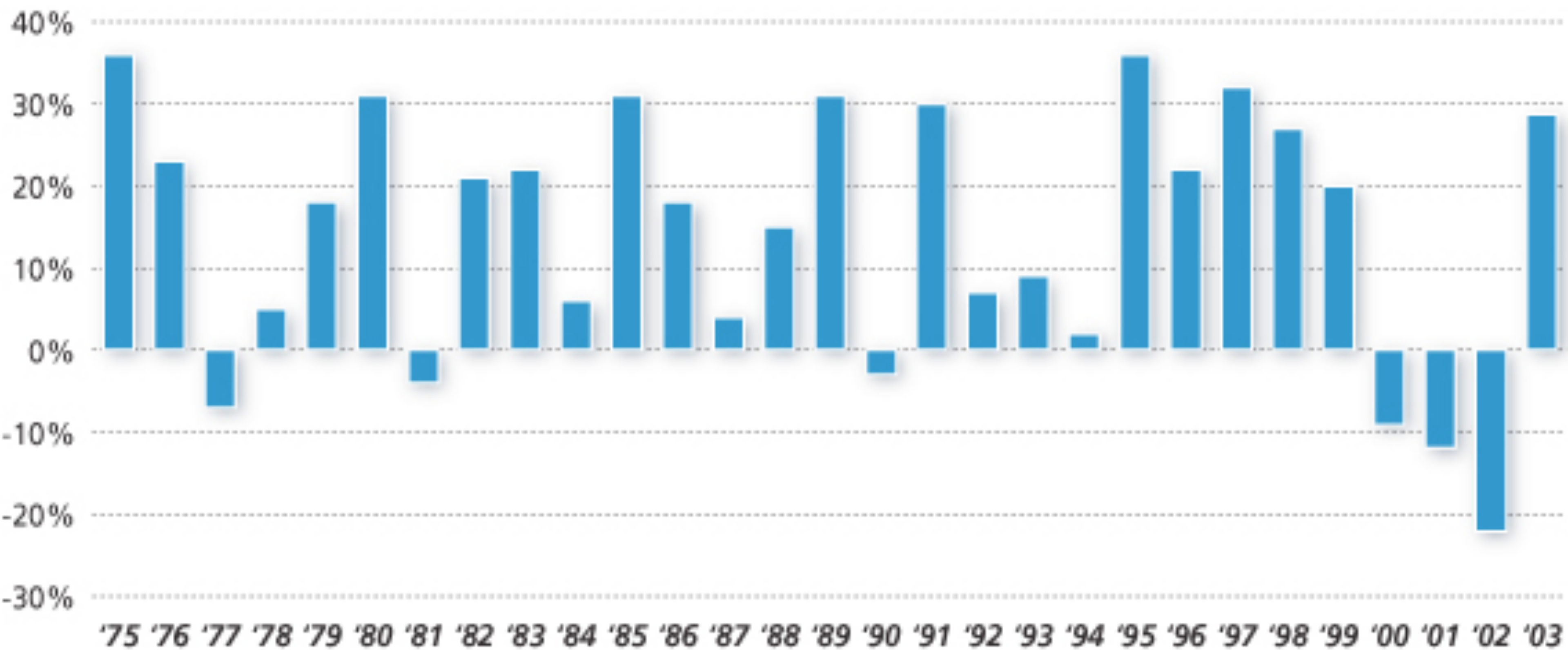
Security Analysis and Investment

Lecture 2

Risk


40%
30%
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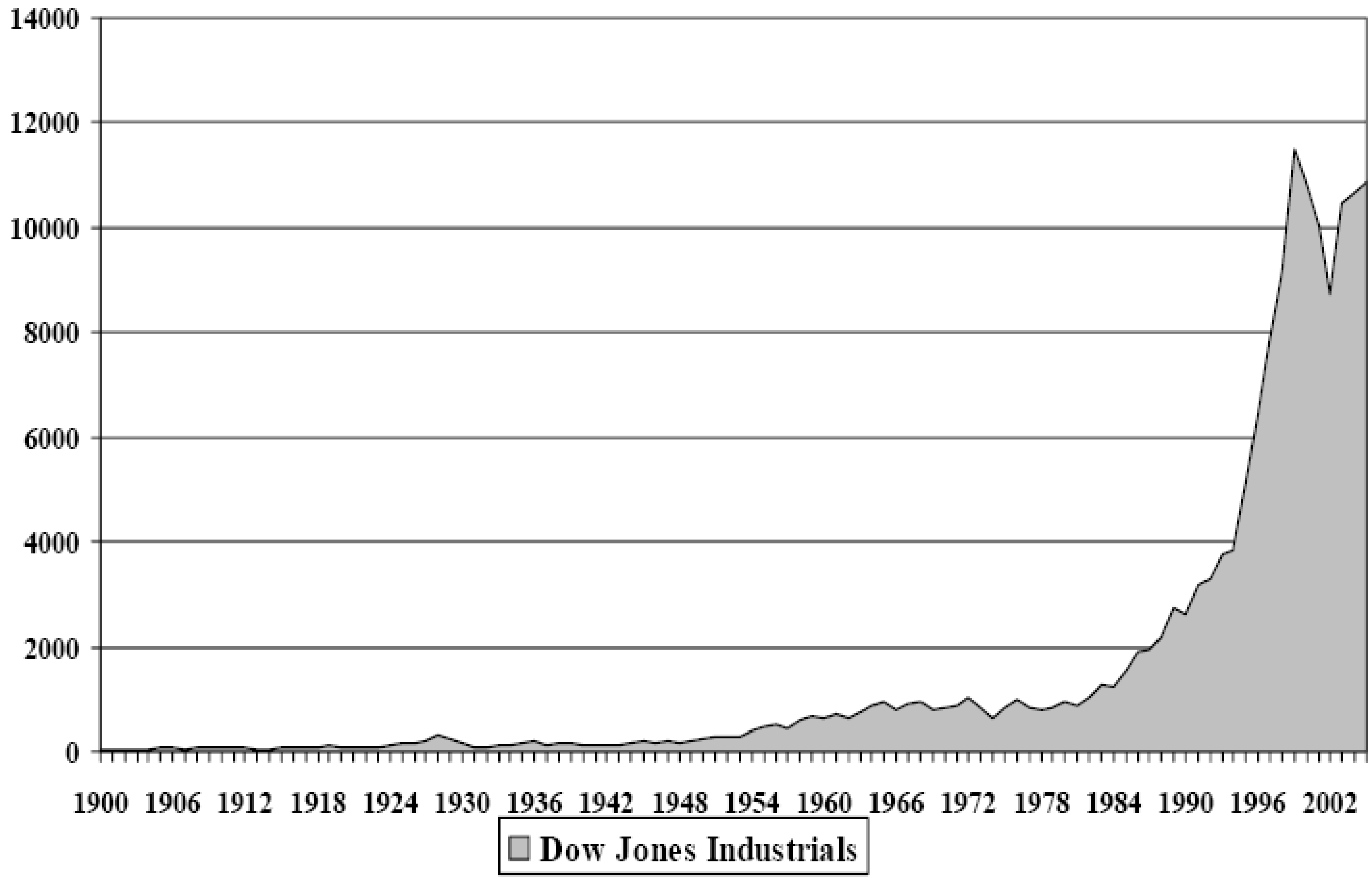
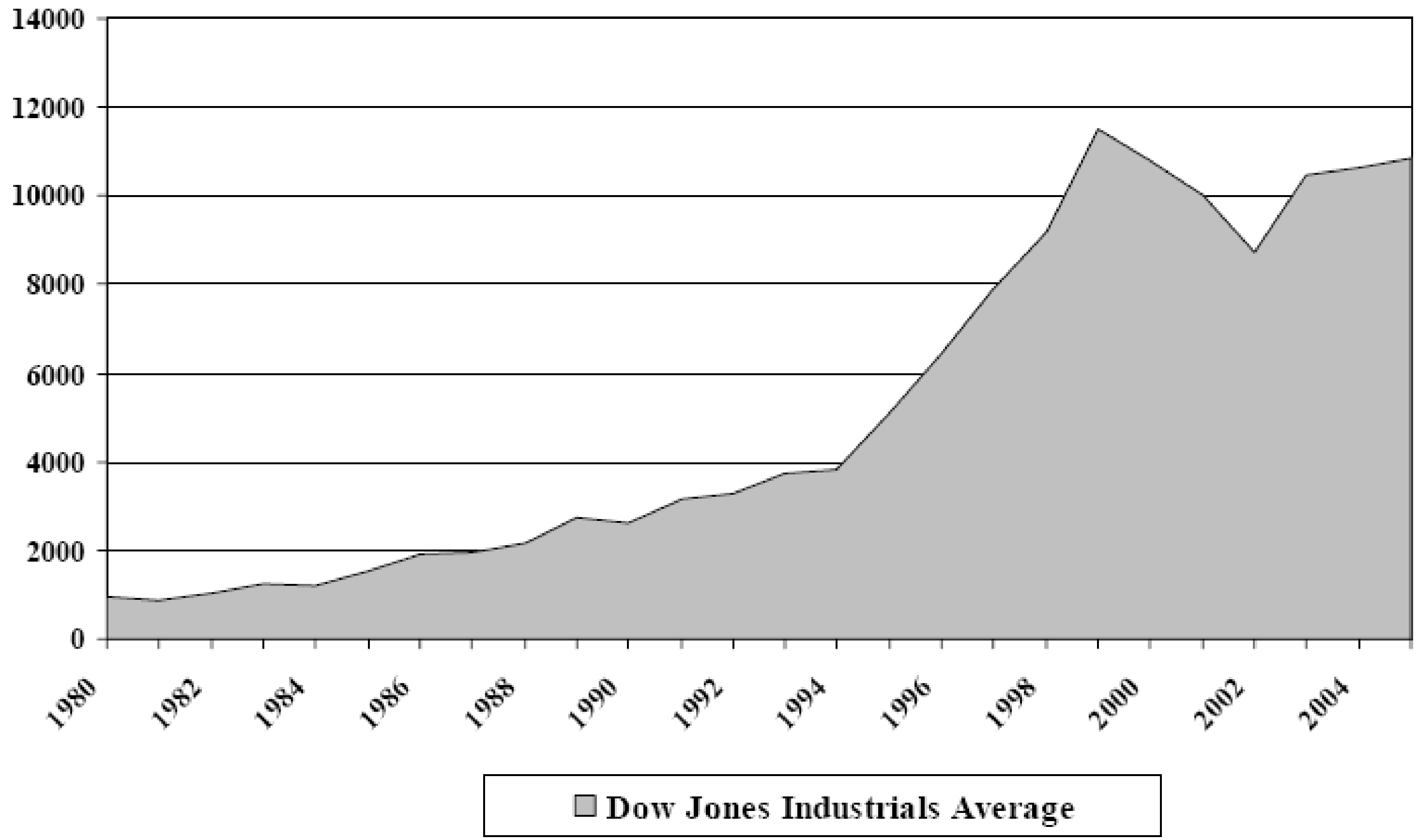
'75 '76 '77 '78 '79 '80 '81 '82 '83 '84 '85 '86 '87 '88 '89 '90 '91 '92 '93 '94 '95 '96 '97 '98 '99 '00 '01 '02 '03

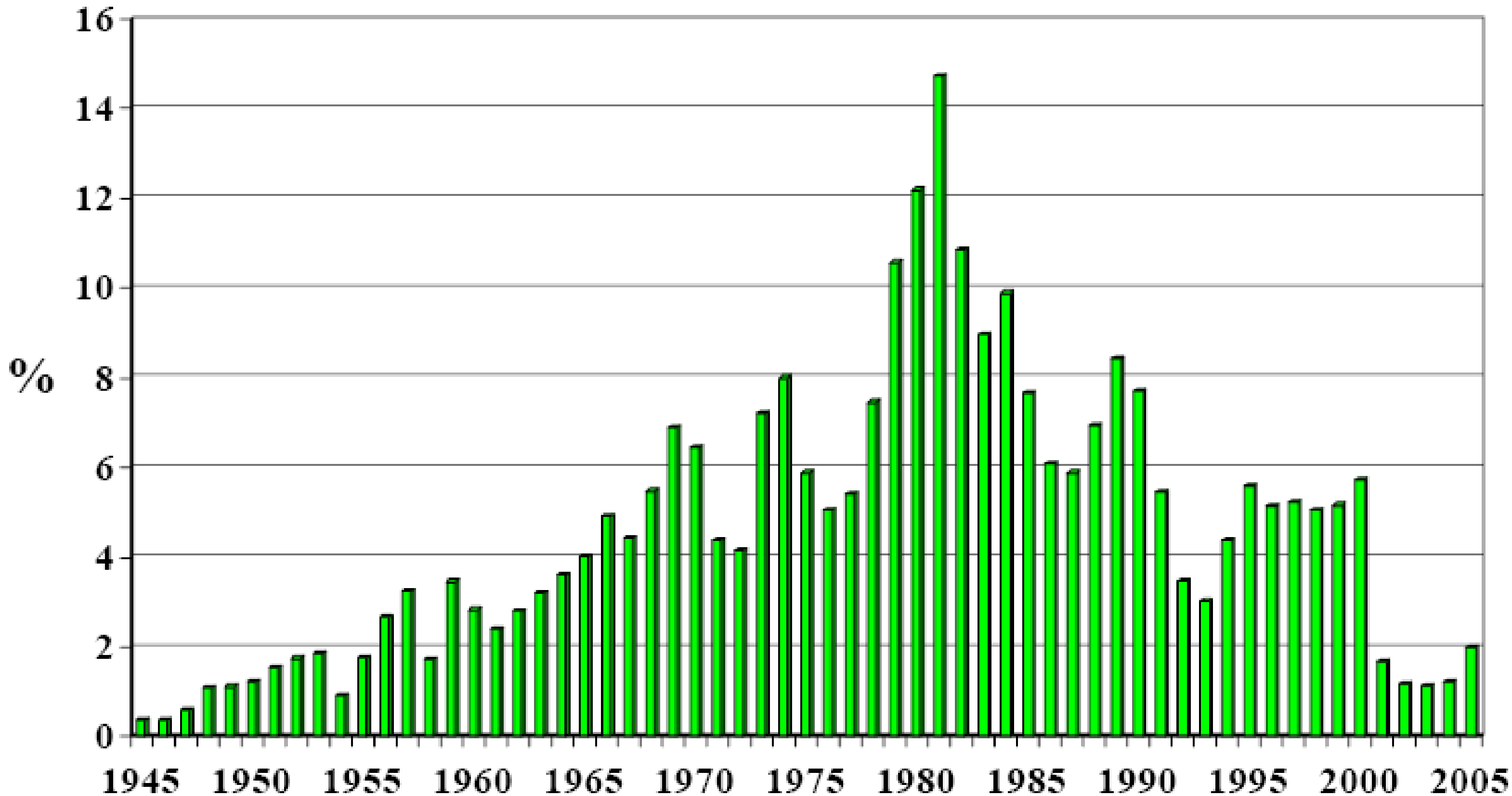
Dow Jones: 1900 - 2005



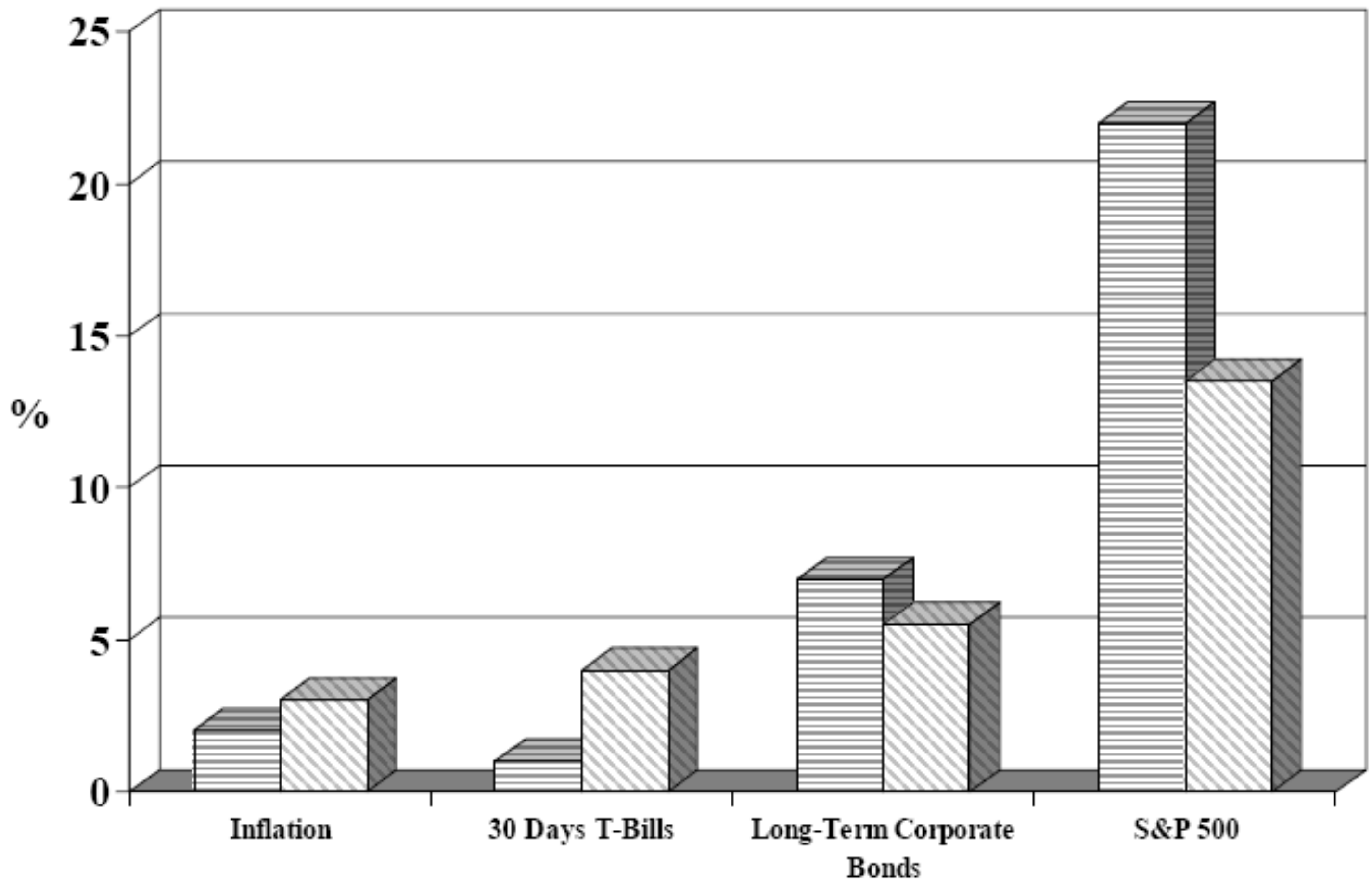
Dow Jones: 1980 - 2005



U.S. Treasury Bills Annual Returns (1945-2005)



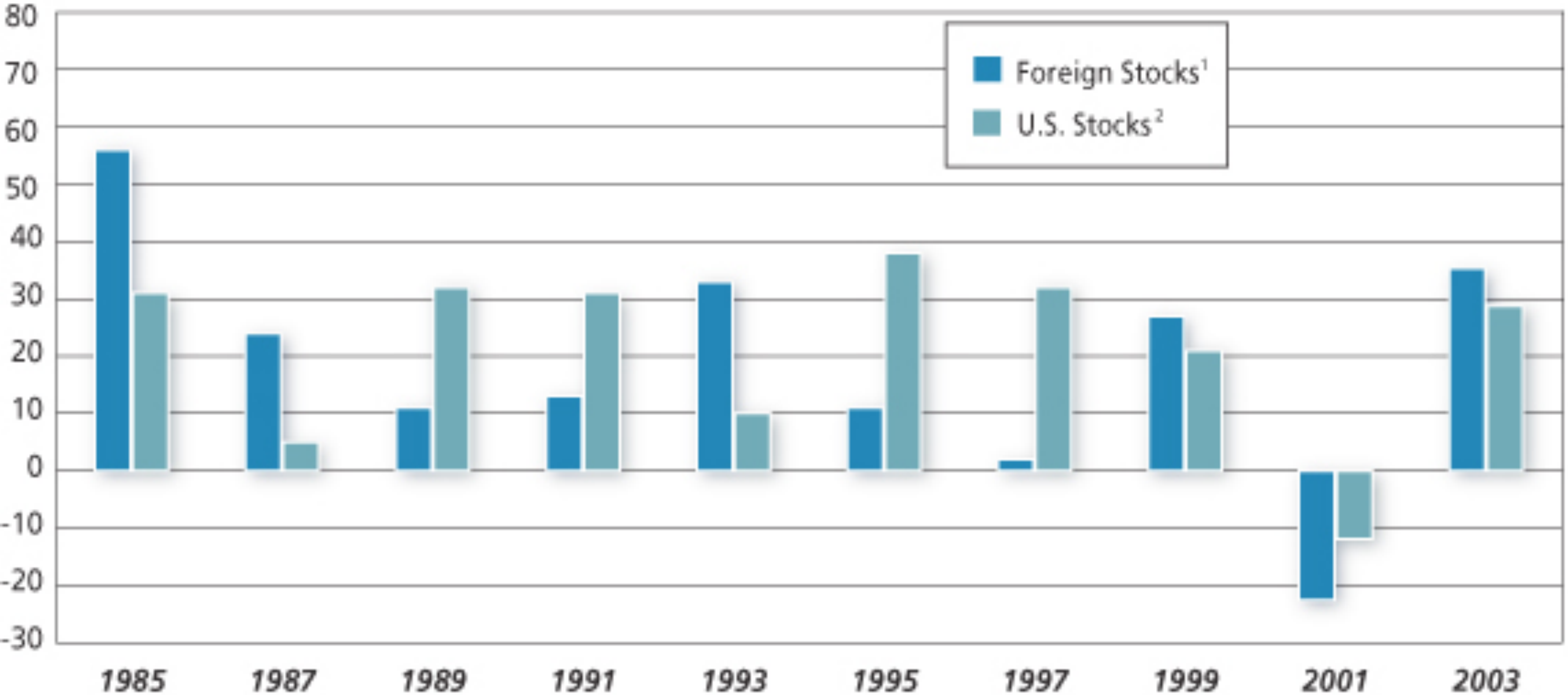
Risk-Return Relationship for Different Instruments (1928-2000)



Annual Returns on Stock, T.Bonds and T.Bills: 1928 - Current

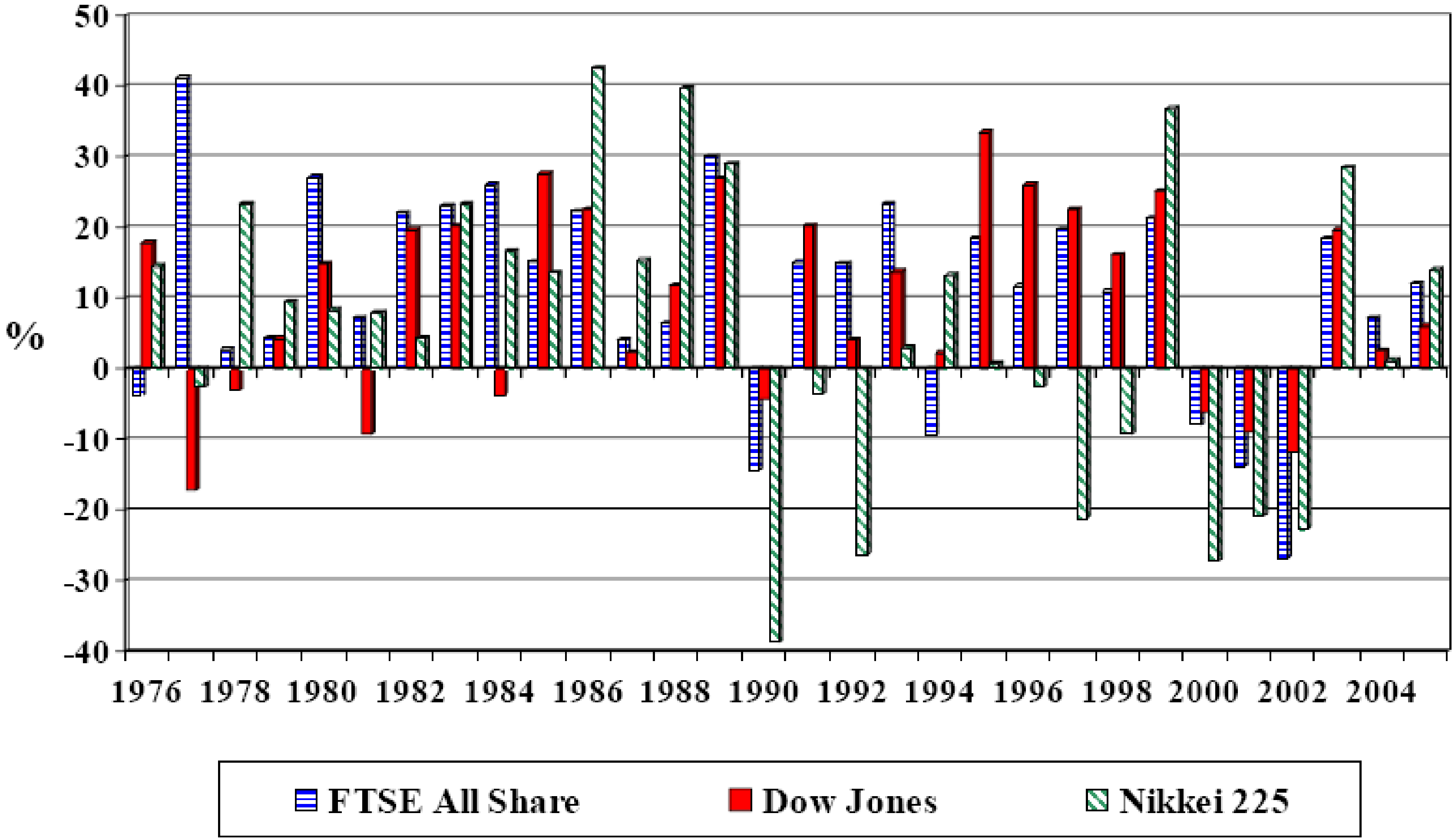
- http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/histretSP.html

- For the Chinese market, see Chinese Capital Market: An Empirical Overview, by Hu, Pan and Wang (2017)



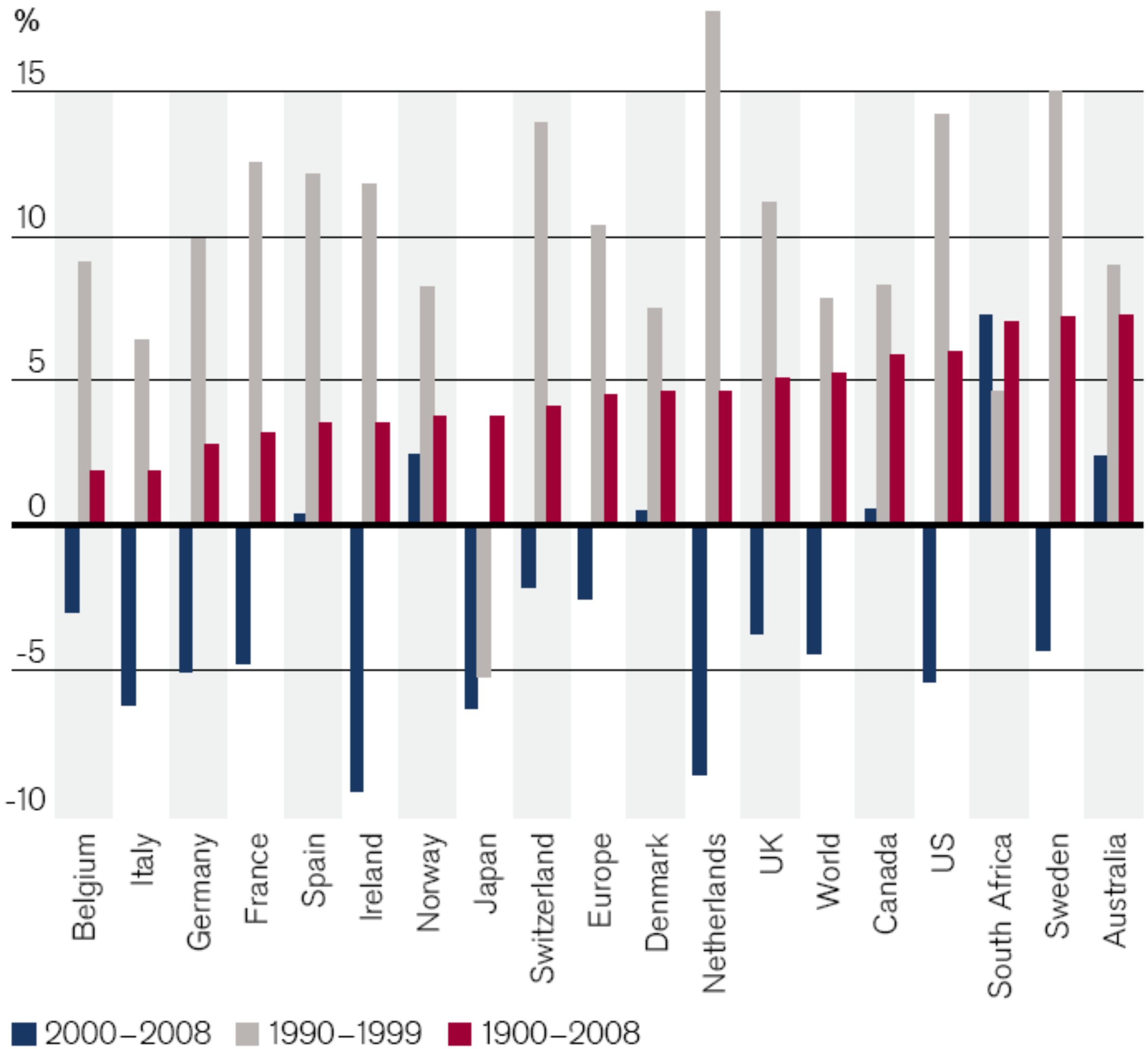
Foreign Stocks[1]
U.S. Stocks[2]
80
70
60
50
40
30
20
10
0
-10
-20
-30
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003

US, Japan and UK Markets: Annual Returns (1976-2005)



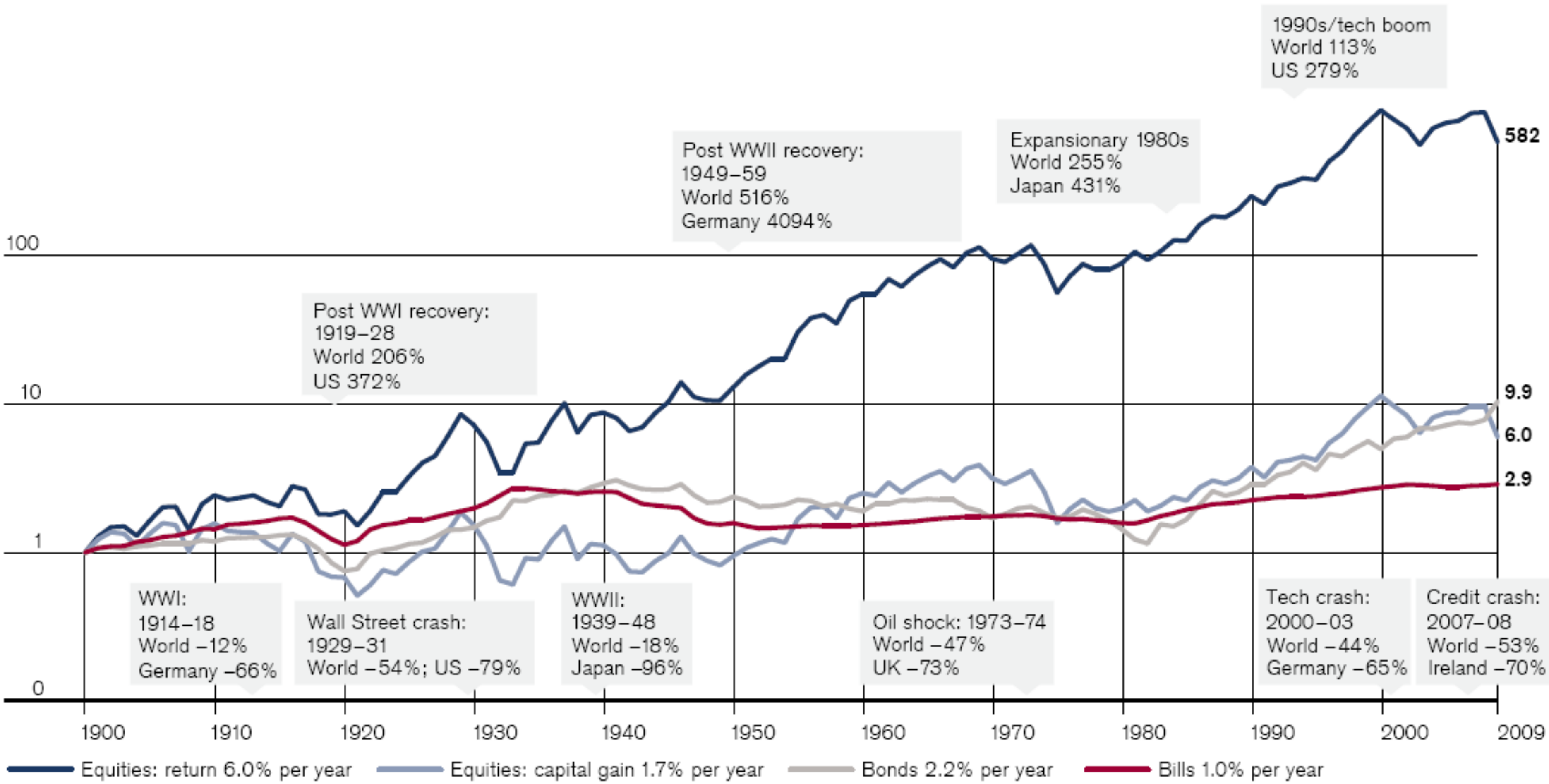
Real equity returns around the world in recent periods and over the long run

Source: Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Investment Returns Sourcebook 2009 and Triumph of the Optimists, Princeton University Press, 2002



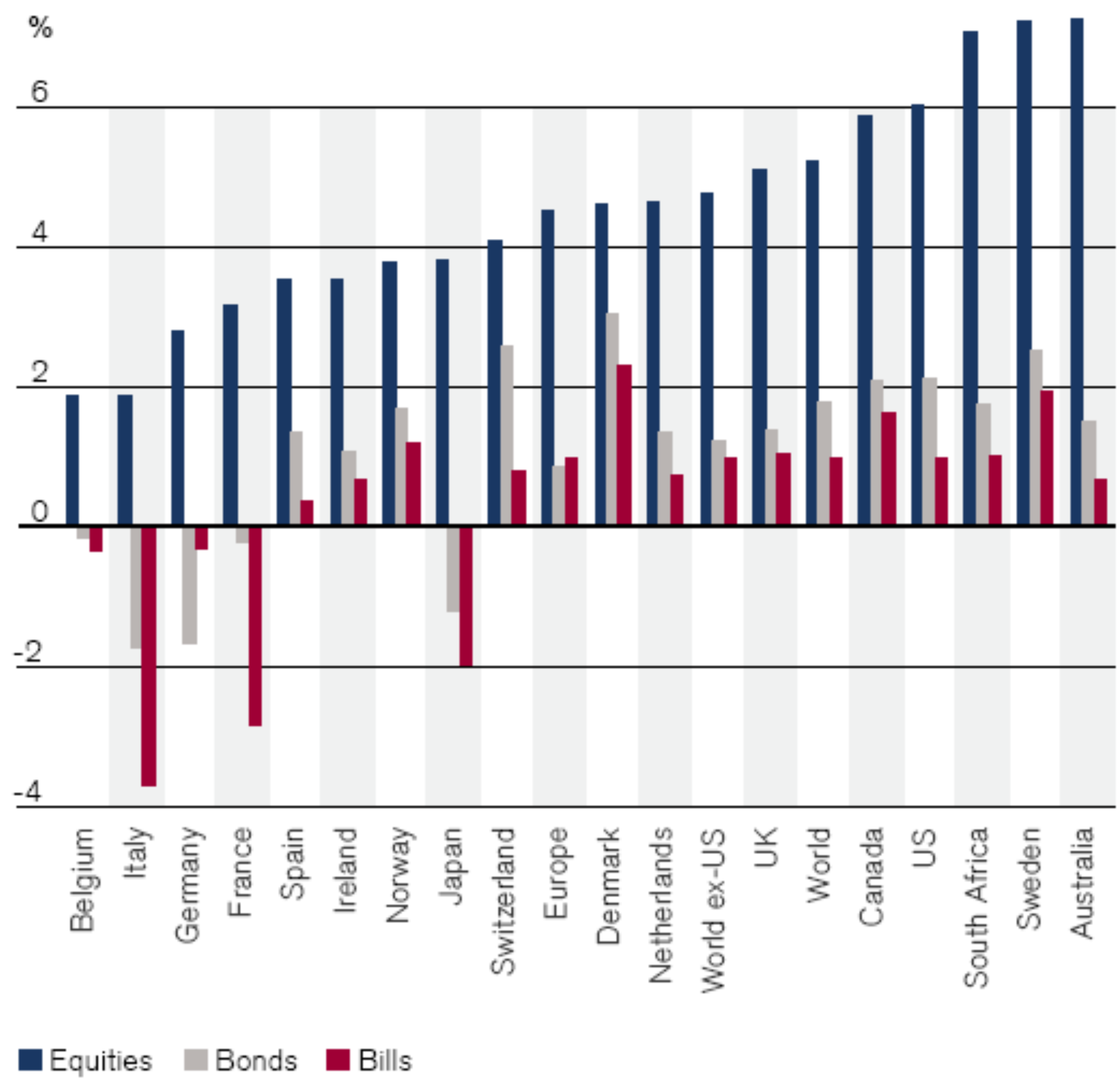
Cumulative returns on US asset classes in real terms, 1900–2008

Source: Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Investment Returns Sourcebook 2009 and Triumph of the Optimists, Princeton University Press, 2002



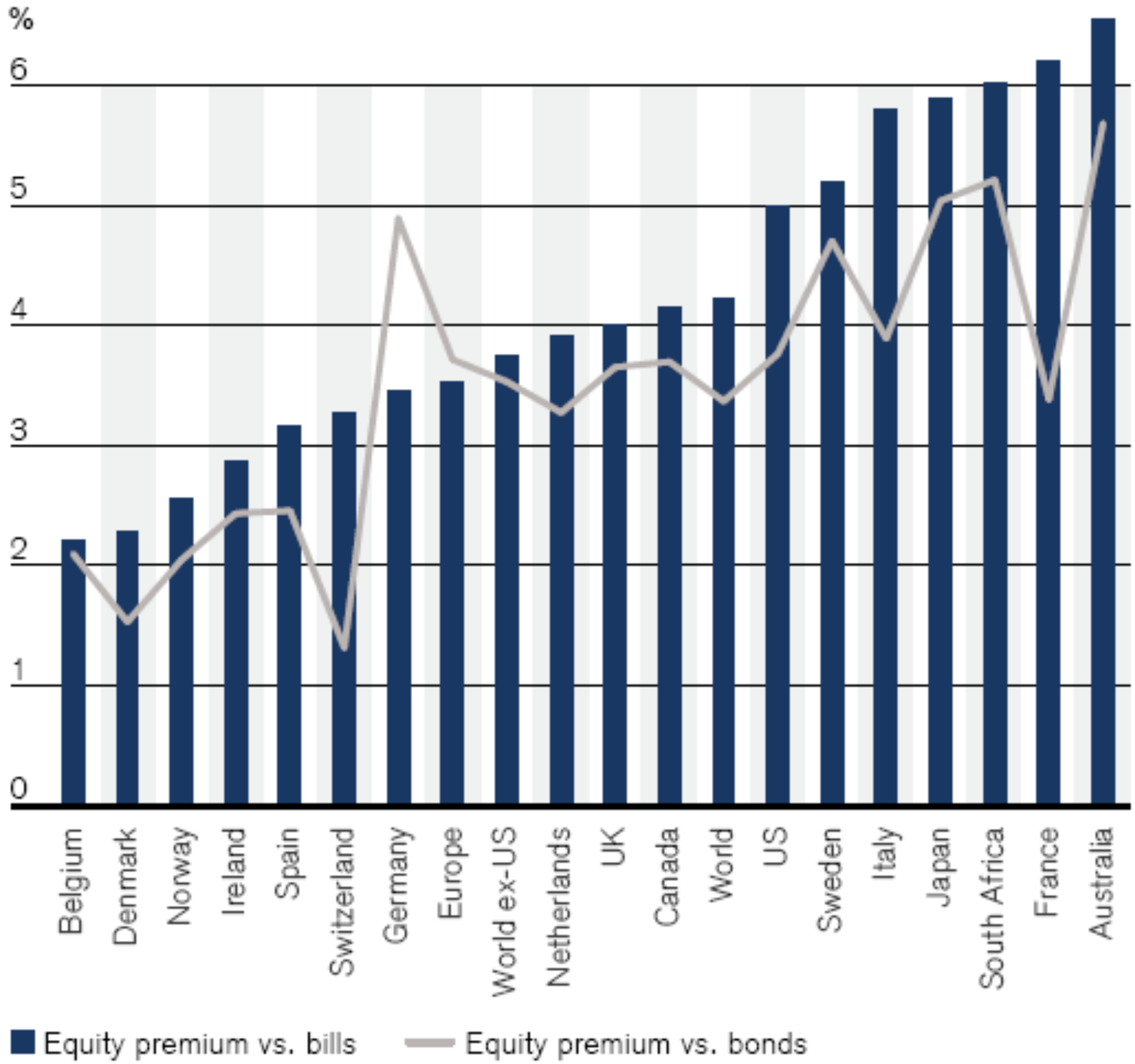
Real returns on equities, bonds and bills internationally, 1900–2008

Source: Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Investment Returns Sourcebook 2009 and Triumph of the Optimists, Princeton University Press, 2002



Worldwide annualized risk premiums relative to bills and bonds, 1900–2008

Source: Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Investment Returns Sourcebook 2009 and Triumph of the Optimists, Princeton University Press, 2002



Risk

- Risky return:

$$\tilde{r} = \frac{\tilde{D} + \tilde{P}_1}{P_0} - 1$$

- This notation means realized returns may take on different values (ie. D and P are risky therefore r is risky).

Risk

- Eg. Suppose a stock pays no dividends and tomorrow's price is determined on the basis of the flip of two coins. Today's price is 900 and tomorrow's price is 1000 x (# heads).
- This stock is risky.
- We don't know what tomorrow's price will be but we do know what it can be.

Risk

$\tilde{P}_1$	$\tilde{r}$	Probability
0	-100	.25
1000	11	.50
2000	122	.25

- Price can take on three possible values with different probabilities for each value.

Risk

- We also know the distribution of the stock's returns:
  - eg. What is the probability that the above stock's return is negative?

Risk

- In reality a stock's return may take on any value and its distribution of returns is subjective (ie. It's based on beliefs).
  - Eg. What does the probability distribution of Apple returns look like?
- Risk will have to be related to the distribution of returns.

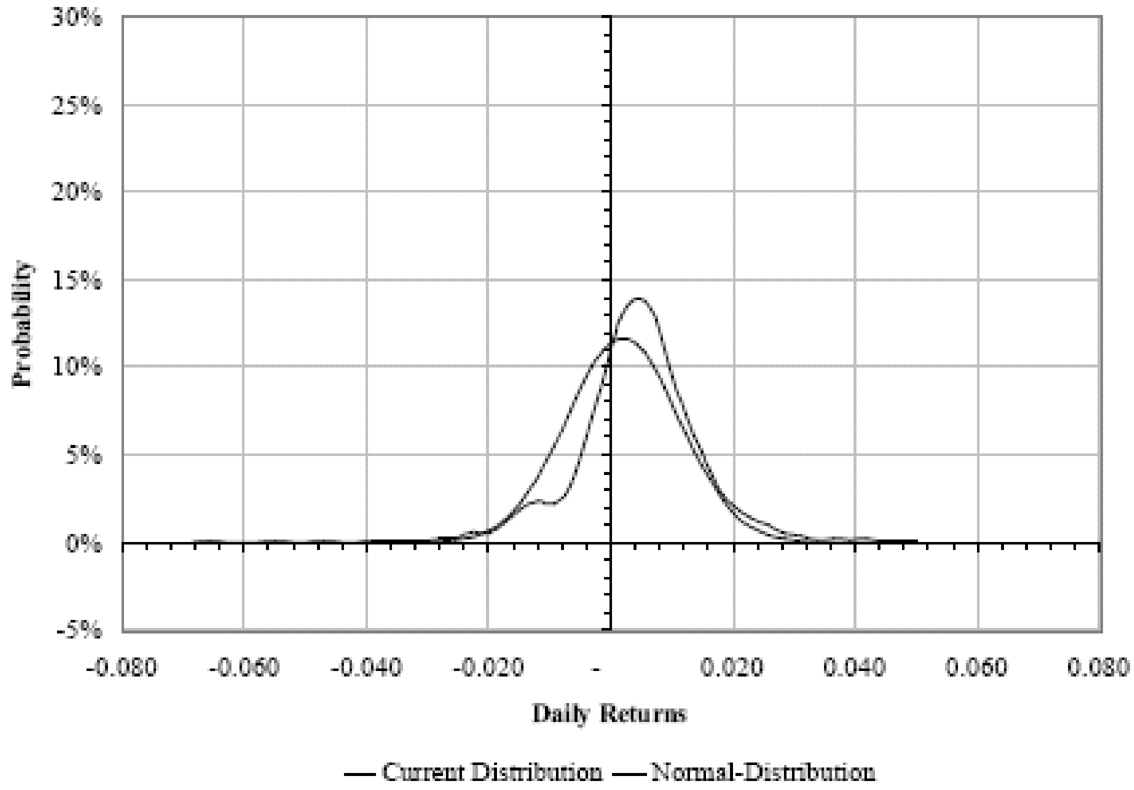


Figure 2: Return of S & P 500 Index,

Source: Bloomberg Professional.

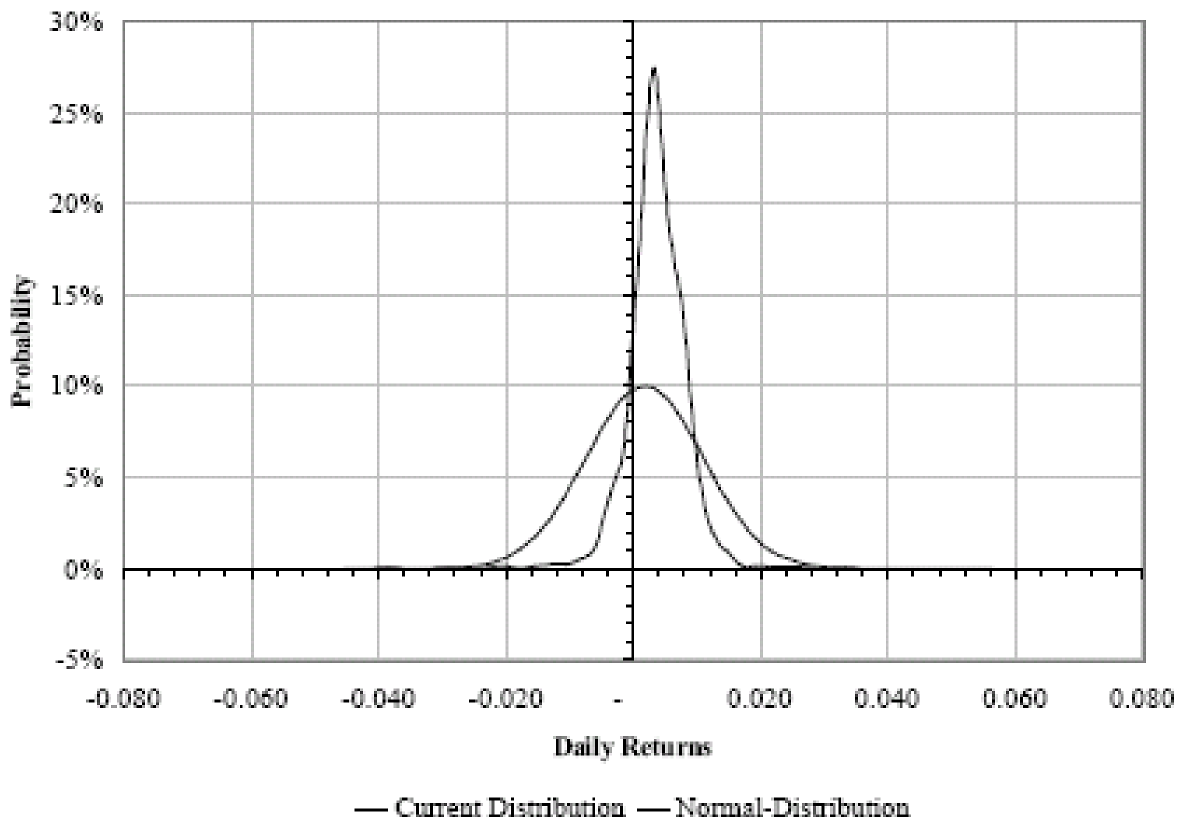
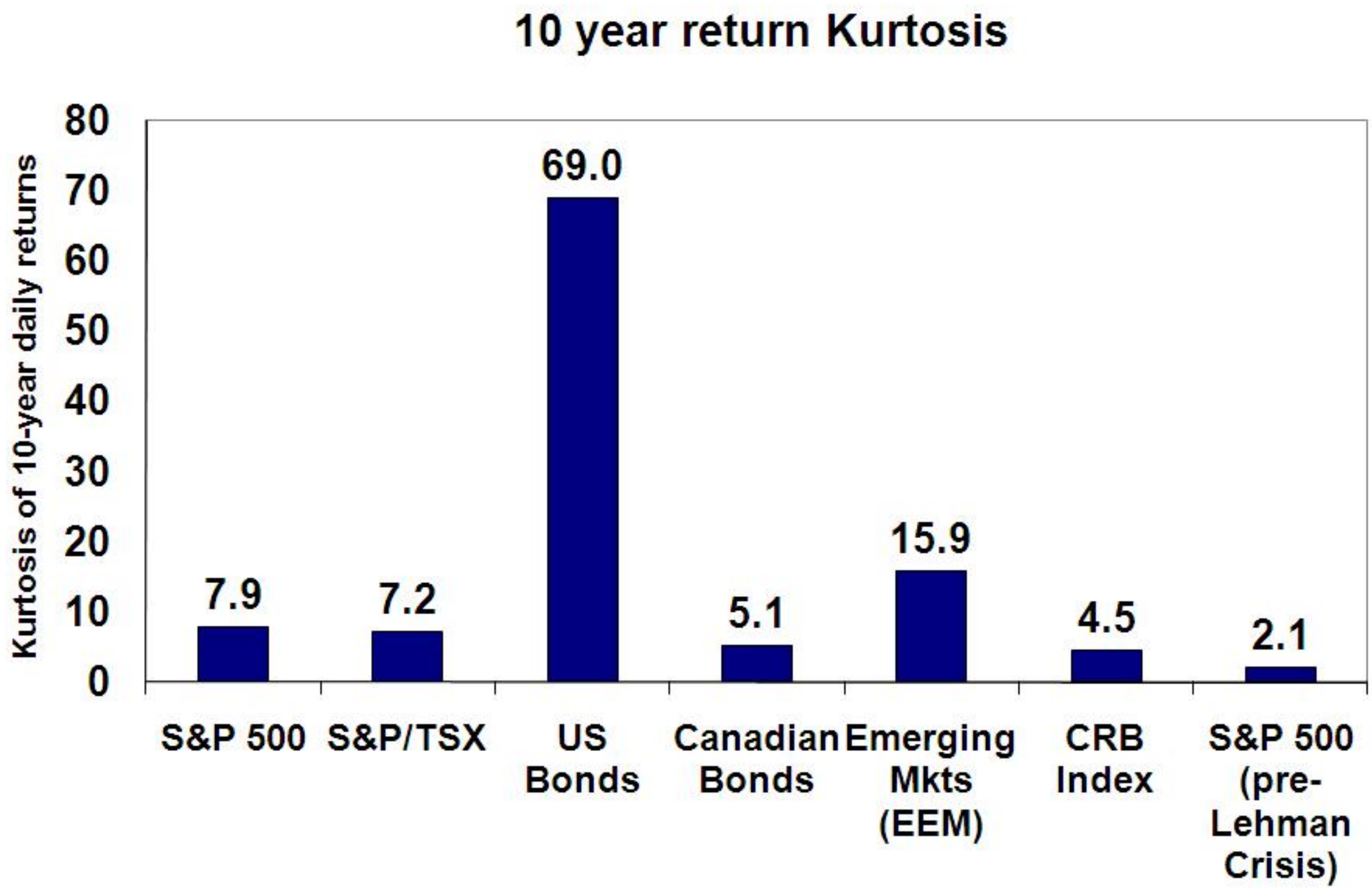


Figure 3: Return of 10 Year Treasury Bills,

Source: Bloomberg Professional.

More digression on SP500 v.s. US 10Y T-Bond



Risk

- More risky returns demand higher expected returns:
  - Expected Stock Return = riskless rate + risk premium
- BUT - how do we measure risk?

Some Statistics

- We need to calculate expected return and variance of stock returns:

$$E(\tilde{r}) = \sum_{\text{all } \tilde{r}} \tilde{r}\, p(\tilde{r})$$

$$Var(\tilde{r}) = \sum_{\text{all } \tilde{r}} (\tilde{r} - E(\tilde{r}))^2\, p(\tilde{r})$$

$$SDev(\tilde{r}) = \left(Var(\tilde{r})\right)^{1/2}$$

Risk

- From previous example:

Class Simulation

Assets	Return (Annual)	Standard Deviation
GREEN	7.5%	20%
BLUE	71%	132%
YELLOW	0%	6%

- Which asset do you like the most?

Dice	Green	Blue	Yellow
1	0.8	0.05	0.95
2	0.9	0.2	1
3	1.1	1	1
4	1.1	3	1
5	1.2	3	1
6	1.4	3	1.1

FIXED-INCOME SECURITIES

Fixed-income Securities

- Bond Characteristics
- Bond Pricing and Yield to Maturity (YTM)
- Relationships among:
  - Yield to Maturity
  - Spot Rates
  - Discount Factors
  - Forward Rates

Different Issuers of Bonds

- Treasury bonds
- Provincial government bonds
- Corporations
- Municipalities
- International Governments and Corporations
- Innovative Bond
  - Indexed Bonds (Inflation)
  - Floaters (LIBOR etc)

Bond Characteristics (Bond Indenture)

- Face value (Par value)
- Maturity
- Coupon rate
  - Zero coupon bond
- Payment schedule
  - T-bonds make semiannual coupon payments
  - Accrued interest (see next slide)

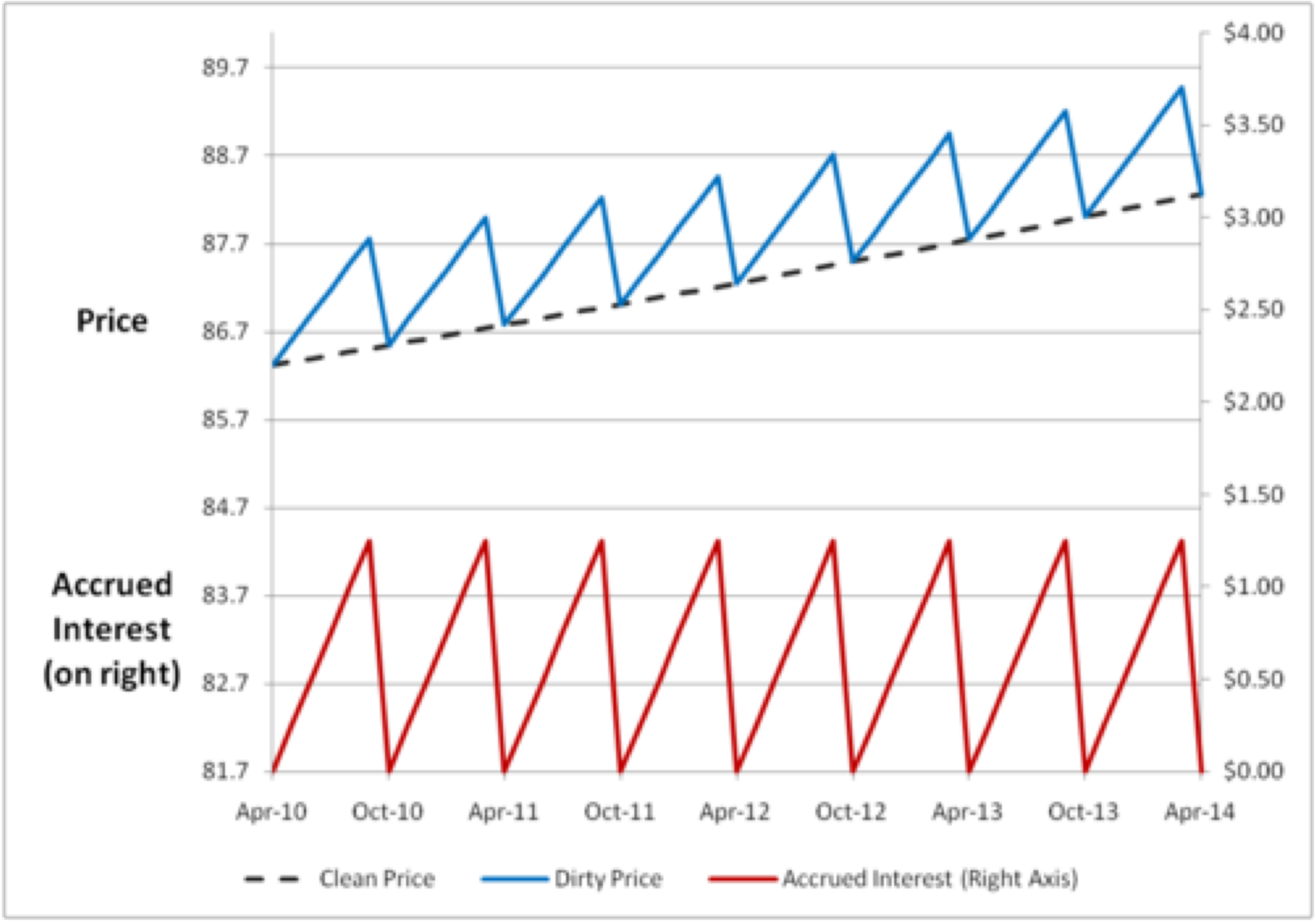
Accrued Interest

- Accrued Interest
  - A complication that arises from the fixed schedule of coupon payments
  - Accrued interest is the interest on a bond that has accumulated since the last coupon payment
  - Example: Last coupon date Jan 1. Today is Feb 1.
    Accrued Interest = Prorated interest from Jan 1 to Feb 1.

- "Clean Price" vs "Dirty Price":
  - Clean price excludes accrued interest. Dirty price includes accrued interest.
  - Quoted prices on Bloomberg/news are "clean prices":
    - Accrued interest creates a "saw-tooth" pattern in dirty prices (see next slide).
    - The quoted price is the clean price so that there is no "saw-tooth" pattern
  - Buyers pay "dirty prices":
    - Buyers pay both (1) the quoted price and (2) accrued interest:

$$\text{Dirty Price} = \text{Clean Price} + \text{Accrued Interest}$$

Accrued Interest, Clean Price and Dirty Price



Quoted Bond Prices

- The WSJ of March 6, 2018 gives the following information on a Treasury bond with a face value of $1,000:

Coupon	Maturity	Bid	Asked	Chg	Ask Yld
2.75	Feb '28	98.91	98.92	0.02	2.875

  - How much interest do you receive on this bond?
  - How much do you have to pay for this bond?

名称	代码	全价	净价	期限(年)	剩余期限(天)	应计利息(元)	应计天数(天)	付息方式	年利率(%)	到期收益率(%)	修正久期	凸性	行情
15国债04	019504	103.56	100.50	3.00	19	3.0612	347	按年付息	3.22	-6.33	0.06	0.06	
国债1308	101308	103.12	100.20	7.00	772	2.9204	324	按年付息	3.29	3.18	1.96	5.87	
17国债09	019563	102.85	100.05	1.00	58	2.8015	308	到期一次还本付息	3.32	2.87	0.15	0.17	
13国债19	019319	109.76	107.50	30.00	9318	2.2561	173	半年付息	4.76	4.27	14.79	307.81	
16国债12	019540	101.83	99.82	2.00	73	2.0149	293	按年付息	2.51	3.31	0.19	0.22	
17国债17	019571	102.04	100.06	1.00	149	1.9798	217	到期一次还本付息	3.33	3.10	0.40	0.54	
15国债08	019508	99.04	97.56	20.00	6256	1.4791	132	半年付息	4.09	4.29	11.98	183.47	
国债0303	100303	98.37	97.05	20.00	1866	1.3227	142	半年付息	3.40	4.04	4.57	24.50	
03国债(3)	010303	98.38	97.06	20.00	1866	1.3227	142	半年付息	3.40	4.04	4.57	24.50	
15国债22	019522	101.14	99.82	3.00	201	1.3200	165	按年付息	2.92	3.20	0.53	0.80	
16国债08	019536	87.50	86.21	30.00	10269	1.2923	134	半年付息	3.52	4.38	16.61	384.82	
15国债23	019523	94.18	93.00	10.00	2777	1.1796	144	半年付息	2.99	4.07	6.61	50.58	

Characteristics of Bonds

- Zero Coupon Bonds
  - Bonds that pay no interest payments
- Floating Rate Bonds (Floaters)
  - Coupon rates are reset periodically to specific market rates
- Indexed Bonds
  - The payments of the bonds are tied to specific price indices

Treasury Inflation Protected Bonds (TIPS)

- Treasury Inflation Protected Bonds (TIPS)
  - The face value of the bond FV_t increases with the consumer price index CPI_t
    - $FV_t = FV_{t-1} * (CPI_t / CPI_{t-1})$
  - The coupon payment C_t depends on the real interest rate r_t and the face value FV_t:
    - $C_t = r_t * FV_t$

Characteristics of Bonds

- Callable Bonds
  - The issuer can repurchase the bonds at specific call prices during the call period
    - Useful when issuer expects low future interest rates
- Puttable Bonds
  - The investor of the bonds can sell the bonds at par value during the call period
    - Useful when investors expect high future interest rates
- Convertible Bonds
  - The investor of the bonds can exchange the bonds for a specific number of common stocks

Default Risk

- Investment Grade Bonds
  - Bonds rated BBB or above (S&P) or Baa and above (Moody's)
- Speculative Grade Bonds or Junk Bonds
  - Lower rated bonds

Provisions of Bonds

- Secured or unsecured (collateral)
- Registered or bearer bonds (whether name of the investor is registered)
- Call provision
- Convertible provision
- Retractable and extendable bonds
  - Equivalent to callable and puttable
  - "Calling" = retracting / retiring
  - Not "putting" = extending
- Floating rate bond

Bond Pricing

$$P_B = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} + \frac{ParValue_T}{(1+r)^T}$$

P_B = price of the bond

C_t = interest or coupon payments

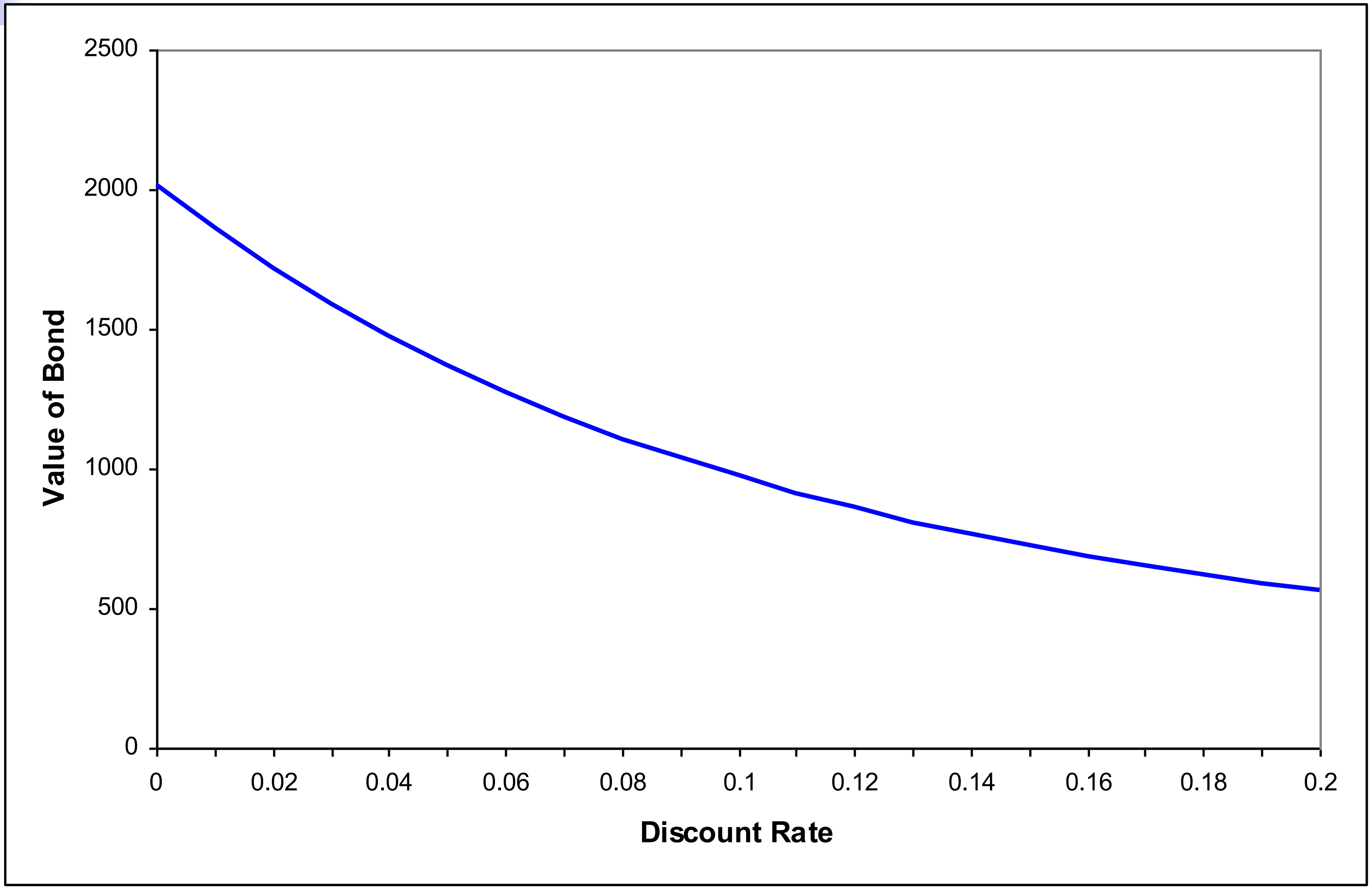
T = number of periods to maturity

r = the appropriate semi-annual discount rate

Bond Pricing: Example

- Let's look at a 9.25% Treasury Bond with maturity on February 1st, 2023
- What is the value of this bond?
  - The bond has a face value of $1,000
  - Treasury bonds pay semi-annual coupons
  - Assume that the discount rates for all maturities equal 4%

Bond Values Decrease if Discount Rates Increase



Bond Prices and Interest Rates

- Prices and market interest rates have an inverse relationship
- When interest rates get very high the value of the bond will be very low
- When rates approach zero, the value of the bond approaches the sum of the cash flows

Yields and Realized Returns

Yield-to-Maturity

- Definition:
  - The Yield to Maturity of a bond (YTM) is the single interest rate that makes the discounted value of the bond's future payments equal to its price.
- Bond's payments:
  - Face Value (M) received at maturity,
  - Coupon (C) received periodically (semi-annually for government bonds)

YTM

- The YTM is the discount rate, r, that implicitly solves the following equation:

$$\text{Price} = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} + \frac{M}{(1+r)^T}$$

- e.g. a two year pure-discount bond sells for 857.34. Show the YTM is 8%.

YTM Example

$$950 = \sum_{t=1}^{20} \frac{35}{(1+r)^t} + \frac{1000}{(1+r)^T}$$

10 yr Maturity Coupon Rate = 7%

Price = $950

Solve for r = semiannual rate

$$\boxed{r = 3.8635\%}$$

Yield Measures

Bond Equivalent Yield

- Make semiannual etc comparable with annual
- This is the yield quoted in newspapers

$$3.86\% \times 2 = 7.72\%$$

Effective Annual Yield

- Takes into account effects of compounding

$$(1.0386)^2 - 1 = 7.88\%$$

Yield Measures

YTM is different to Current Yield (Annual Interest/Market Price)

$70 / $950 = 7.37 %

- Here YTM > Current Yield because we expect capital gains ($950->$1,000)

Yield to Call

- For callable bonds, can compute Yield to Call
  - T = the next call date
  - M = the call price

Holding-Period Return: Single Period

$$HPR = \frac{I + (P_0 - P_1)}{P_0}$$

where

I = coupon payment

P_1 = price in one period

P_0 = purchase price

Holding-Period Return

- HPR can differ from YTM
  - Changes in interest rates affect bond prices and so affect returns
  - Reinvestment assumption of coupon payments

Holding-Period Example

CR = 8% ; YTM = 8%; N=10 years

Semiannual Coupon P_0 = \$1000

In 6M the rate falls to 7%; P_1 =\$1068.55

$$HPR = \frac{40 + (1068.55 - 1000)}{1000}$$

HPR = 10.85% (semiannual)

Realized Compound Return versus YTM

- Realized Compound Return = holding period return compounded over the entire lifecycle of the bond
- RCR = YTM if coupons reinvested at an interest rate equal to the YTM
  - Read BKM
- Realistically, RCR can differ from YTM
  - Changes in interest rates affect bond prices and so affect returns
  - Reinvestment assumption of coupon payments

Realized Compound Return vs. YTM

- RCR requires calculation of the actual reinvestment income
  - The coupon payments are invested at what rate?

Example

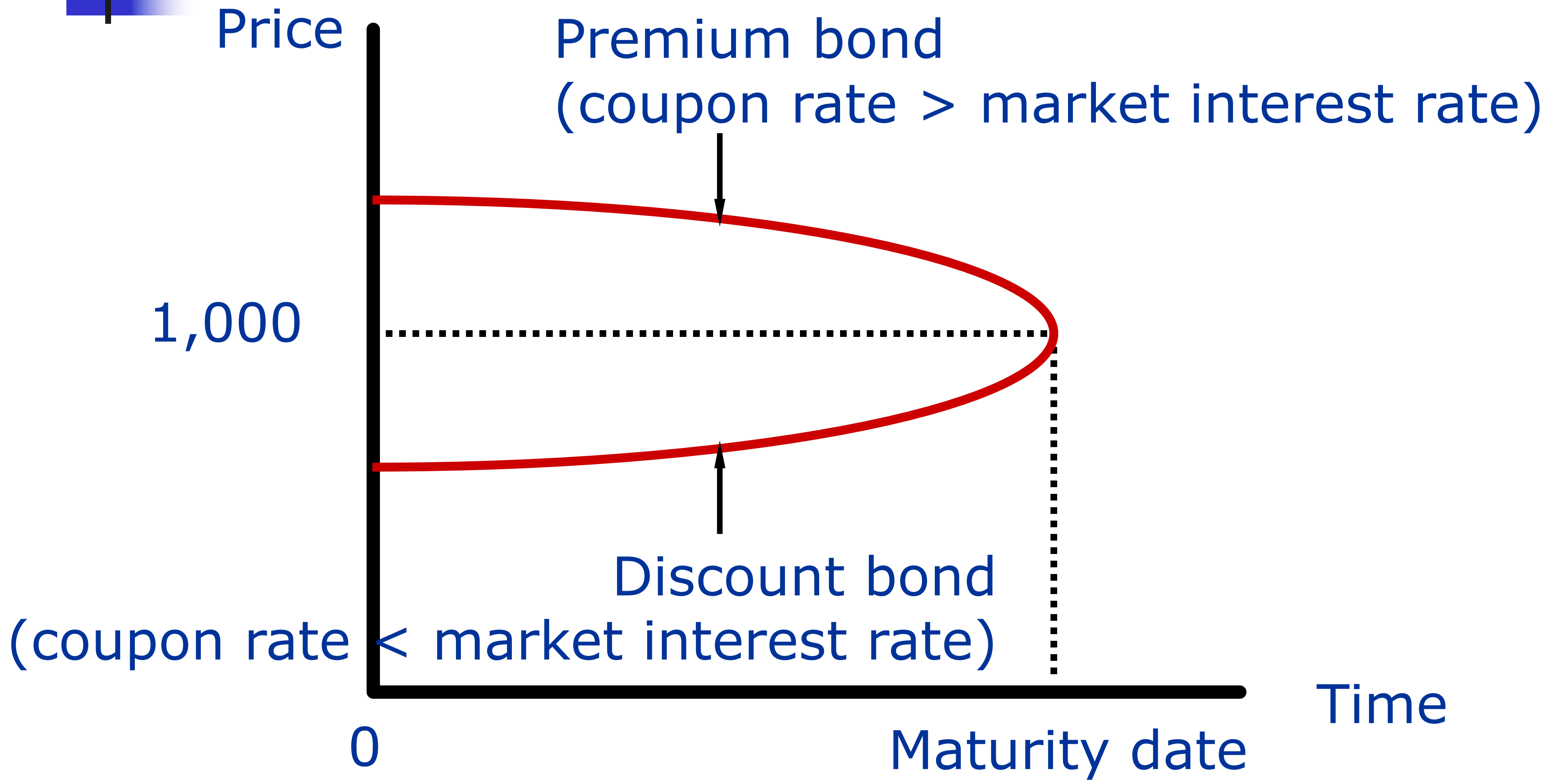
- Two-year bond selling at par (P=1000), 10% coupon paid once a year. First coupon is reinvested at 8%. Then the realized compounded return (y) is:

$$FV = 1{,}100 + 100 \cdot 1.08 = 1{,}208$$

$$P \cdot (1 + y)^2 = 1{,}208$$

$$y(\text{realized}) = (1.208)^{0.5} - 1$$

Price Paths of Coupon Bonds



Default Risk

- "Promise of fixed income" ≠ "Fulfillment of fixed income"
- When bonds are subject to potential default, the stated (promised) yield to maturity is the maximum possible yield to maturity that can be realized by the bondholder.
- To compensate for default risk, bonds subject to potential default must offer default premiums – promised yields in excess to yields offered by default-free government bonds

Bond Ratings								
	Very High Quality		**High Quality**		**Speculative**		**Very Poor**	
Standard & Poor's	AAA	AA	A	BBB	BB	B	CCC	D
Moody's	Aaa	Aa	A	Baa	Ba	B	Caa	C
	At times both Moody's and Standard & Poor's have used adjustments to these ratings: S&P uses plus and minus signs: A+ is the strongest A rating and A– the weakest. Moody's uses a 1, 2, or 3 designation, with 1 indicating the strongest.							

Moody's	S&P	
Aaa	AAA	Debt rated Aaa and AAA has the highest rating. Capacity to pay interest and principal is extremely strong.
Aa	AA	Debt rated Aa and AA has a very strong capacity to pay interest and repay principal. Together with the highest rating, this group comprises the high-grade bond class.
A	A	Debt rated A has a strong capacity to pay interest and repay principal, although it is somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions than debt in higher-rated categories.
Baa	BBB	Debt rated Baa and BBB is regarded as having an adequate capacity to pay interest and repay principal. Whereas it normally exhibits adequate protection parameters, adverse economic conditions or changing circumstances are more likely to lead to a weakened capacity to pay interest and repay principal for debt in this category than in higher-rated categories. These bonds are medium-grade obligations.
Ba B Caa Ca	BB B CCC CC	Debt rated in these categories is regarded, on balance, as predominantly speculative with respect to capacity to pay interest and repay principal in accordance with the terms of the obligation. BB and Ba indicate the lowest degree of speculation, and CC and Ca the highest degree of speculation. Although such debt will likely have some quality and protective characteristics, these are outweighed by large uncertainties or major risk exposures to adverse conditions. Some issues may be in default.
C	C	This rating is reserved for income bonds on which no interest is being paid.
D	D	Debt rated D is in default, and payment of interest and/or repayment of principal is in arrears.

Example 14.11 Expected vs. Promised Yield to Maturity

Suppose a firm issued a 9% coupon bond 20 years ago. The bond now has 10 years left until its maturity date, but the firm is having financial difficulties. Investors believe that the firm will be able to make good on the remaining interest payments, but at the maturity date, the firm will be forced into bankruptcy, and bondholders will receive only 70% of par value. The bond is selling at $750.

Yield to maturity (YTM) would then be calculated using the following inputs:

	Expected YTM	Stated YTM
Coupon payment	$45	$45
Number of semiannual periods	20 periods	20 periods
Final payment	$700	$1,000
Price	$750	$750

The yield to maturity based on promised payments is 13.7%. Based on the expected payment of $700 at maturity, however, the yield to maturity would be only 11.6%. The stated yield to maturity is greater than the yield investors actually expect to receive.