max\{0, K - S_T\}.$$

The put writer's payoff is the negative of this.

Options


Contract
Payoff
Long Put
Intrinsic value
S_T
K
Short Put
In the Money
Out of the Money

Swaps

Swaps come in "all shapes and sizes" and in this course we focus on:

- Interest rate swaps.
- Foreign exchange (FX) swaps.
- Currency swaps.
- Credit default swaps.
- Possibly some others, time permitting.

Interest rate swaps

A plain vanilla **fixed-for-floating interest rate swap** involves two parties swapping their existing loan payment obligations:

- One party swaps fixed-rate payments with floating-rate payments.
  - They have an existing fixed-rate loan but want to pay floating.
- The other swaps floating-rate payments with fixed-rate payments.
  - They have an existing floating-rate loan but want to pay fixed.

Hence, interest rate swaps can help businesses manage interest rate risk. Also, they enable a business to borrow at terms most favourable to them and then swap their loan to their desired interest rate exposure, thus helping the business to reduce borrowing costs.

Interest rate swaps

The mechanics of a fixed-for-floating swap can be described as follows:

- The parties continue to pay off their original loans as per normal.
- On each loan payment date:
  - The parties calculate their new desired and contracted loan payments, as negotiated and agreed between them in the swap.
  - One party exchanges a net amount to the other so that this exchange combined with their original loan payment results in them achieving their overall desired loan payment exposure as agreed in the swap.

Note that interest rate swaps are overwhelmingly traded OTC.

FX swaps

A **foreign exchange** (**FX**) **swap** is an agreement to exchange one currency for another at an agreed rate on an agreed date and to re-exchange those two currencies at a later date at an agreed rate.

- They are typically used for exchange rate risk management.

So in a FX swap you simultaneously agree to two transactions, namely an initial transaction and then a reversing transaction at a later date.

- The initial transaction can be spot or on a future date.
- If it's spot then they're typically called a **spot-forward FX swap**.

FX swaps are negotiated and arranged OTC.

Currency swaps

A **currency swap** is an agreement between two parties to swap interest payments on a loan made in one currency for interest payments on a loan made in another currency.

- Hence, each party has an existing loan in their respective currency, but now wants to make their loan payments in the other's currency.

A currency swap may also involve the parties exchanging the loan principal, which is then exchanged back at the swap's maturity date.

- This is effectively a FX swap feature added to the currency swap.

Again, only a net amount is transferred on each loan payment date:

Currency swaps

The mechanics of a currency swap can be described as follows:

- The parties continue to pay off their original loans in their original currencies as per normal.
- On each loan payment date:
  - The parties calculate their new loan payments in their desired currencies, as agreed in the currency swap.
  - One party exchanges a net amount to the other which combined with their original loan payment results in them achieving their overall desired loan payment exposure in their desired currency.

Currency swaps

Not only can currency swaps contain a FX swap feature, but they can also contain a fixed-for-floating interest rate swap feature:

- One party has borrowed at a fixed rate in one currency but now wants to now pay their loan at a floating rate in the other currency!
- The other has borrowed at a floating rate in their currency but now wants to pay off their loan at a fixed rate in the other currency!

This is termed a **fixed-for-floating currency swap**, and I think you get the idea of what fixed-for-fixed or floating-for-floating currency swaps are.

Currency swaps

Currency swaps enable businesses to manage their exchange rate (and interest rate) exposures. In general, the "full package" of a fixed-for-floating currency swap with a FX swap feature enables a business to borrow in the currency and at loan terms most favourable to them, and then swap into their desired currency and interest rate exposures, thus helping the business to reduce borrowing costs and manage exchange rate and interest rate risk at the same time.

- Currency swaps are negotiated and arranged OTC.

Credit default swaps

A **credit default swap** is effectively an insurance contract between two parties in which one party purchases protection for a defined period of time from another party against losses from the occurrence of some credit event, usually default of a third party called the **reference entity**.

- The buyer pays the seller regular premiums, and in return receives a payout from the seller if the reference entity defaults.

Hence, credit default swaps help businesses manage credit risk, but they're also used for speculation and arbitrage.

- They are negotiated and arranged OTC.

Relative market sizes

To get an idea of the relative size of exchange vs OTC derivative markets, we can look at the Bank for International Settlements (BIS) derivatives statistics datasets (see the BIS Data Portal):

- "*The exchange-traded derivatives (XTD) statistics cover the turnover and open interest of foreign exchange and interest rate futures and options.*"
- "*The over-the-counter (OTC) derivatives statistics capture the outstanding positions of derivatives dealers, mainly banks.*"
- "*The Triennial Central Bank Survey of foreign exchange and over-the-counter (OTC) derivatives markets aims to obtain comprehensive and consistent information on the size and structure of global foreign exchange and OTC derivatives markets.*".

Relative market sizes

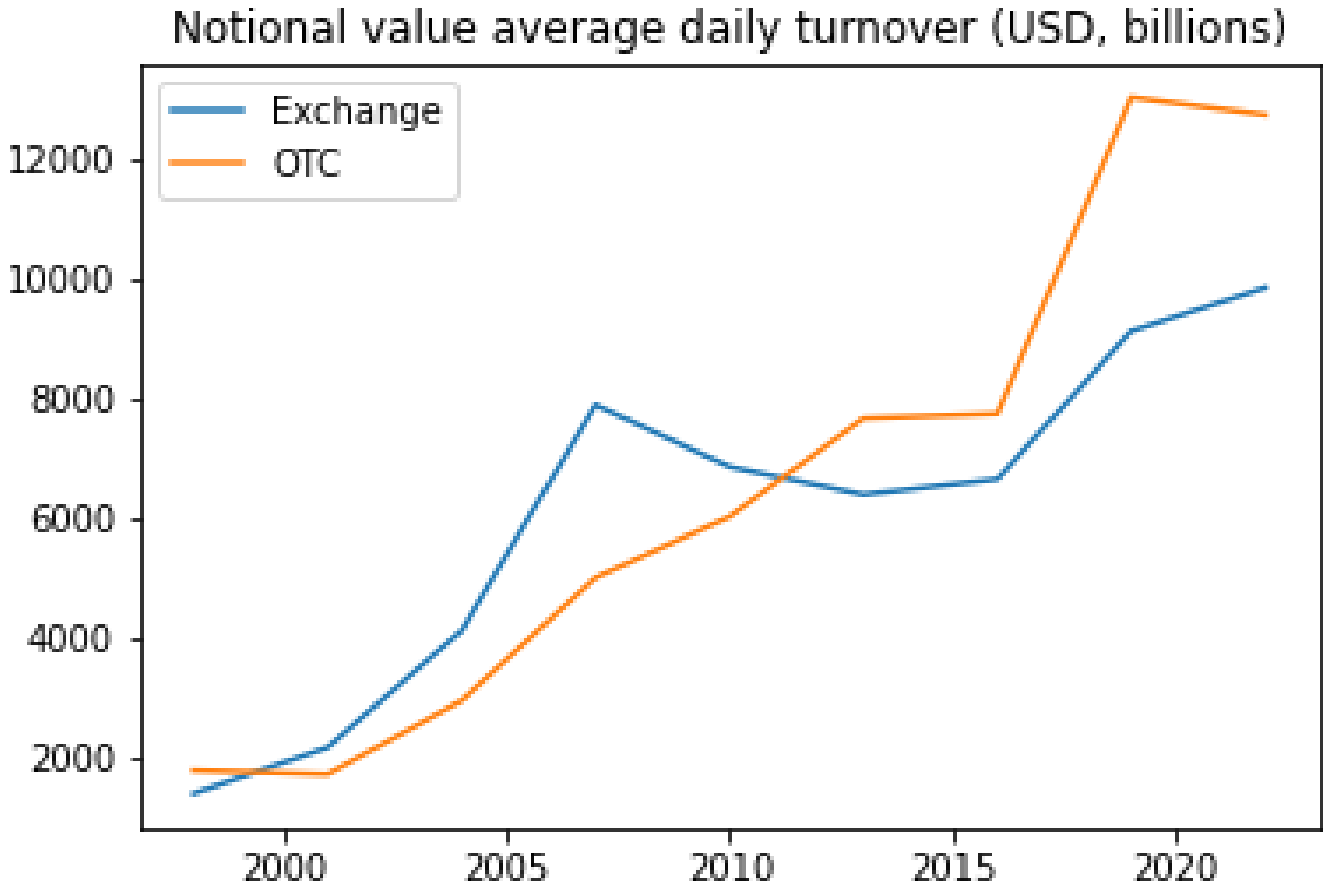


Figure: Average daily turnover in notional value of exchange vs OTC trading in foreign exchange (FX) plus interest rate derivatives (*source*: BIS).

Relative market sizes

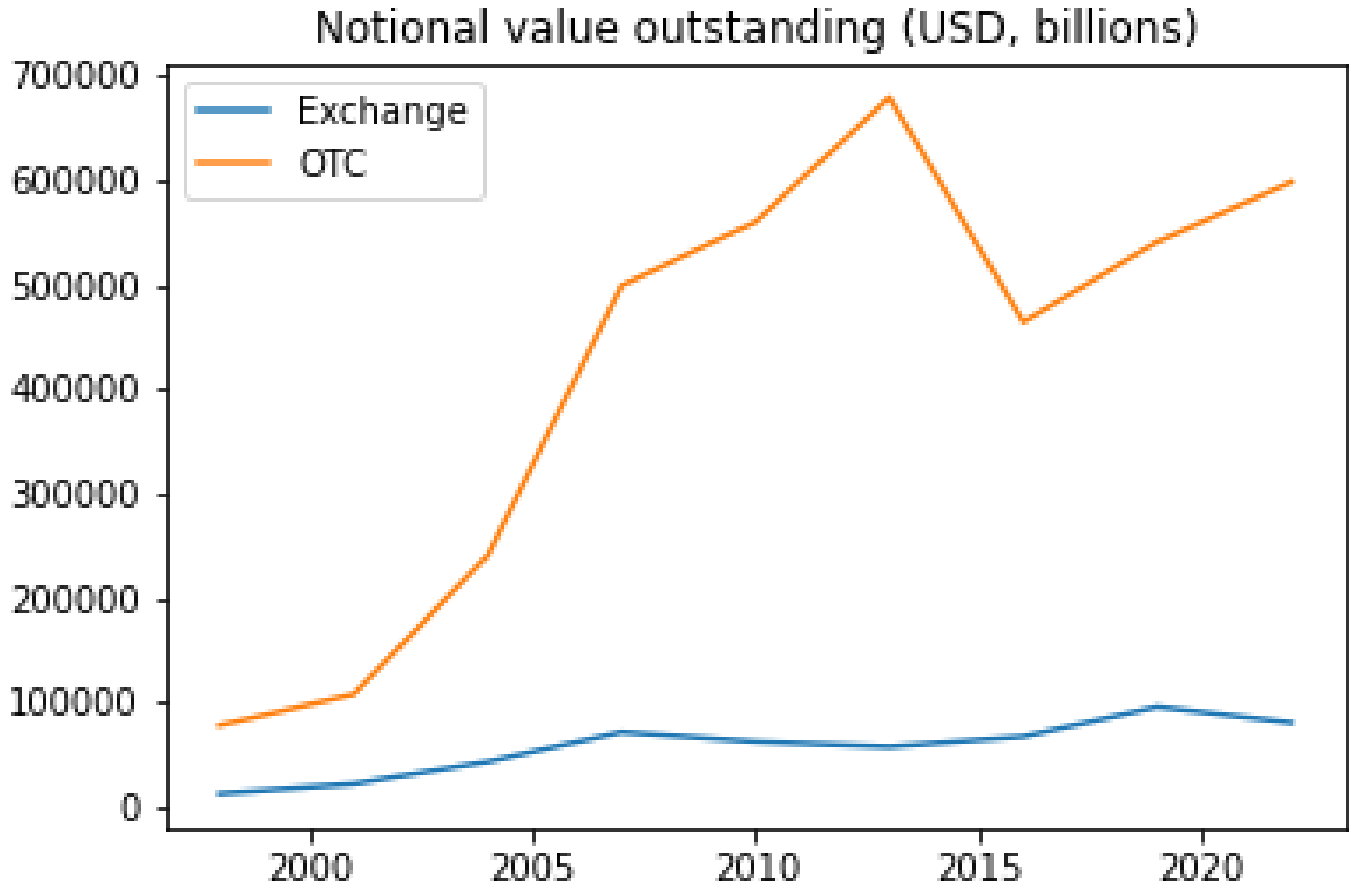
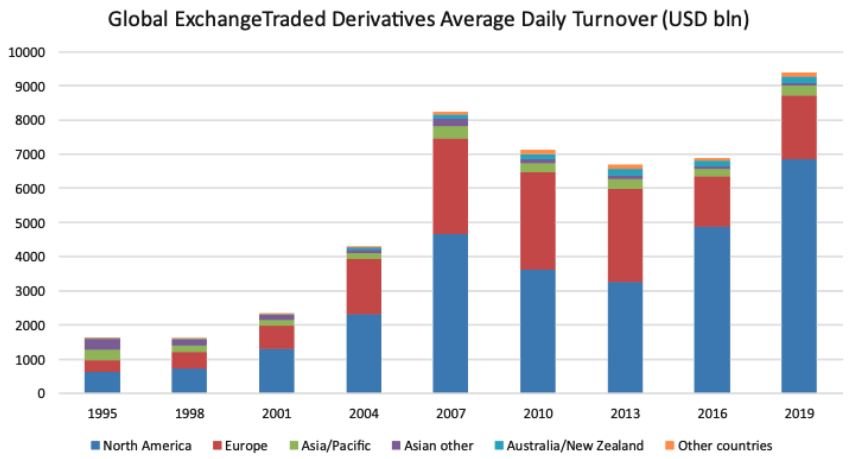
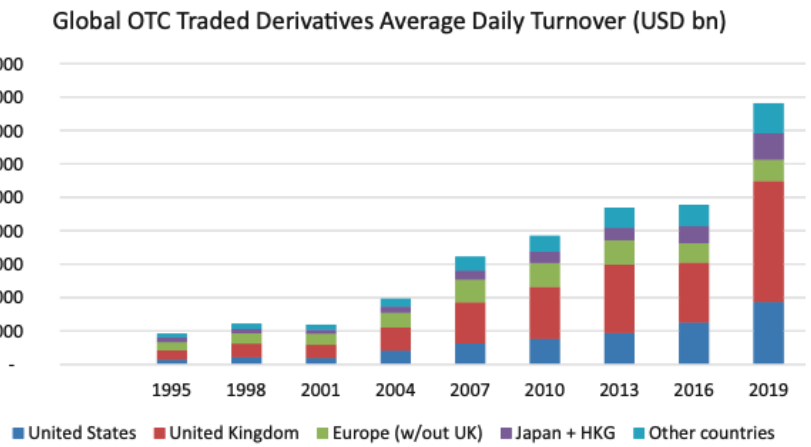


Figure: Notional value outstanding of exchange vs OTC FX plus interest rate derivatives (*source*: BIS).

Relative market sizes

A breakdown of the average daily notional turnover by country/region:





- The above covers only interest rate and FX derivatives, and is in terms of notional value (average daily turnover and outstanding).
- The World Federation of Exchanges (see 1, 2) gives breakdowns of exchange-traded derivatives on all underlyings in terms of *volume*:

Exchanges

Figure 3: Volumes of exchange-traded derivatives

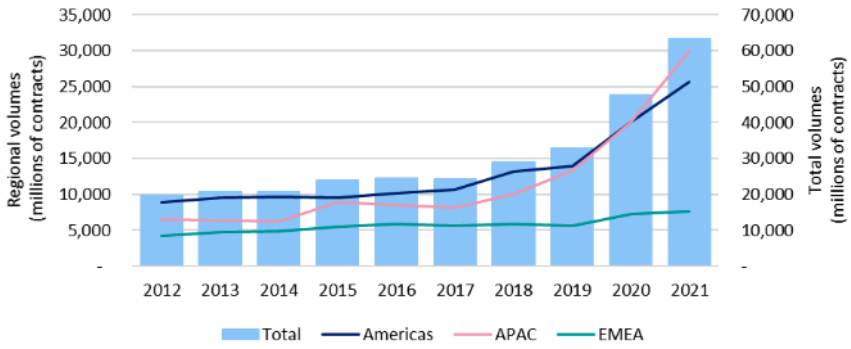


Figure 4: Share of total volumes: breakdown by regions

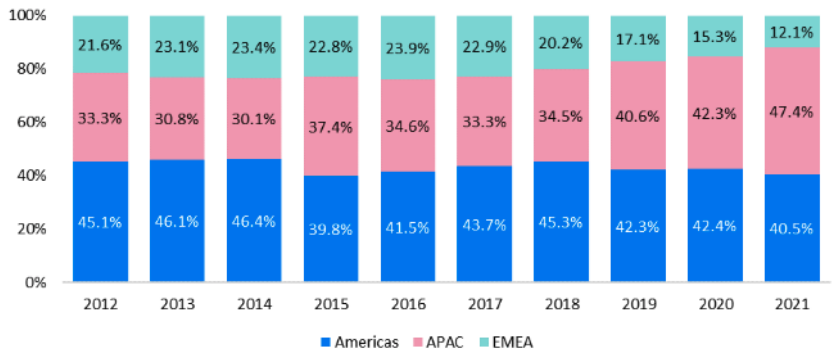


Figure 7: Volumes by asset class (billions of contracts)

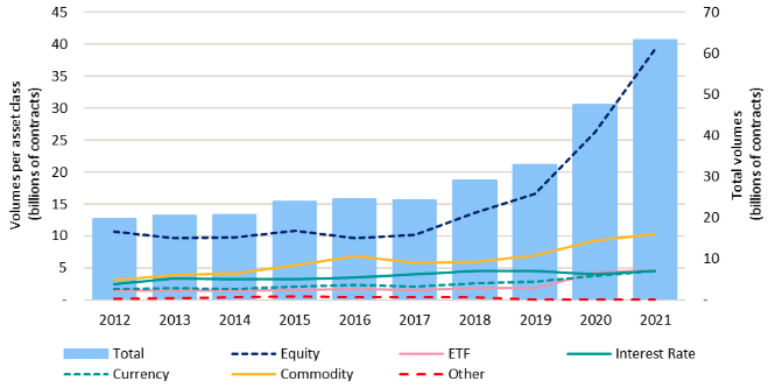
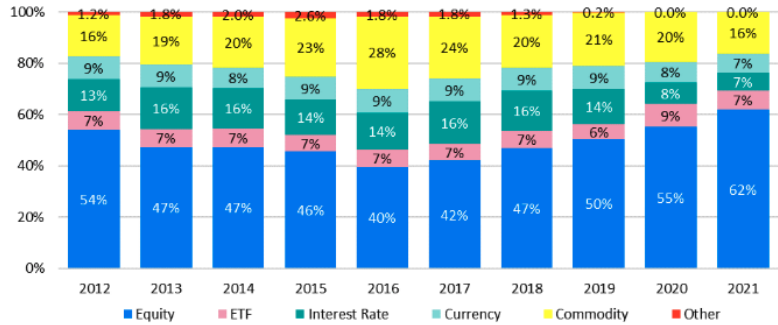


Figure 8: Product composition over time by share of total volume



Exchanges

Figure 9: Volumes of equity derivatives (billions of contracts)

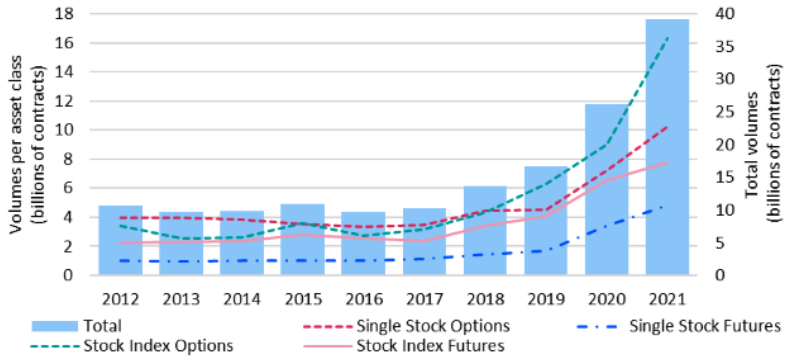


Figure 22: Volumes of commodity options and futures

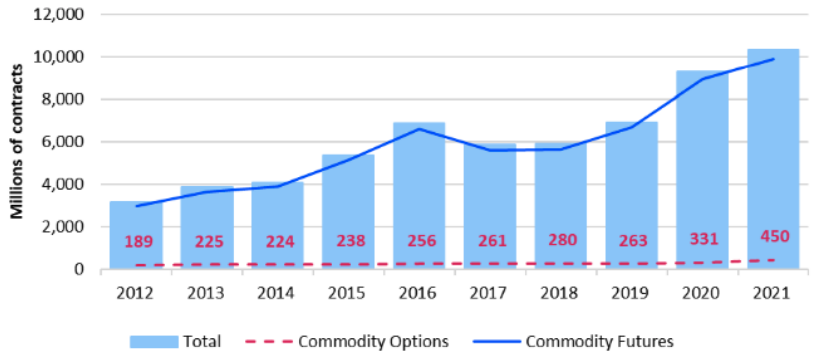


Figure 20: Volumes of currency derivatives

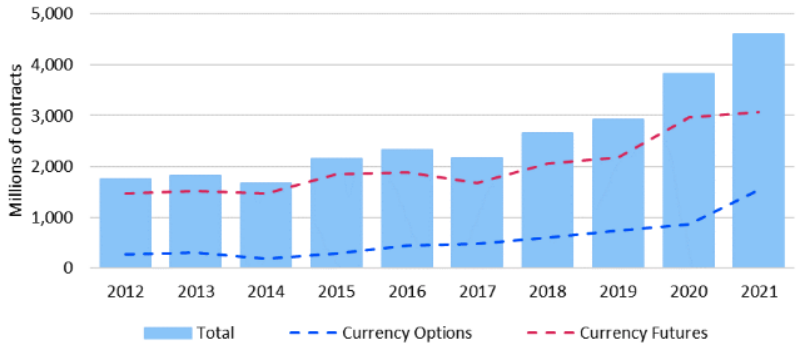
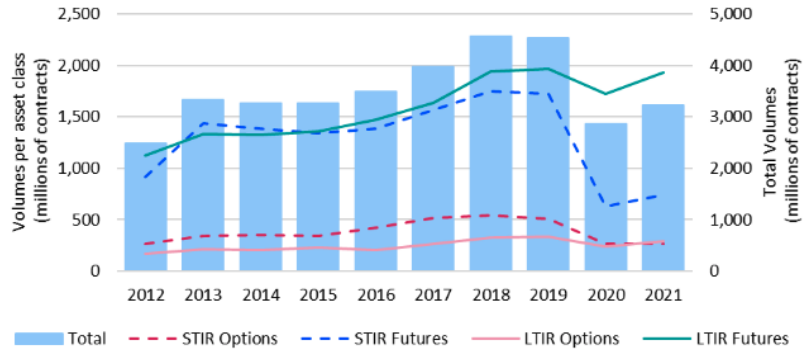
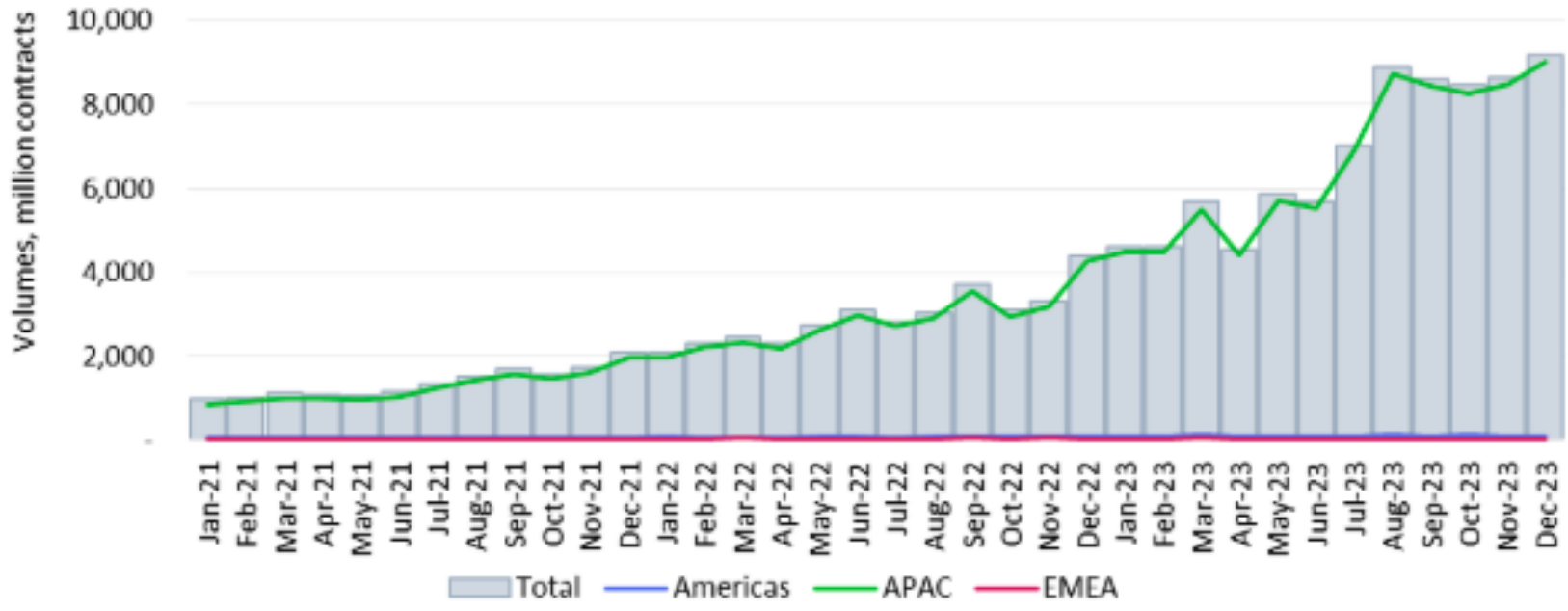


Figure 16: Volumes of interest rate exchange traded derivatives (millions of contracts)



Exchanges

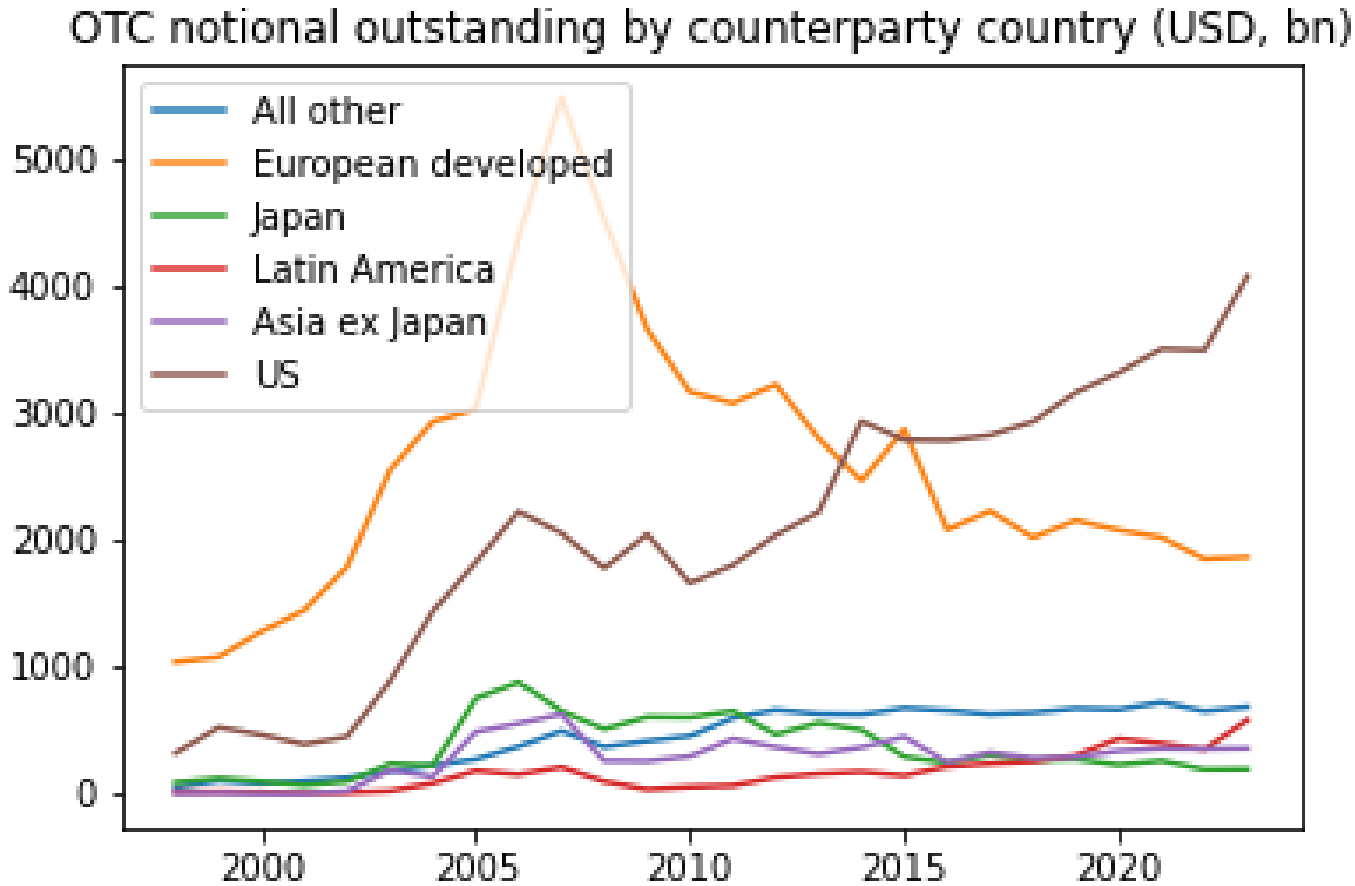
Chart 23: Stock index options



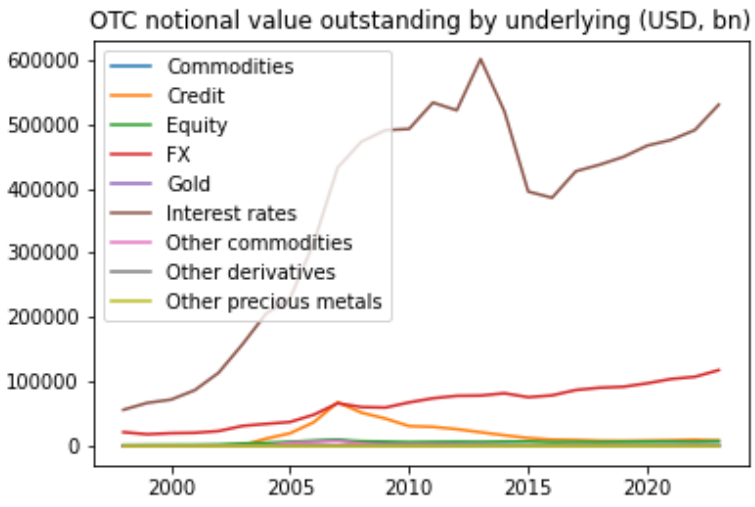
This growth is particularly due to the National Stock Exchange of India.

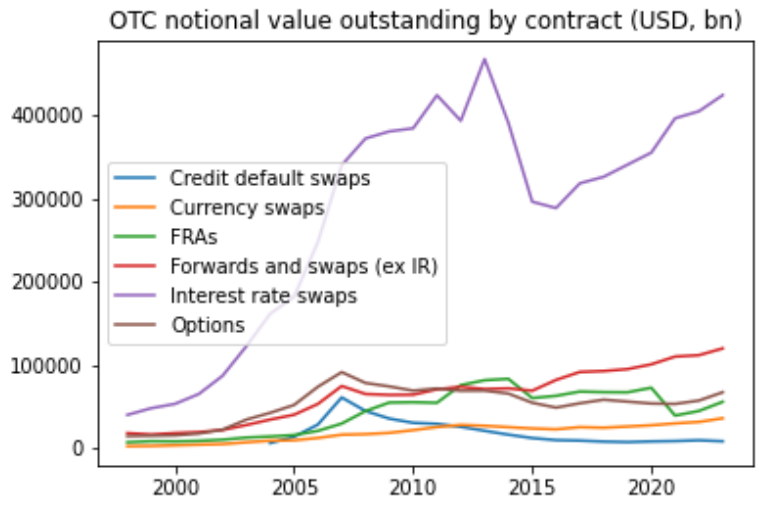
OTC markets

We can use the BIS data to break down OTC notional value outstanding for all types of underlying assets, derivative contracts, countries.



OTC markets





From all these graphs we can draw the following conclusions:

- Interest rate and FX forwards and swaps dominate OTC markets.
- Share and share index options dominate exchange-traded markets.

We focus on these in FINM3405 Derivatives and Risk Management.

Uses and market participants

Derivative securities have a number of different uses, and in general financial markets have a lot of "moving parts" with different players and participants all all doing different things:

- Trading, speculation and arbitrage.
- Risk management or hedging.
- Market making.
- Regulators and other industry bodies and associations.

Traders and speculation

We saw above the different payoffs depending on the movement in the underlying asset from taking long and short positions in futures and options. Derivatives can be more efficient and cost effective means by which to speculate on movements in the underlying asset than trading the asset itself. Of course there's a huge variety of trading strategies that various market participants employ to make a profit by trading derivatives. Derivatives also introduce other variables and factors that can be speculated on, over and above the movement in the underlying asset, including time, volatility, interest rates, credit conditions and spreads, market liquidity, weather, political events, you name it! Then you have the whole world of quant/algo/HFT/arbitrage/automated/etc trading, which nowadays is often very machine learning and AI driven.

Risk management and hedging

This course focuses on introducing derivative securities in the context of risk management. As mentioned at the start of this lecture, businesses, governments, financial institutions, etc, are naturally exposed to a variety of financial risks just by going about their usual daily business, including:

- Credit/default and counterparty risk.
- Market risks including adverse movements in interest rates, exchange rates, commodity prices, equity/share prices, etc.
- Government/political/sovereign risk, uncertainty and instability, including changing regulations, elections and military conflict.

In this course we present a number of basic techniques to manage some of these financial risks using the derivative securities we cover.

Market makers

Trading venues have contracts with companies called **market makers** to provide liquidity in markets. Market makers, and dealers in OTC markets, perform this liquidity function by continuously providing bid and ask quotes in the market for other participants to trade at, thereby taking one side of the transaction. Market makers typically earn a profit from the bid-ask spread they quote, but they also engage in speculation and proprietary trading, particular algo/automated/computerised. Some large market makers include Susquehanna, Optiver, Jane Street, Citadel, DRW, IG Markets, IMC, Flow Traders, etc; working for them is very lucrative.

Regulators and industry associations

Finally, financial markets are heavily regulated in order to enforce the law, maintain orderly and ethical conduct, protect retail savings and investments, enhance economic and financial stability and trust, encourage financial efficiency and technological innovation, ensure competition and cost effectiveness, and so on.

The stability, efficiency and optimal functioning of a country's financial system is one of the main determinants of a country's level of economic development and modernisation, and consequently its living standards, prosperity and quality of life. Derivative security markets contribute to this by enabling businesses to take and then manage or reallocate risks they otherwise would not be able to.

Regulators and industry associations

In Australia, the Council of Financial Regulators (CFR) "*is the coordinating body for Australia's main financial regulatory agencies. The CFR is a non-statutory body whose role is to contribute to the efficiency and effectiveness of financial regulation and to promote stability of the Australian financial system. There are four members – the Australian Prudential Regulation Authority (APRA), the Australian Securities and Investments Commission (ASIC), the Reserve Bank of Australia (RBA) and The Treasury.*"

Regulators and industry associations

Also consider the roles of the following industry associations:

- FICA: Finance Industry Council of Australia.
- AFMA: Australian Financial Markets Association.
- FINSIA: Financial Services Institute of Australasia.
- ABA: Australian Bankers Association.
- SIAA: The Stockbrokers and Investment Advisers Association.

Other useful concepts

We now refresh two basic concepts in finance that are used throughout the course, particularly to price or value derivatives securities:

1. The law of finance: Present value.
2. The law of one price: No arbitrage principle.

Present value: Law of finance

Law of finance: The value of an asset is the present value of its expected future cashflows.

There is really no other concept more important than present value. When we value derivative securities, we spend quite a bit of time constructing their future cashflows or payoffs and discounting them back to the present in order to calculate their price. Note that for some derivatives such as options, this involves some subtleties and mathematical complexities, and the law of finance becomes what is known as the risk-neutral approach to derivative security pricing.

Arbitrage: Law of one price

The other central technique used and assumption typically relied upon to price derivative securities is that of no arbitrage. A very common approach or technique used in derivative security valuation is to construct a portfolio of more basic securities (such as stocks, bank accounts, simple forwards and futures, etc) which replicates the derivative's future cashflow structure or payoff. The assumption of no arbitrage leads to the:

> **Law of one price**: Securities or portfolios with the same future cashflow structure or payoff must have the same price.

If the law of one price is violated, then an arbitrage opportunity exists in financial markets, which is assumed to be immediately exploited and traded away. But what do we precisely mean by the concept of arbitrage?

Arbitrage: Law of one price

An **arbitrage** opportunity can be defined in various equivalent ways, and the following two alternative definitions will suffice for this course:

1. An arbitrage opportunity is a scenario that has no initial, upfront cashflow or exchange of money, no risk of future loss (negative cashflow), but a chance of a future profit (positive cashflow).
   - Keep investing at 0 cost with the possibility of a future profit.
2. Alternatively, an arbitrage opportunity is a scenario of two different portfolios or financial securities having the same future cashflow structure or payoff, but different prices.
   - Long the cheap and short the expensive security/portfolio.

Neither of these scenarios can last long in efficient financial markets.

Summary

- Course admin
- Introduction to derivatives
  - Function of the financial system
  - Vanilla derivatives and payoffs
    - Futures and forwards
    - Options
    - Swaps
- Relative market sizes
  - Exchanges
  - OTC markets
- Uses and market participants
- Other useful concepts
  - Present value: Law of finance
  - Arbitrage: Law of one price