MATH4511
Quantitative Methods for Fixed-income Securities

By

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Prerequisite

- This course requires background of
  - Multivariable calculus
  - Linear algebra
  - Probability
  - Background in finance and financial markets is *desirable*

Grading Rules

- Performance will be judged by
  - weekly or biweekly homework assignments,
  - 4 quizzes
  - one midterm, and
  - one final exam.
- Total course scores will be calculated according to the weights of

  (20%, 10%, 20%, 50%)?

Guideline for Grade Assignments

- University statistics
  - A 10-20%
  - B 25-40%
  - C 35-45%
  - D 5-10%
  - F 0-5%

Reference Books

- Reference books
  - Bruce, T. (2002) Fixed Income Securities: Tools for Today's Markets, 2nd edition (Wiley Finance)
  - Hull, John (2014). Options, Futures, and Other Derivatives, 9th ed. Prentice Hall.
  - McDonald, Robert, L. (2014). Derivatives Markets, 3rd ed. Pearson.

Other Reference Books

- Veronsi, P. (2010). Fixed-income securities: valuation, risk and risk management. Wiley.
- Fabozzi, Frank J. (1997). Fixed income mathematics: analytical & statistical techniques, 3rd ed., McGraw-Hill (ISBN: 0-7863-1121-5).
- Fabozzi, Frank J. (2003). Bond markets, analysis and strategies, 5th ed. Pearson/Prentice Hall (ISBN: 0-13-049782-7).
- Zipf Robert (1996). How the Bond Market Works, the 2nd edition, New York Institute of Finance (ISBN:0-13-124306-3).

Course Outlines

Introduction to financial markets
Bond and interest-rate derivatives markets
Yields, forward rate and swap rates
Yield-based hedging and regression-based hedging
Mortgage mathematics.
Binomial models for equity and fixed-income derivatives.
Arbitrage pricing and risk-neutral valuation principle
Eurodollar futures
Lognormal models
Black formula for caps and swaptions.

Chapter 0
An Overview of Global Financial Markets

New York

London

Chicago

Singapore

Tokyo

Zurich

Frankfurt

Dubai

Hong Kong

What People Trade?

- Stocks
- Bonds
- Currencies
- Commodities
- and a combination of all of them with optionality involved (and the securities can be very complex!)

- Welcome to Bloomberg!

What people do in an exchange, like this?

Or like this?

Traders

Sales

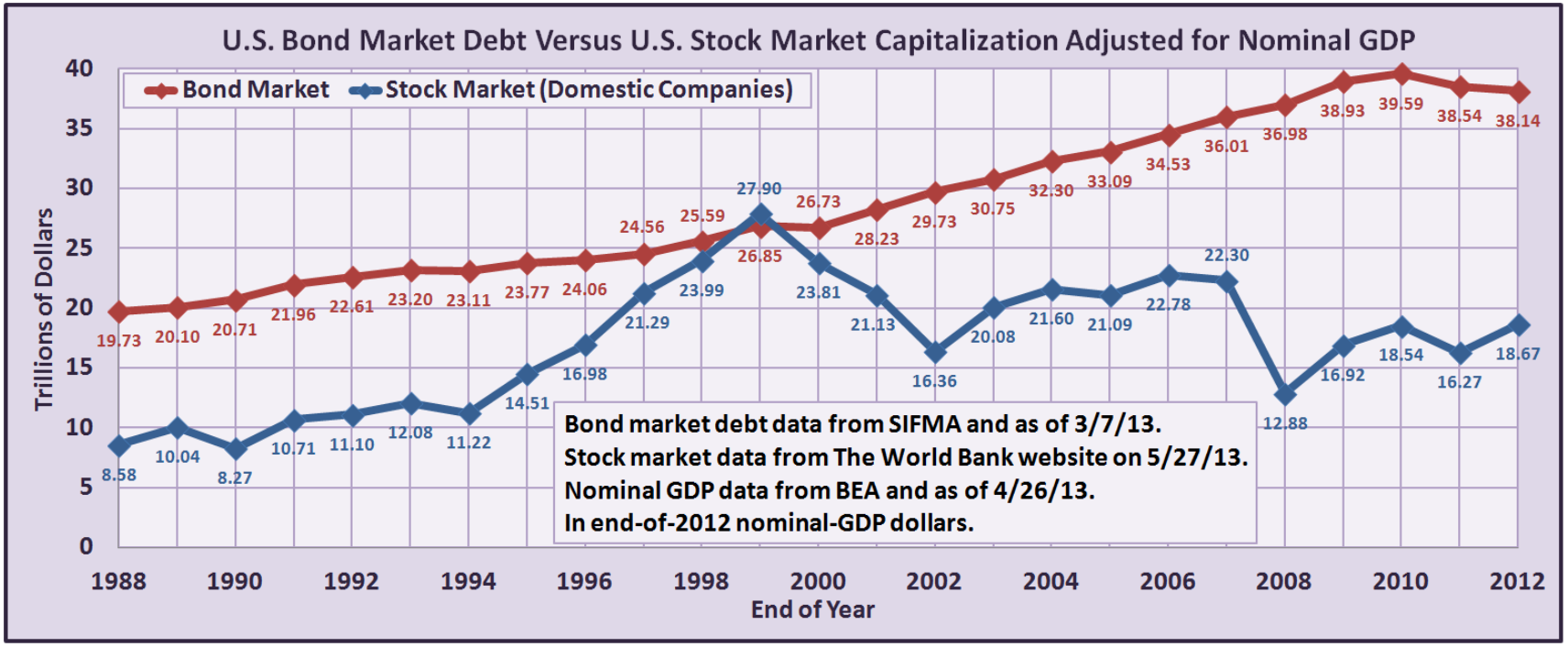
How to make a deal or trade?

- Go through an exchange
  - Standardized products
- Go through Over-The-Counter (OTC) markets
  - Trade can be standardized or non-standardized.
  - Used to be less regulated

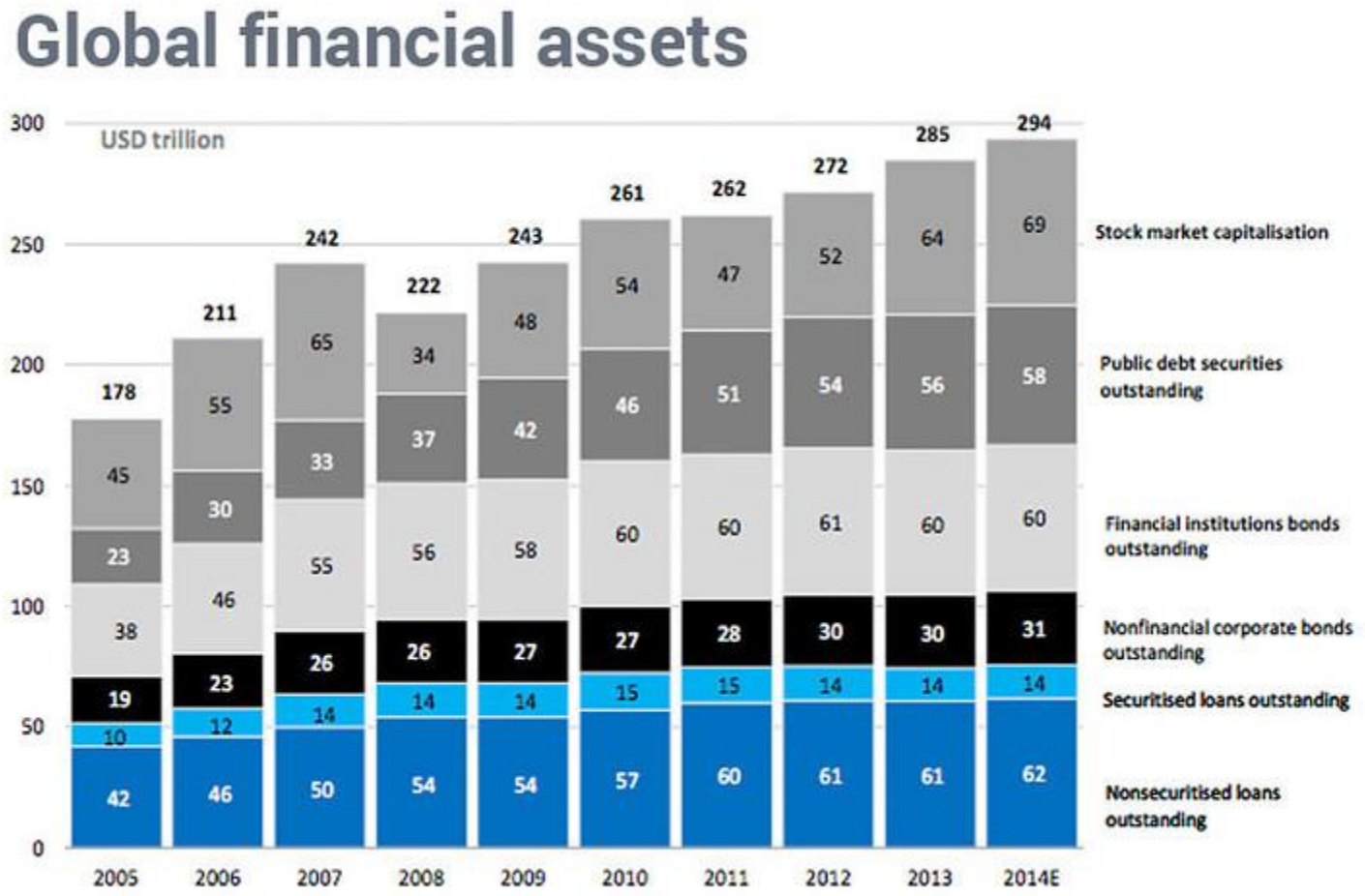
Bond Note


UNITED STATES SAVINGS BOND
100
THE UNITED STATES OF AMERICA
TEN YEARS FROM THE ISSUE DATE HEREOF WILL PAY
ONE HUNDRED DOLLARS
100
ISSUE DATE
WHICH IS THE FIRST DAY OF
To
MR. AND MRS. AMERICA
EVERYWHERE
U. S. A.
WAR SAVINGS
BOND SERIES E
TREASURY DEPARTMENT
WASHINGTON
C91 473 455 E
NONTRANSFERABLE

Which is Bigger, Bond vs. Equity?



Debt vs. Equity: Global prospective



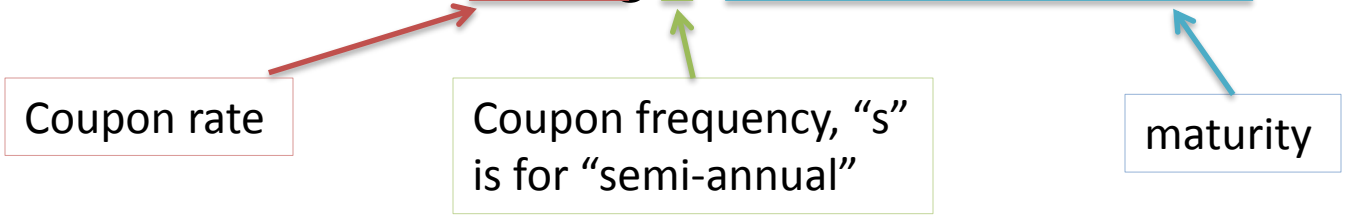
McKinsey Global Institute, Hover, BIS, Deutsche Bank estimates, 2015

Securities Industry and Financial Markets Association (sifma.org)

Chapter 1
Bond Prices, Discount Factors, and Arbitrage

Starting with Coupon Bonds

- Three aspects: In May 2010 the U.S. Treasury sold a bond with
  - a coupon rate of $2\ ^{1}/_{8}\%$ and
  - a maturity date of May 31, 2015
  - a payment frequency of two a year, six months apart
- This bond is called "$2\ ^{1}/_{8}$s of May 31, 2015"



Cash Flow of the Bond

- The unit for bond purchasing is $1,000.
- Suppose that an investor purchases $1m face value of the bond, i.e., 1,000 units.
- The the coupon payment is calculated according to

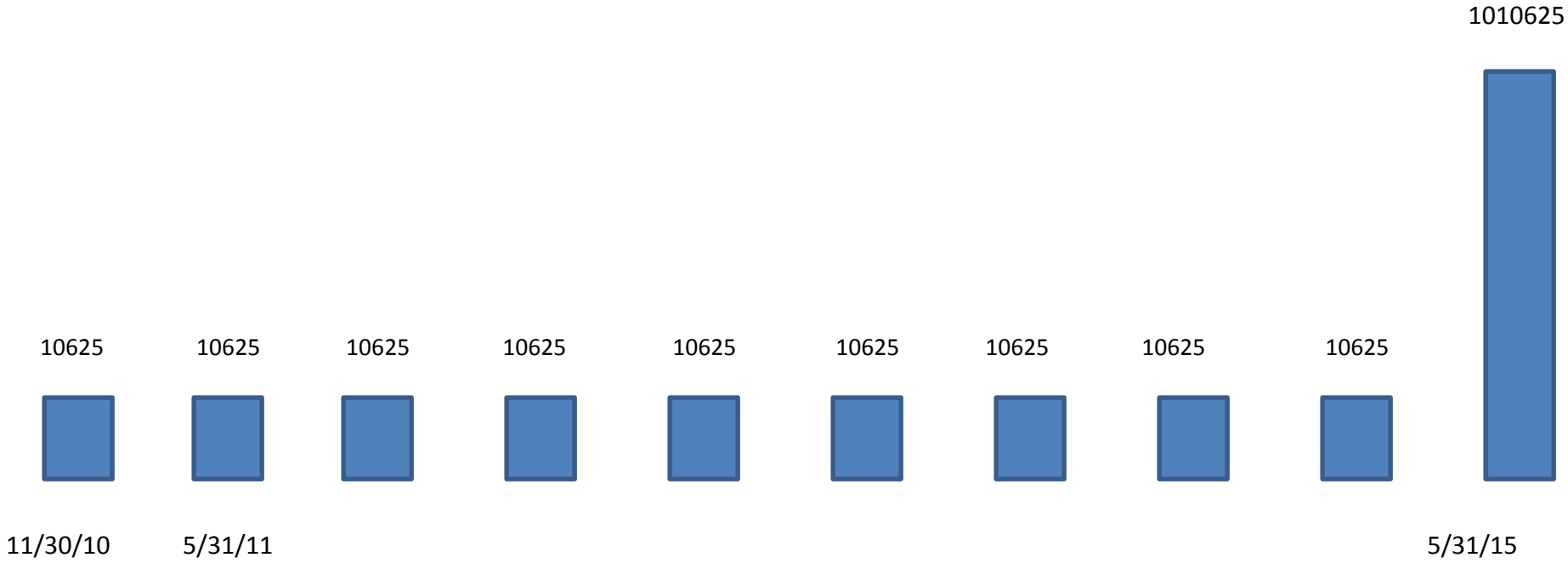
$$\frac{1}{2} \times 2\frac{1}{8}\% \times \$1{,}000{,}000 = \$10{,}625$$

Year fraction | Coupon rate | Face value

Cash Flow of the Bond, cont'd

Table 1.1: Cash Flows of the U.S. $2^{1}/_{8}$ from books of May 31, 2015

Date	Coupon Payment	Principal Payment
"11/30/2010"	$10, 625	
"5/31/2011"	$10, 625	
"11/30/2011"	$10, 625	
"5/31/2012"	$10, 625	
"11/30/2012"	$10, 625	
"5/31/2013"	$10, 625	
"11/30/2013"	$10, 625	
"5/31/2014"	$10, 625	
"11/30/2014"	$10, 625	
"5/31/2015"	$10, 625	$1, 000, 000


1010625
10625
10625
10625
10625
10625
10625
10625
10625
10625
11/30/10
5/31/11
5/31/15

Government Bonds

- US Treasury
- Exchange Fund Bills & Notes Fixings (Hong Kong)