Principles of Finance

Prof. Dr. Dennis A. V. Dittrich

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Measures of Money

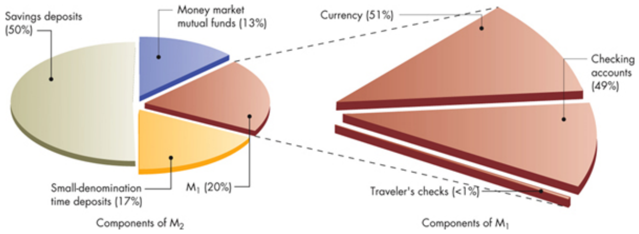
Why is simply counting currency an inadequate measure of money?

Measures of Money

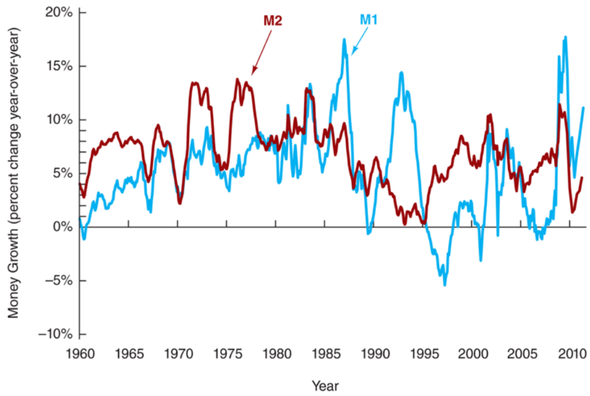
- Economists have developed di: erent measures of money

  M1 is a measure of the money supply; it consists of currency in the hands of the public plus traveler's checks, demand deposits, checking accounts, and other checkable deposits.

  M2 is a measure of the money supply; it consists of M1 plus other relatively liquid assets (small denomination time deposits, savings deposits and money market deposit accounts, money market mutual fund shares)



Does it matter which measure is considered?



M1 and M2 can move in di: erent directions in the short run
Conclusion: the choice of monetary aggregate is important for policy makers.

Measures of the Monetary Aggregates in the USA

Measures of the Monetary Aggregates

	Value as of May 16, 2011 ($ billions)
M1 = Currency	958.8
+ Traveler's checks	4.6
+ Demand deposits	573.1
+ Other checkable deposits	399.0
Total M1	1,935.5
M2 = M1	
+ Small-denomination time deposits	848.3
+ Savings deposits and money market deposit accounts	5,530.4
+ Money market mutual fund shares (retail)	688.4
Total M2	9,002.6

Source: www.federalreserve.gov/releases/h6/hist.

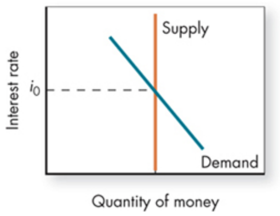
Where Are All the U.S. Dollars?

The more than $2,000 of U.S. currency held per person in the United States is a surprisingly large number Where are all these dollars and who is holding them?

Why People Hold Money

The only reason people would be willing to hold money is if they get some bene, t from doing so

- The **transactions motive** is the need to hold money for spending
- The **precautionary motive** is holding money for unexpected expenses and impulse buying
- The **speculative motive** is holding cash to avoid holding , nancial assets whose prices are falling



- The demand for money is downward-sloping: as the interest rate falls the cost of holding money falls
- When interest rates rise, bonds & other , nancial assets become more attractive, so you hold more of these & less money

Understanding Interest Rates and The Discounted Utility Model

The marshmallow test

Interest Rates and Present Value

A dollar paid to you one year from now is less valuable than a dollar paid to you today.

Why?

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Why?

A dollar deposited today can earn interest and become $\$1 \times (1 + r)$ one year from today.

Simple Interest

Simple interest is computed using the following formula:

$$I = Pr$$

I is the Interest, P is the principal, and r is the rate of interest.

Suppose you borrow $1000 for a year at an annual interest rate of 9%. How much interest will you owe the lender?

Cost of credit

You borrow $1000 (for a period of one year) with your Silver Axxess Visa Card. What is the total cost if this is the only charge to this card in this year?

Table 8.1 Credit-card offers for customers with bad credit

Credit-card offer	APR	Fee
Silver Axxess Visa Card	19.92%	$48
Finance Gold MasterCard	13.75%	$250
Continental Platinum MasterCard	19.92%	$49
Gold Image Visa Card	17.75%	$36
Archer Gold American Express	19.75%	$99
Total Tribute American Express	18.25%	$150
Splendid Credit Eurocard	22.25%	$72

Liability

The Liability L is:

$$L = P + I$$
$$= P + Pr$$
$$= P(1 + r)$$

Cost of credit

You borrow $1000 (for a period of one year). Which credit card will cost the most to pay back?

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Implicit Interest

Suppose somebody o: ers to lend you \$ 105 on the condition that you pay back \$ 115 one year later.

What is the interest rate r?

Exponential Discounting

People discount the future and hence prefer their rewards sooner than later.

Example: Tom prefers to have $100 today rather than $100 next year.

A person's time preference represents the extent to which they discount the future.

Exponential discounting is designed to capture this phenomenon.

Exponential Discounting

Let $u > 0$ be the utility you get from getting a dollar now.

Getting a dollar tomorrow is worth slightly less to you. Hence, we multiply it by a discount factor δ between 0 and 1: δu

Getting a dollar the day after tomorrow is worth even less. Thus, we multiply it by an additional δ: $\delta^2 u$

Exponential Discounting

If we are interested in the entire utility stream $u = \{u_0, u_1, u_2, \ldots\}$, the discounted utility from the point of view of time zero is given by the following expression:

$$U^0(u) = \delta^0 u_0 + \delta^1 u_1 + \delta^2 u_2 + \ldots$$

This is the delta function.

Example

Table 8.2 Simple time-discounting problem

	$t=0$	$t=1$	$t=2$
a	1		
b		3	
c			4
d	1	3	4

Suppose $\delta = 0.9$ and you are making a decision at $t = 0$.
What is the value of each choice?
What about if $\delta = 0.1$?

Utility of a future income

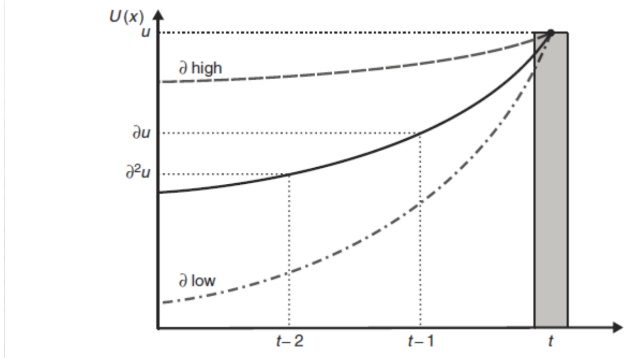


Figure 8.1 Exponential discounting

Examples

Table 8.3 Time-discounting problems

	$t=0$	$t=1$
a	3	4
b	5	1

(a)

	$t=0$	$t=1$	$t=2$
a		6	1
b		3	4

(b)

	$t=0$	$t=1$	$t=2$
a	1		1
b			5

(c)

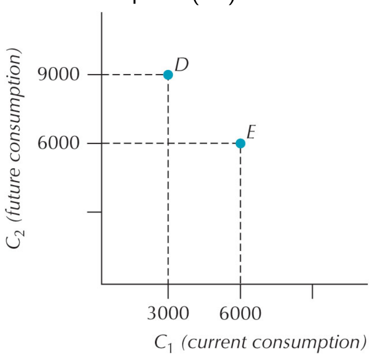
You are indi: erent between a and b. For each table, , nd δ.

Discount Factor δ and Discount Rate r

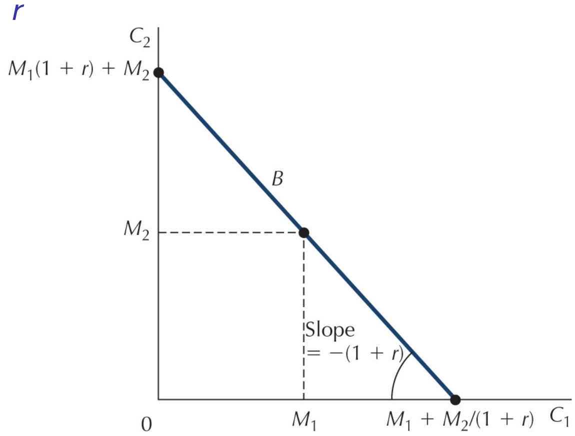
$$r = \frac{1-\delta}{\delta}$$
$$\delta = \frac{1}{1+r}$$

The Intertemporal Choice Model

- How would rational consumers distribute their consumption over time?
- Two time periods: current and future.
- Two alternatives (goods): current consumption (C1) versus future consumption (C2).



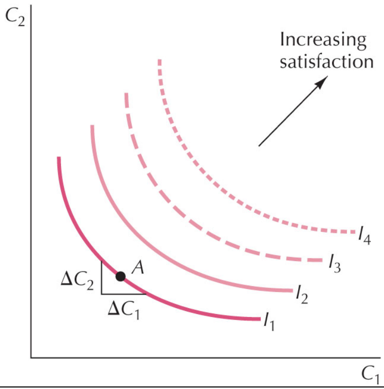
Intertemporal Budget Constraint with Income in Both Periods, and Borrowing or Lending at the Rate r



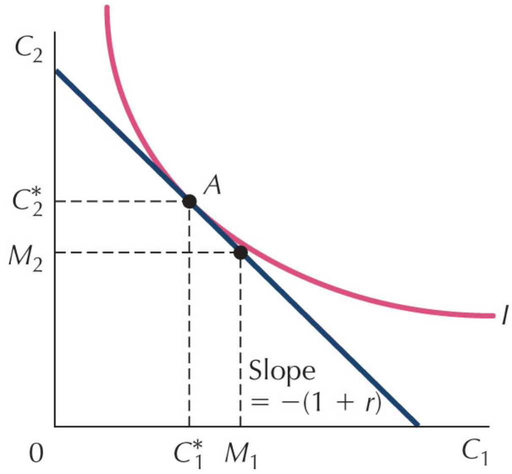
Marginal rate of time preference

the number of units of consumption in the future a consumer would exchange for 1 unit of consumption in the present.

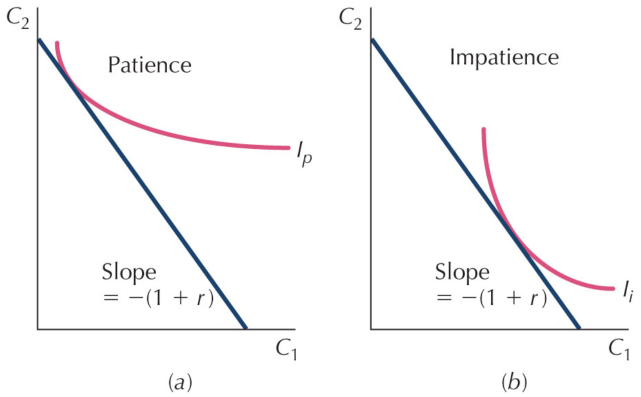
- It declines as one moves downward along an indi: erence curve.



The Optimal Intertemporal Allocation

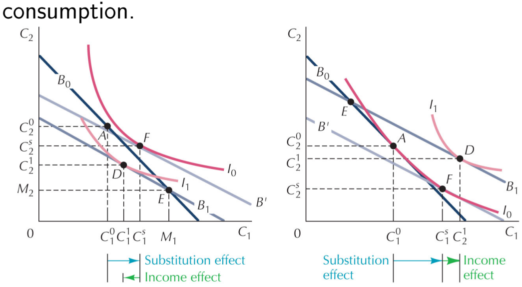


Patience and Impatience



The e: ect of a fall (or rise) in the interest rate depends on whether the consumer is a borrower or a saver.

- The income e: ect ...
  - A borrower has more income after an interest rate fall. So, her income epect is to consume more in both periods.
  - A saver has less income after an interest rate fall. So, her income epect is to consume less in both periods.
- The Substitution e: ect after a fall in the interest rate is always to increase current consumption and reduce future consumption.



Future Value: Compound Interest

$$FV = P \times (1 + r)^t$$

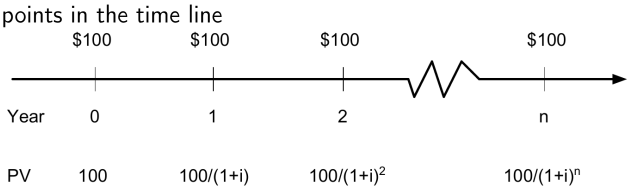
You put \$100 into a savings account. Your bank promises an annual rate of 5%.
What is your balance after 1 year?
10 years?
50 years?

You have an inheritance of \$100,000 you will receive in 10 years. What is it worth right now if the interest you could get on an investment is 4.5% (compounded annually)?

Simple Present Value

$$PV = \frac{CF}{(1+i)^t}$$

You cannot directly compare payments scheduled in di: erent points in the time line



Assume an annual interest rate of 7.5%.

What is the Present Value of $10000 received in (a) one year, (b) 5 years, and (c) 10 years?

What is better?

a Receiving $100 in one year and $200 in two years.

b Receiving $340 in three years.

if the (constant) interest rate is 10%?

Net Present Value

$$NPV = \sum_{0}^{T} \frac{B_t - C_t}{(1+r)^t}$$

B_t Cash indow in period t

C_t Cash outdow in period t

r discount rate

An initial investment on plant and machinery of $8,320,000 is expected to generate cash indows of $3,411,000, $4,070,000, $5,824,000 and $2,065,000 at the end of , rst, second, third and fourth year respectively. At the end of the fourth year, the machinery will be sold for $900,000. Calculate the present value of the investment if the discount rate is 18%.

You win the state lottery and will receive $100,000 now and then each year for all eternity, i.e. your heirs will continue to receive the yearly payments once you die. For how much can you sell your prize right now?
Assume the annual interest rate will always be 2%.

Present Value of a Perpetuity

$$P = \sum_{1}^{\infty} \frac{B}{(1+i)^t}$$

$$= B \times \sum_{1}^{\infty} \frac{1}{(1+i)^t} = B \times \sum_{1}^{\infty} \left(\frac{1}{1+i}\right)^t$$

$$1 + x + x^2 + x^3 \ldots = \frac{1}{1-x} \quad \forall x < 1$$

$$P = B \times \left(\frac{1}{1 - 1/(1+i)} - 1\right)$$

$$= B \times \left(\frac{1 - 1 + 1/(1+i)}{1 - 1/(1+i)}\right)$$

$$= B \times \left(\frac{1/(1+i)}{(1+i-1)/(1+i)}\right)$$

$$= B \times \frac{1}{i}$$

Four Types of Credit Market Instruments

- Simple Loan
- Fixed Payment Loan
- Coupon Bond
- Discount Bond

Yield to Maturity a Internal Rate of Return

The interest rate that equates the present value of cash dow payments received from a debt instrument with its value today

Simple Loan

$$\text{PV} = \text{amount borrowed} = \$100$$

$$\text{CF} = \text{cash flow in one year} = \$110$$

$$n = \text{number of years} = 1$$

$$\$100 = \frac{\$110}{(1+i)^1}$$

$$(1+i)\,\$100 = \$110$$

$$(1+i) = \frac{\$110}{\$100}$$

$$i = 0.10 = 10\%$$

For simple loans, the simple interest rate equals the yield to maturity

Fixed Payment Loan

The same cash flow payment every period throughout the life of the loan

$$\text{LV} = \text{loan value}$$

$$\text{FP} = \text{fixed yearly payment}$$

$$n = \text{number of years until maturity}$$

$$\text{LV} = \frac{\text{FP}}{1+i} + \frac{\text{FP}}{(1+i)^2} + \frac{\text{FP}}{(1+i)^3} + \ldots + \frac{\text{FP}}{(1+i)^n}$$

Bonds

- A bond is a sophisticated IOU that documents who owns how much and when payment must be paid.
- Issuing bonds allows borrowing directly from the public.
- Lender: one who buys a bond
- Borrower: one who issues a bond
- Corporations and governments at all levels borrow money by issuing bonds.
- All bonds involve a risk.
  - Major issues are graded by rating companies: Standard and Poor's, Moody's
  - Grades range from lowest risk (AAA) bonds in current default (D)
  - The higher the risk the greater the interest rate required to get lenders to buy the bonds.

Coupon Bond

A **coupon** payment on a bond is a periodic interest payment that the bondholder receives during the time between when the bond is issued and when it matures.

Coupon Bond

Using the same strategy used for the fixed-payment loan:

P = price of coupon bond

C = yearly coupon payment

F = face value of the bond

n = years to maturity date

$$P = \frac{C}{1+i} + \frac{C}{(1+i)^2} + \frac{C}{(1+i)^3} + \ldots + \frac{C}{(1+i)^n} + \frac{F}{(1+i)^n}$$

Yields to Maturity on a 10%-Coupon-Rate Bond Maturing in Ten Years (Face Value = $1,000)

Yields to Maturity on a 10%-Coupon-Rate Bond Maturing in Ten Years (Face Value = $1,000)

Price of Bond ($)	Yield to Maturity (%)
1,200	7.13
1,100	8.48
1,000	10.00
900	11.75
800	13.81

- When the coupon bond is priced at its face value, the yield to maturity equals the coupon rate
- The price of a coupon bond and the yield to maturity are negatively related
- The yield to maturity is greater than the coupon rate when the bond price is below its face value

Consol or Perpetuity

- A bond with no maturity date that does not repay principal but pays , xed coupon payments forever

$$P = C/i$$

P Price of consol
C yearly interest payment
i yield to maturity

$$i = C/P$$

- For coupon bonds, this equation gives the current yield, an easy to calculate approximation to the yield to maturity

Discount Bond Z Zero Coupon Bond

- No interest payments (=coupons)
- Sold for a price below face value
- US Treasury Bills are examples of such Zero Coupon Bonds
- Some zero coupon bonds are indation indexed, the nominal face value is indation adjusted
- Short term zero coupon bonds are called Bills

Discount Bond

For any one year discount bond

$$i = \frac{F - P}{P}$$

F = Face value of the discount bond

P = current price of the discount bond

The yield to maturity equals the increase in price over the year divided by the initial price.

As with a coupon bond, the yield to maturity is negatively related to the current bond price.

Interest Rates vs Rate of Returns

Rate of Return

The payments to the owner plus the change in value expressed as a fraction of the purchase price

$$RET = \frac{C}{P_t} + \frac{P_{t+1} - P_t}{P_t}$$

RET = return from holding the bond from time t to time $t + 1$

P_t = price of bond at time t

P_{t+1} = price of the bond at time $t + 1$

C = coupon payment

$$\frac{C}{P_t} = \text{current yield} = i_c$$

$$\frac{P_{t+1} - P_t}{P_t} = \text{rate of capital gain} = g$$

The Distinction Between Interest Rates and Returns

- The return equals the yield to maturity only if the holding period equals the time to maturity
- A rise in interest rates is associated with a fall in bond prices, resulting in a capital loss if time to maturity is longer than the holding period
- The more distant a bond's maturity, the greater the size of the percentage price change associated with an interest-rate change
- The more distant a bond's maturity, the lower the rate of return the occurs as a result of an increase in the interest rate
- Even if a bond has a substantial initial interest rate, its return can be negative if interest rates rise

One-Year Returns on Diderent-Maturity 10%-Coupon-Rate Bonds When Interest Rates Rise from 10% to 20%

One-Year Returns on Different-Maturity 10%-Coupon-Rate Bonds When Interest Rates Rise from 10% to 20%

(1) Years to Maturity When Bond Is Purchased	(2) Initial Current Yield (%)	(3) Initial Price ($)	(4) Price Next Year* ($)	(5) Rate of Capital Gain (%)	(6) Rate of Return (2 + 5) (%)
30	10	1,000	503	−49.7	−39.7
20	10	1,000	516	−48.4	−38.4
10	10	1,000	597	−40.3	−30.3
5	10	1,000	741	−25.9	−15.9
2	10	1,000	917	−8.3	+1.7
1	10	1,000	1,000	0.0	+10.0

*Calculated with a financial calculator using Equation 3.

Interest-Rate Risk

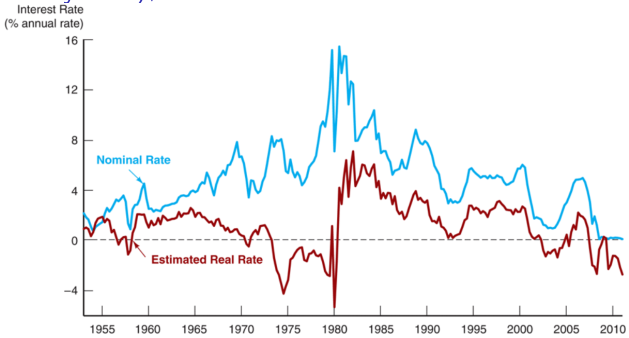
Prices and returns for long-term bonds are more volatile than those for shorter-term bonds There is no interest-rate risk for any bond whose time to maturity matches the holding period

The Distinction Between Real and Nominal Interest Rates

Nominal interest rate makes no allowance for indation Real interest rate is adjusted for changes in price level so it more accurately redects the cost of borrowing Ex ante real interest rate is adjusted for expected changes in the price level Ex post real interest rate is adjusted for actual changes in the price level

Fisher Equation

Real and Nominal Interest Rates (Three-Month Treasury Bill), 1953Z2011



Sources: Nominal rates from
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