SYLLABUS

IEOR E4724 – Topic in Quantitative Finance: Introduction to Structured and Hybrid Products

Term: Spring 2011
Department: Industrial Engineering and Operations Research (IEOR)

Instructor: Iraj Kani
TAs: Irene Song

References:


Structured Products, Equity, commodity, Credit and New Markets, Volume 2, Satyajit Das, Wiley Finance 2005


Inflation-Indexed Securities, Bonds, Swaps and Other Derivatives, 2nd Edition, Mark Deacon, Andrew Derry and Dariush Mirfendereski, Wiley 2004

Credit Derivatives Pricing Models – Models, Pricing and Implementation, Phillipp J. Schonbucher, Wiley 2003


Option Pricing, Mathematical models and computation, Paul Wilmott, Jeff Dewynne, Sam Howison, Oxford Financial Press, 1993

Requirements: Basic understanding of financial products, financial derivatives and pricing methodologies and techniques is strongly recommended. Knowledge of Microsoft Excel/VBA, Matlab and/or other programming languages and concepts is also strongly recommended.
Assignments and Grading: There will be 6-8 homework assignments and a group project that together determine the grade for this course. Homework assignments will typically involve implementation in Microsoft Excel / VBA, MATLAB or other standard programming environments (C/C++, Java). All assignments and the project will involve groups of 3-5 students based on the class size. Grades are individually assigned, based on performance on assignments (90%) and general level of learning and class participation (10%).

Office Hours: There will be 3-5 office hours by each TA (in the computer laboratory or alternative location), all to be announced in the first session of the course.

Course Website: CourseWorks (E4724)

Overview

During the past two decades there has been an unprecedented growth in structured and hybrid products and an explosion of interest in these transactions both from individuals and institutions around the world. As a result there was a rapid expansion in size and liquidity of these markets and a proliferation in type and complexity of structured/hybrid products. The recent credit crisis had an adverse impact on these markets by impeding their normal functioning, diminishing their liquidity, raising credit concerns and reducing investor interest in these product overall. However, there are now growing signs that some or many of these markets are beginning to return to their normal state of health.

Most financial professionals agree that structure/hybrid products are now part of financial mainstream and essential component of capital markets. These products are used for managing exposure to a variety of risk factors, for enhancing return, reducing funding cost, and for exploiting the financing, tax, accounting and regulatory environment, by private and institutional investors.

In this course we will seek to gain a conceptual and practical understanding of structured and hybrid products from the standpoint of relevant risk factors, design goals and characteristics, pricing, hedging and risk management. We will perform detailed analysis of the underlying cash-flows, embedded derivative instruments and various structural features of these transactions, both from the investor and issuer perspectives, and we will analyze the impact of the prevailing market conditions and parameters on their pricing and risk characteristics. We will cover numerical methods for valuing and managing risk of structured/hybrid products and their imbedded derivatives and we will examine their application to equity, interest rates, commodities and currencies, inflation and credit related products. We will discuss the conceptual and mathematical principals underlying these techniques, and examine practical issues that arise in their implementations in the Microsoft Excel/VBA and other programming environments. We will review special
contractual provisions often encountered in structured and hybrid transactions, and attempt to incorporate yield curves, volatility smile, and other features of the underlying processes into our pricing and implementation framework for these products.

**Aims and Objectives**

- To develop a conceptual and practical understanding of structured and hybrid products, including their design principals, payoffs and cash-flows, contractual features, financing, legal, tax and accounting aspects, and structural issues that are relevant to the investors and issuers of these products.

- To gain familiarity with common design features of structured/hybrid transactions, including index-linked cash-flows (indexation), choice of underlying risk factors (equity, interest rates, inflation, credit, etc.), degree of risk exposure (leverage, participation, caps/floors, etc.), coupon/payment structure (fixed, floating, range accrual, zero-coupon etc.), principal protection (fully protected, partially protected, unprotected), conversion/call/put features, and other special contractual features of structured and hybrid products.

- To review common examples of structured transactions in different markets, e.g equity linked derivates and structured products, inflation linked products, commodity and currency linked swaps and structured notes, credit linked notes, CDOs and other types of structured transactions.

- To examine common examples of hybrid products connecting different markets sectors, including convertible bond structures (reverse, mandatory etc.), equity-inflation annuities and structured notes, equity-credit hybrid structures, and other types of hybrid products.

- To be exposed to the theoretical treatment of structured/hybrid products from a pricing, risk and hedging standpoint, along with application and examination of different valuation methods (analytical, tree, finite-difference and Monte Carlo), hedging techniques (e.g. static, dynamic), sensitivity analysis, and risk management issues.

- To understand the impact of prevailing market parameters (e.g. yield curves), real-world conditions (e.g. credit conditions), and specific features of underlying price processes (default, volatility skew, correlation structure) in pricing, hedging and risk management of structured and hybrid transactions.

- To gain exposure to practical application and implementation of various pricing and risk management techniques for structured and hybrid products in the context of Excel/VBA, Matlab, C/C++ or other programming environments.
Course Outline

Part I – Fundamentals

Structured Products Fundamentals

General Structuring Framework

- Vanilla and Index-Linked Cash-flows
- Basic Contractual Features
- Monetization, Currency Translation and Scaling
- Tax, Accounting and Regulatory Issues
- Other Investor and Issuer Considerations

Special Contractual Features

- Upside/Downside Participation
- Caps, Floors and Principal Redemption Features
- Knock-In and Knock-Out Features
- Convertibility, Extensibility, Callability and Puttability Features

Index-Linked Cash-flows

- Standard Fixed and Floating Cash-flows
- Vanilla Index-Linked Cash-flows
- Baskets as Reference Indices
- Piecewise Linear Cash-flows
- Vanilla Average and Look-back Features
- Stepwise Extrema and Cliquet Features
- Other Exotic Features

Pricing Fundamentals

Fundamentals of Contingent Claims Pricing

- Martingale Measures and Fundamentals of Pricing
- Change of Measure and Girsanov’s Theorem
- Point Processes, Stopping Times, Hazard Rates, and Intensity
- Jump and Compensator Measures
- Ito’s Lemma for Diffusion and Jump Processes
Interest Rate Fundamentals

- The Bank Account and Short Rate
- Zero-Coupon Bonds, Spot Interest Rates, and Forward Rates
- Fundamental Interest Rate Curves
- Interest Rate Swaps and FRAs
- Interest Rate Caps/Floors and Swaptions.

Inflation Fundamentals

- Inflation-Linked Bonds
- Real Rates, Nominal Rates, and Inflation Breakevens
- The Foreign Exchange Analogy
- Inflation-Indexed Swaps, Caps and Floors
- Calibration to Market Data
- Stochastic Models of Real and Nominal Rates

Credit Risk Fundamentals

- Stopping Times, Hazard Rates, and Intensity
- Credit Spread and Implied Default Probabilities
- Implied Hazard Rates and Forward Spreads
- Construction and Calibration of Credit Spread Curves
- Asset Swaps, Total Return Swaps and Credit Default Swaps
- Hedge-based Pricing of Credit Derivatives
- Stochastic Credit Spread Models

Part II – Real-World Structured and Hybrid Products

Equity-Linked Structured Products

- General Structuring of Note Issues
- Unprotected Bull Notes
- Capped Bull Notes / Reverse Convertibles
- Protected Bull Notes
- Linear Segmentation of Note Payoff
- Knock-in and Knock-out Features
- Lookback and Ladder Bull Notes
- Asian Bull Notes
- Cliquet Bull Notes
- Principal Protected Bear Notes
- Range Accrual Notes
- Digital and Coupon-Bearing Notes
Fixed Income Structured Products

- General Structuring Features
- Callable and Puttable Notes
- Capped, Floored and Collared FRNs (Floaters)
- Leveraged Capped Floaters
- Range Floaters / Range Accrual Notes
- Reverse Floaters
- CMS-Linked Notes
- CMS Inversion Notes
- Spread Notes
- Bear Notes
- Leveraged Swap Notes

Commodity and Currency Linked Structured Products

- Commodity-Linked Notes
- Currency-Linked Structures
- Dual and Multi-Currency Structures
- Quanto Currency Structures

Inflation-Indexed Products

- Zero-Coupon Inflation-Indexed Swaps
- Year-on-Year Inflation-Indexed Swaps
- Inflation-Indexed Caps and Floors
- Exotic inflation-linked products

Credit Derivatives and Structured Products

- Default Digital Swaps
- Rating-triggered Credit Default Swaps
- Options on Defaultable Bonds
- Default Correlation Products: First-to-default Swaps and CDOs
- Credit Linked Notes

Hybrid Products and Derivatives

- Equity – Interest Rate Hybrid Products
- Equity – Inflation Hybrid Products
- Equity – Credit Hybrids
- Currency – Linked Hybrid Products
- Other Hybrid Structures