Fixed Income Markets*

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Overview

Course overview and objectives

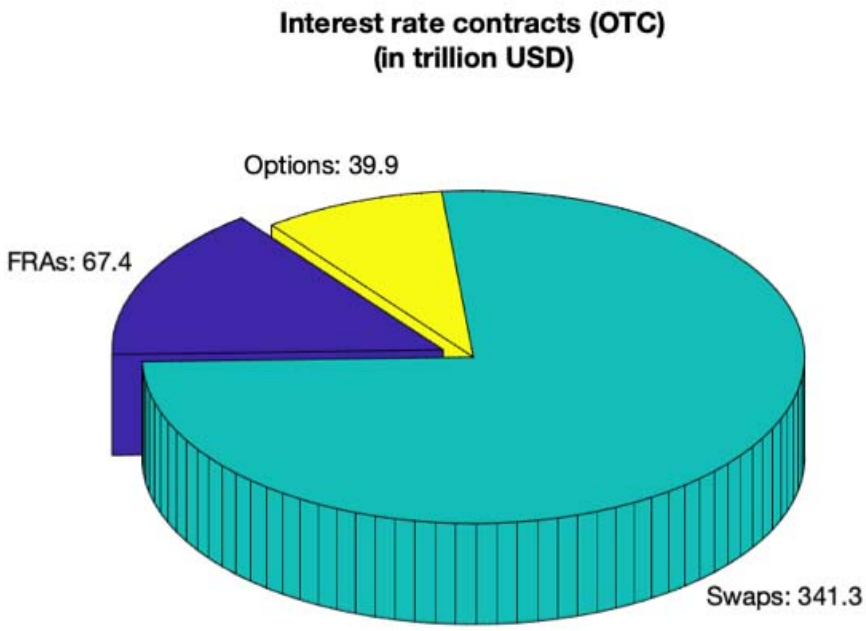
The economic significance of the fixed income markets

- The market for fixed income products is surely one of the largest security markets. Nearly *two-thirds* of the market value of all the securities that are outstanding in the world are classified as "fixed income securities".
  - Government debt
  - Corporate borrowing
  - Fixed income derivatives
  - Securitized assets
  - Credit risk transfers

Numbers

- Bank for International Settlements (BIS), 2019
  - Notional amount outstanding in the global over-the-counter (OTC) derivatives market = nearly \$600 trillion. Of this notional amount,
    - foreign exchange contracts $\approx$ \$92 trillion
    - equity-linked contracts $\approx$ \$6.8 trillion
    - interest rate derivatives $\approx$ \$449 trillion.
- Thus, OTC markets are predominantly about interest rate derivatives
- Interest rate products are also listed on exchanges such as Chicago Mercantile Exchange, Eurex or NYSE LIFFE
  - In the dollar case, BIS reports for the 2019 year notional values for futures contracts of
    - interest rate derivatives $\approx$ \$35 trillion
    - forex derivatives $\approx$ \$272 billion
  - option value is $>$ \$60 trillion for interest rate contracts and $\approx$ \$116 billion for foreign exchange

Some additional statistics



- *Note*. These figures refer to *notional* values
  - Gross *market values* are much less than those reported in the previous picture
  - Gross market values are calculated using the replacement costs of all outstanding contracts
    - for example, in 2019 interest rate contracts $\approx$ \$8.35 trillion
    - Still, according to Veronesi (2016), gross market values of interest rate derivatives were between 25% and 30% of global GDP from 2007 to 2013, approximately half of the total market capitalization of G-20 countries in 2012.

Complexity of the fixed income markets

- Many instruments in the fixed income markets differ substantially from those in the remaining portions of the capital markets.
  - For example, a simple instrument such a pure discount bond is very difficult to price. Intuitively, the price of a pure discount bond reflects the time value for money. It is related to the intertemporal preferences and beliefs of the market participants, which are unobservable.
  - The situation is different in the case of traditional "relative pricing", in which we price a number of assets given the price of some other assets, while ensuring that there are no arbitrage opportunities "left on the table".
  - In this case, we can evaluate derivatives without reference to any preferences or beliefs. The Black & Scholes formula, for example, is a preference free formula.
- The rapid growth in the fixed income markets was also led by many new instruments that are substantially more complex than the traditional plain vanilla bonds (i.e. default-free, non-callable bonds, defaultable bonds).
  - Credit risk transfers
  - Baskets of fixed income instruments
  - Callable bonds (i.e. the borrower can "call" the contract to anticipate the payment of the principal).

- The standard tools of asset evaluation are unlikely to work in this context.
- For example,
  - We can't "adapt" such models as the Black & Scholes model to price interest rate derivatives.
  - Indeed, the Black & Scholes model relies on the assumption of a constant volatility of the asset price underlying the contract. In the context of interest rate derivatives, instead, the volatility of the underlying asset price depends on the maturity of the underlying (tends to zero as the maturity goes to zero).
- More generally, pricing and hedging interest rate derivatives requires a model that describes the evolution of the entire term structure of interest rates. Academics and practitioners have proposed a variety of solutions to this problem, from the mid 80s to the beginning of the 90s.
- Today, dozens of new methods are available to price fixed income products.
- The general principles underlying the APT ("arbitrage pricing theory") are still the same, though.

Many paradigms

- While dozens of new methods are available to price fixed income products, we do not see the emergence of a "single" model to price all of the extant fixed income products!
  - Market participants use different models to price interest rate derivatives.
  - Typically, a single investment bank has a "battery" of different models with which to "fight" in the market.
  - Pieces of this "battery" may fight for different goals. For example, an investment bank might display a preference for a certain type of models as a result of
    - Its culture and history (see, e.g., the intellectual legacy of Fisher Black and Emanuel Derman in Goldman)
    - The particular business the bank is pursuing. For example,
      - We shall see that to price "caps" (which are options on interest rates), we may use the so-called market model, which relies on the "Black 76" formula. However, using this model implies that we do not have a "closed form" solution[1] for the price of "swaptions", which can only be solved through numerical methods. If the "swaptions" business is not important for the bank then, we may safely adopt the market model.
      - Otherwise, we should invest in additional human capital to support the pricing of these derivatives through numerical methods.

[1] Heuristically, a "closed form" solution is a solution that can be expressed in one equation, rather than by an algorithm.

Course objectives

- This course provides a thorough grounding in recent developments in fixed income securities pricing, hedging and portfolio management that insists on both conceptual evaluation methods and the many details arising in market practice. By the end of the course, you will be familiar with a variety of topics, including:

(i) the institutions, organization and conduct of the fixed income markets;
(ii) the basic techniques to analyze and hedge fixed income products, such as "curve fitting," "bootstrapping," duration, convexity, duration-based hedging and asset-liability management;
(iii) the analysis of the "destabilizing" effects related to the use of certain fixed income derivative products;
(iv) the economic forces, or "factors," driving the variation in the entire spectrum of interest rates at different maturities;
(v) relations between the yield curve and macroeconomic developments;
(vi) introduction to the main evaluation tools used in the industry practice (trees, no arbitrage trees, calibration of the yield curve, and continuous time models), applied to a consistent pricing and hedging of a wide range of products, including government bonds, corporate bonds (convertible, callable, puttable), plain vanilla interest rate derivatives (bond options, interest rate swaps, caps, floors, swaptions, etc.);
(vii) the main conceptual approaches to analyze credit markets;

(viii) an introduction to evaluation and hedging of the main credit derivatives such as total-return swaps, spread options and credit default swaps;

(ix) the process of securitization and the resulting structured products, with particular reference to collateralized debt obligations and mortgage-based securities;

(x) an overview of the main evaluation models of sovereign default.

Emphasis of the course and prerequisites

- The course emphasis is on the application of the models, not their mathematical foundations
  - But it would be misleading to state this course is "mathematics-free."
- However, the models we shall see are representative of the current "industry practice".
- A few classes will be devoted to analyze real world "case studies"

Sources for this course

- The source for this course is a comprehensive set of lecture notes, based on Chapters 12 through 14 my book:

  (i) Mele, A. (2022). *Financial Economics*. MIT Press: Cambridge, Mass.

- Additional and very useful references can be found in the following "classics"

  (ii) Brigo, Damiano and Fabio Mercurio (2006). *Interest Rate Models—Theory and Practice, with Smile, Inflation and Credit*. Springer Verlag (2nd Edition).

  (iii) Duffie, Darrell and Kenneth Singleton (2003). *Credit risk. Pricing, management and measurement*. Princeton: Princeton University Press (Princeton Series in Finance).

  (iv) Veronesi, Pietro (2010). *Fixed Income Securities*. John Wiley & Sons.

Course outline

Part I: Interest rates

Chapter I: Institutions and standard introductory details

- Classification of fixed income securities and their related risks
- Reviews of basic tools and facts regarding fixed income securities markets

Chapter II: Empirical properties of interest rates

- The yield curve and the business cycle
- Factors determining the term structure of interest rates

Chapter III: Foundational issues on interest rate modeling

- Modeling interest rates with trees
- Reverse engineering; implied interest rate trees
- A few continuous time models

Chapter IV: Introduction to the industry modeling practice

- No-arbitrage models
- Calibration
- The market model

Chapter V: Interest rate derivatives

- Bond options, interest rate swaps, caps, floors, swaptions

Part II: Credit risk

Chapter VI: Conceptual approaches to valuation of defaultable securities

- Structural approaches to evaluation
- Intensity-based evaluation

Chapter VII: Credit-risk shifting derivatives and structured products

- Total-return swaps; spread options
- Credit default swaps
- Collateralized debt obligations; Nth to default; mortgage-based securities