

Dynamic Macroeconomics

Chapter 12: Financial markets

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① Financial markets: Introduction

② The bond market

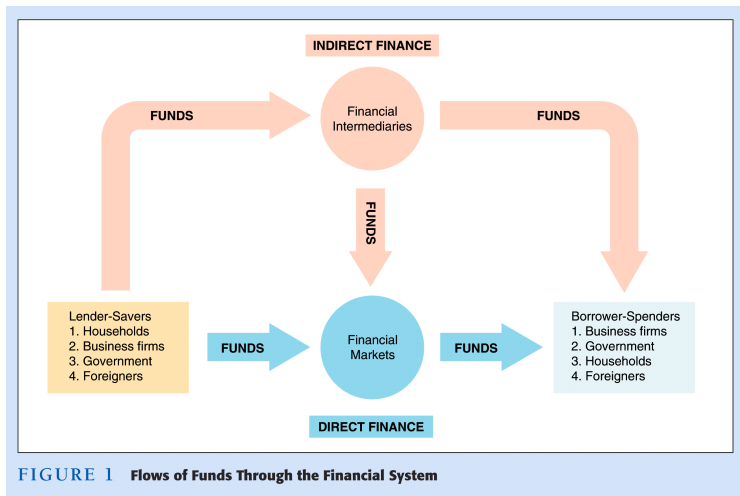
The bond market: Introduction

The bond market: The term structure of interest rates

Financial markets: Introduction

- Objective of financial markets:
 - ⇒ Perform the essential function of channeling funds from economic players that have saved surplus funds to those that have a shortage of funds
 - ⇒ Promote economic efficiency by producing an efficient allocation of capital which increases production (they allow funds to flow to people with the best investment opportunities)
 - ⇒ Directly improve the well-being of consumers by allowing them to time purchases better

Financial markets: Introduction



Source: Mishkin (2009)

Financial markets: Introduction

- Structure of financial markets (categorization based on essential features of individual markets):
 - Debt and equity markets
 - Primary and secondary markets
 - Money and capital markets
- Debt and equity markets:
 - Direct funding is possible in two ways: By issuing a debt instrument or equities
 - Debt: Debt can be short-term (maturity is less than a year) or long-term (maturity is more than ten years)
 - Most common debt instruments:
 - Bonds
 - Mortgages
 - Equity: In the broadest sense, equity means ownership.

Financial markets: Introduction

- Structure of financial markets (continued):
 - Primary and secondary markets:
 - A primary market is a financial market in which new issues of a security are sold to initial buyers.
 - A secondary market is a financial market in which previously issued stocks are traded.
 - Money and capital markets:
 - Money markets deal in short-term debt instruments.
 - Capital markets deal in longer-term debt and equity instruments.

Financial markets: Introduction

- Major money market instruments

Type of Instrument	Amount Outstanding (\$ billions, end of year)			
	1980	1990	2000	2008
U.S. Treasury bills	216	527	647	1060
Negotiable bank certificates of deposit (large denominations)	317	543	1053	2385
Commercial paper	122	557	1619	1732
Federal funds and Security repurchase agreements	64	387.9	768.2	2118.1

Sources: Federal Reserve Flow of Funds Accounts; Federal Reserve Bulletin; Economic Report of the President.

Source: Mishkin (2009)

Financial markets: Introduction

- negotiable bank certificate of deposit (CD): a debt instrument sold by a bank to depositors that pays annual interest of a given amount and at maturity pays back the original purchase price
- US Treasury Bill: a short-term debt instrument issued in 1, 3 and 6 month maturities to finance the federal government
- commercial paper: a short-term debt instrument issued by large banks and well-known corporations
- repurchase agreement: short-term loans (maturity less than 2 weeks) for which Treasury bills serve as collateral
- Federal Funds: overnight loans between banks of their deposits at the Federal Reserve

Financial markets: Introduction

- Major capital market instruments

Type of Instrument	Amount Outstanding (\$ billions, end of year)			
	1980	1990	2000	2008
Corporate stocks (market value)	1,601	4,146	17,627	19,648
Residential mortgages	1,106	2,886	5,463	12,033
Corporate bonds	366	1,008	2,230	3,703
U.S. government securities (marketable long-term)	407	1,653	2,184	3,621
U.S. government agency securities	193	435	1,616	8,073
State and local government bonds	310	870	1,192	2,225
Bank commercial loans	459	818	1,091	1,605
Consumer loans	355	813	536	871
Commercial and farm mortgages	352	829	1,214	2,526

Sources: Federal Reserve Flow of Funds Accounts; Federal Reserve *Bulletin*. 2008, 3rd Quarter.

Source: Mishkin (2009)

Financial markets: Introduction

- stocks: equity claims on the net income and assets of a corporation
- mortgages: loans to households or firms to purchase land, housing or other real structures in which the structure or land itself serves as collateral for the loans
- corporate bonds: long-term bonds issued by corporations with very strong credit ratings
- US government securities: long-term debt instruments issued by the Treasury to finance the deficits of the federal government

Financial markets: Introduction

- US government agencies securities: long-term bonds issued by various government agencies to finance mortgages, farm loans, power generating equipment etc.
- state and local government bonds: long-term debt instruments issued by state and local government to finance expenditures on schools, roads and other large programs
- consumer and bank commercial loans: made principally by banks but also by finance companies

The bond market: Introduction

- Credit market instruments:
 - Simple loans: Lender provides the borrower with an amount of funds, which must be repaid to the lender at the maturity date together with an interest rate payment
 - Fixed payment loan: Lender provides the borrower with an amount of funds, which has to be repaid by making the same payment (interest and part of the principal) every period
 - Coupon bond: Pays the owner a fixed interest payment (coupon payment) every year until the maturity date, when a specified final amount (face value) has to be repaid
 - Discount bond (Zero-coupon bond): Bought at a price below its face value, at the maturity the face value is repaid
- Yield to maturity: Interest rate that equates the present value of cash flow payments received from a debt instrument with its value today

The bond market: The term structure of interest rates

- Consider a coupon bond with the following characteristics:
 - n : number of years until maturity
 - $P_{n,t}$: price of the coupon bond
 - c : yearly coupon payment
 - $F = 1$: face value of the bond
 - $R_{n,t}^c$: nominal discount rate for the income stream on a bond with coupon c ; yield to maturity

The bond market: The term structure of interest rates

- The price of this coupon bond is given by:

$$\begin{aligned}
 P_{n,t} &= \frac{c}{1 + R_{n,t}^c} + \frac{c}{(1 + R_{n,t}^c)^2} + \dots + \frac{1 + c}{(1 + R_{n,t}^c)^n} \quad (1) \\
 &= c \sum_{i=1}^n \frac{1}{(1 + R_{n,t}^c)^i} + \frac{1}{(1 + R_{n,t}^c)^n} \\
 &= \frac{1}{1 + R_{n,t}^c} c \sum_{i=0}^{n-1} \frac{1}{(1 + R_{n,t}^c)^i} + \frac{1}{(1 + R_{n,t}^c)^n} \\
 &= \frac{c}{1 + R_{n,t}^c} \frac{1 - \frac{1}{(1 + R_{n,t}^c)^n}}{1 - \frac{1}{(1 + R_{n,t}^c)}} + \frac{1}{(1 + R_{n,t}^c)^n} \\
 &= \frac{c}{R_{n,t}^c} \left(1 - \frac{1}{(1 + R_{n,t}^c)^n} \right) + \frac{1}{(1 + R_{n,t}^c)^n}
 \end{aligned}$$

The bond market: The term structure of interest rates

- For a zero-coupon bond ($c = 0$) we obtain:

$$\begin{aligned}
 P_{n,t} &= \frac{c}{R_{n,t}^c} \left(1 - \frac{1}{(1 + R_{n,t}^c)^n} \right) + \frac{1}{(1 + R_{n,t}^c)^n} & (2) \\
 &= \frac{1}{(1 + R_{n,t}^c)^n} = \frac{1}{(1 + R_{n,t}^0)^n}
 \end{aligned}$$

- An n -period coupon bond can be considered as a collection of $n - 1$ zero-coupon bonds (due in periods $1, 2, \dots, n - 1$) with face value c and one zero-coupon bond with face value $1 + c$ (due in period n).
- Then, we can write:

$$P_{n,t} = \frac{c}{1 + R_{1,t}^0} + \frac{c}{(1 + R_{2,t}^0)^2} + \dots + \frac{1 + c}{(1 + R_{n,t}^0)^n} \quad (3)$$

The bond market: The term structure of interest rates

- To compute the yields to maturities of the involved zero-coupon bonds (denoted by $R_{i,t}^0$ with $i = 1, 2, \dots, n$) we proceed as follows:
 - If the holding period is only one period we have:

$$P_{1,t} = \frac{1 + c}{1 + R_{1,t}^0} \quad (4)$$

⇒ Equation determines $R_{1,t}^0$

- If the holding period is two periods we have:

$$P_{2,t} = \frac{c}{1 + R_{1,t}^0} + \frac{1 + c}{(1 + R_{2,t}^0)^2} \quad (5)$$

⇒ Equation determines $R_{2,t}^0$

- Repeating these steps allows to solve for the remaining zero-coupon interest rates.

The bond market: The term structure of interest rates

- If one buys a n -period bond today (t) and sells it in the next period ($t + 1$) the rate of return is given by:

$$1 + h_{n,t+1} = \frac{P_{n-1,t+1}}{P_{n,t}} = \frac{1}{\frac{(1+R_{n-1,t+1}^0)^{n-1}}{1}} \quad (6)$$

- Taking logs of this equation, observing that $\ln(1+a) \approx a$ (for small values of a) and using $p_{n,t} = \ln P_{n,t}$ one can write:

$$h_{n,t+1} \approx p_{n-1,t+1} - p_{n,t} = nR_{n,t} - (n-1)R_{n-1,t+1} \quad (7)$$

- Given that no-arbitrage opportunities exist the expected return $h_{n,t+1}$ must be equal to the interest rate on a risk-free bond s_t plus a risk premium $\rho_{n,t}$ on an n -period bond, i.e., we must have:

$$E_t h_{n,t+1} = s_t + \rho_{n,t} \quad (8)$$

The bond market: The term structure of interest rates

- Combining the two expressions for $h_{n,t+1}$ we can write:

$$\begin{aligned}
 h_{n,t+1} &= nR_{n,t} - (n-1)E_t R_{n-1,t+1} = s_t + \rho_{n,t} \iff & (9) \\
 (n-1)(E_t R_{n-1,t+1} - R_{n,t}) &= (R_{n,t} - s_t) + \rho_{n,t}
 \end{aligned}$$

where $(R_{n,t} - s_t)$ denotes the term spread.

- Solving this equation for $R_{n,t}$ yields:

$$R_{n,t} = \frac{n-1}{n} E_t R_{n-1,t+1} + \frac{1}{n} (s_t + \rho_{n,t}) \quad (10)$$

- For $R_{n-1,t+1}$ we obtain:

$$R_{n-1,t+1} = \frac{n-1}{n} E_{t+1} R_{n-2,t+2} + \frac{1}{n} (s_{t+1} + \rho_{n-1,t+1}) \quad (11)$$

The bond market: The term structure of interest rates

- Plugging the so obtained expression for $R_{n-1,t+1}$ into the equation for $R_{n,t}$ and repeating these two steps for $R_{n-2,t+2}, \dots$ we obtain:

$$R_{n,t} = \frac{1}{n} \sum_{i=0}^{n-1} E_t (s_{t+i} + \rho_{n-i,t+i}) \quad (12)$$

⇒ Interpretation?

- The nominal interest rate on the risk-free bond is given by:

$$s_t = r_t + E_t \pi_{t+1} \quad (13)$$

(Fisher equation).

- Plugging this expression into the just derived equation for $R_{n,t}$ yields:

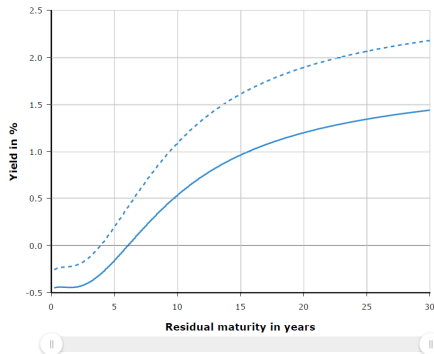
$$R_{n,t} = \frac{1}{n} \sum_{i=0}^{n-1} E_t (r_{t+i} + E_t \pi_{t+1+i} + \rho_{n-i,t+i}) \quad (14)$$

The bond market: The term structure of interest rates

- Yield curve: A plot of the yield on bonds with differing terms to maturity but the same risk, liquidity and tax considerations is called a yield curve.
- A yield curve can be
 - upward-sloping, i.e. long-term rates are above short-term rates
 - flat, i.e. short- and long-term rates are the same
 - downward-sloping (inverted), i.e. long-term rates are below short-term rates or
 - shaped more complicated (very rare)

The bond market: The term structure of interest rates

- Yield Curve Euro Area January 22nd, 2016



Dashed lines indicate the spot rate based on all government bonds; solid lines on AAA-rated bonds only.

Source: Website of the ECB