

Risk, Return, and Portfolio Allocation

SILC Business School

Shanghai University

Week 2

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What is Finance?

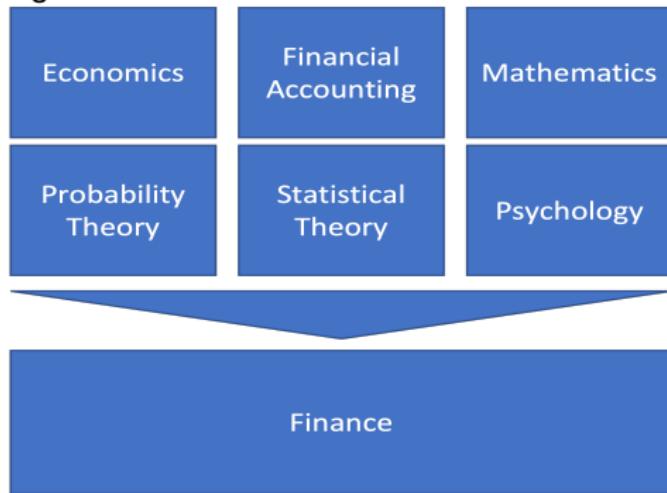
What is Finance?

★ What is Finance?

- The application of economic principles to decision-making that involves the allocation of money under conditions of uncertainty.
- In finance, we worry about money and future.
- Finance provides the framework for making decisions as to how to get funds and what we should do with them once we have them.

What is Finance?

Fig 1 Finance and Its Relation to Other Fields



- ★ The foundations for finance draw from the field of economics and, for this reason, finance is often referred to as financial economics.

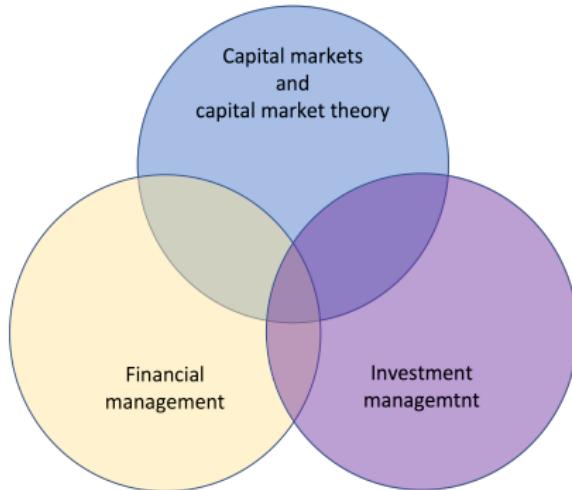
Stochastic and Financial Data Generating Processes

★ Finance is:

- analytical, using statistical, probability, and mathematics to solve problems.
- based on economic principles.
- uses accounting information as inputs to decision-making.
- global in perspective.
- the study of how to raise money and invest it productively.

What is Finance?

Fig 2 The Three Areas within the Field of Finance



- ★ We can think of the field of finance as comprised of three areas:
 - Capital markets and capital market theory
 - Financial management
 - Investment management

What is Finance?

1. Capital markets and capital market theory
 - Financial system (Financial markets and institutions)
 - 1) Financial markets
 - 2) Financial intermediaries
 - 3) Financial regulators
 - Structure of interest rates
 - Pricing of risky assets

What is Finance?

★ Several important topics in Finance:

- Pricing efficiency of financial markets
- Role and investment behavior of the players in financial markets
- Best way to design and regulate financial markets
- Measurement of risk
- Theory of asset pricing

Beat the market (active strategy)

What is Finance?

2. Financial Management (business finance or corporate finance)
 - Financial decision-making within a business entity
 - Investment decisions
 - Use of funds: Buying, holding, or selling
 - Financing decisions (Capital budgeting decisions)
 - Procuring of funds: Use profits raised through the company's revenues or distribute it to the owners?

What is Finance?

- ★ A financial manager must make decisions about a company's current assets.
 - Current assets: Cash, marketable securities, accounts receivable and inventories, support the long-term investment decisions of a company.

Those assets that could reasonably be converted into cash within one operating cycle or one year, whichever takes longer.

- ★ Risk management of a company
 - The four key processes in risk management are risk:
 - 1) Identification
 - 2) Assessment
 - 3) Mitigation
 - 4) Transference

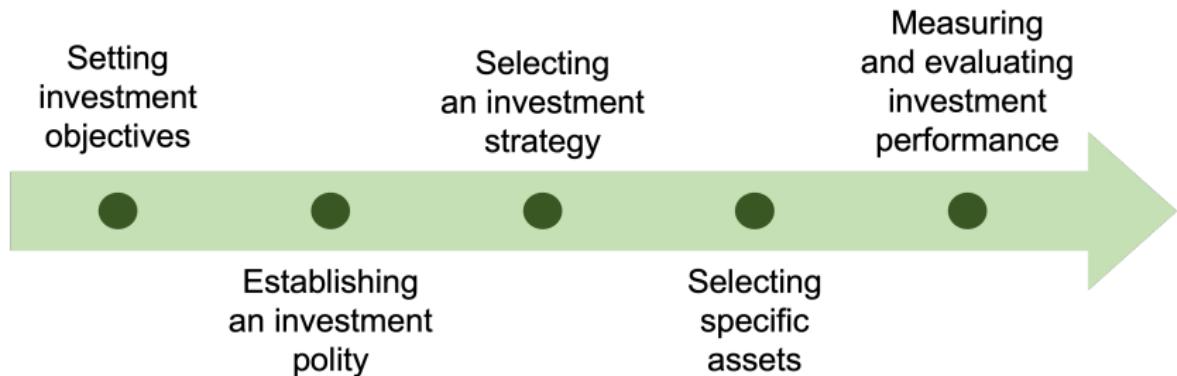
What is Finance?

3. Investment management (Runs money)

- The specialty area within finance dealing with the management of individual or institutional funds.
- Asset management
- Portfolio management
- Money management
- Wealth management

What is Finance?

Fig 3 Investment Management Activities



The Financial System

★ The financial system

- A country's financial system consists of entities that help facilitate the flow of funds from those that have funds to invest to those who need funds to invest.
- Information asymmetry: The problem that one party has a different information set than the other.
- Financial markets: Where transactions take place
- Financial intermediaries: Who facilitate the transactions
- Regulators of financial activities: Who try to make sure that everyone is playing fair

The Financial System

★ Financial assets

- Asset: Any resource having economic value that we expect to provide future benefits.

Tangible assets (fixed asset): Building, aircraft, land, machinery ...

Intangible assets (financial assets or instrument): Patents, copyrights, trademarks ...

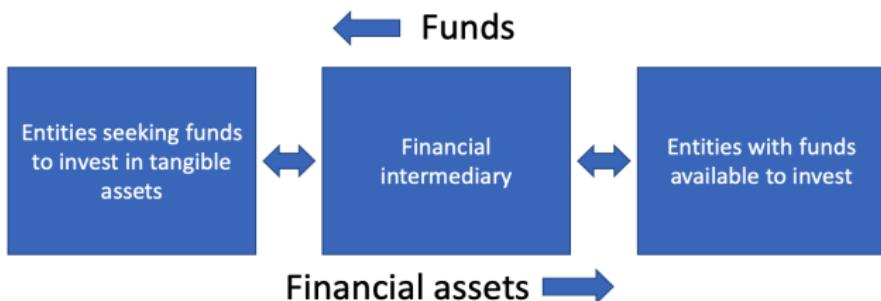
- Typical two parties of financial instrument:
 - 1) Issuer: Has agreed to make future cash payments.
 - 2) Investor: Owns the financial instrument and the right to receive the payments made by the issuer.

The Financial System

★ Why do we need financial assets?

1. They allow the transference of funds from those entities that have surplus funds to invest to those who need funds to invest in tangible assets.
2. They permit the transference of funds in such a way as to redistribute the unavoidable risk associated with the tangible assets' cash flow among those seeking and those providing the funds.

Fig 4 The Role of the Financial Intermediary



The Financial System

- ★ What is the difference between debt and equity?
 - Debt: The issuer agree to pay the investor interest, plus repay the amount borrowed.
 - Equity: The issuer pay the investor an amount based on earnings.

- ★ The classification of debt and equity is important for two legal reasons.
 1. In the case of a bankruptcy of the issuer, investors in debt have a priority on the claim on the issuers assets over equity investors.
 2. The tax treatment of the payments by the issuer differs depending on the type of class.

Verdict of History

Asset Returns Since 1802

★ Net Returns

Let P_t be the price of an asset at time t . Assuming no dividends, the net return over the holding period from time $t - 1$ to time t is:

$$r_t = \frac{P_t}{P_{t-1}} - 1 = \frac{P_t - P_{t-1}}{P_{t-1}}.$$

The net return can be viewed as the relative revenue or profit rate. The revenue from holding an asset is:

$$\text{revenue} = \text{initial investment} \times \text{net return}.$$

Asset Returns Since 1802

★ Arithmetic and Geometric Returns

The average arithmetic return r_A is the average of each yearly return. If r_1, \dots, r_n are the n yearly returns,

$$r_A = \frac{(r_1 + r_2 + \dots + r_n)}{n}. \quad (1)$$

The average geometric (or compound) return r_G is the n th root of the product of one-year total returns minus 1.

$$r_G = [(1 + r_1)(1 + r_2) \cdots (1 + r_n)]^{1/n} - 1 \quad (2)$$

Asset Returns Since 1802

Example A simple example demonstrates the difference between arithmetic and geometric returns.

If a portfolio falls by 50% in the first year and then doubles (up 100%) in the second year, “buy-and-hold” investors are back to where they started, with a total return of zero.

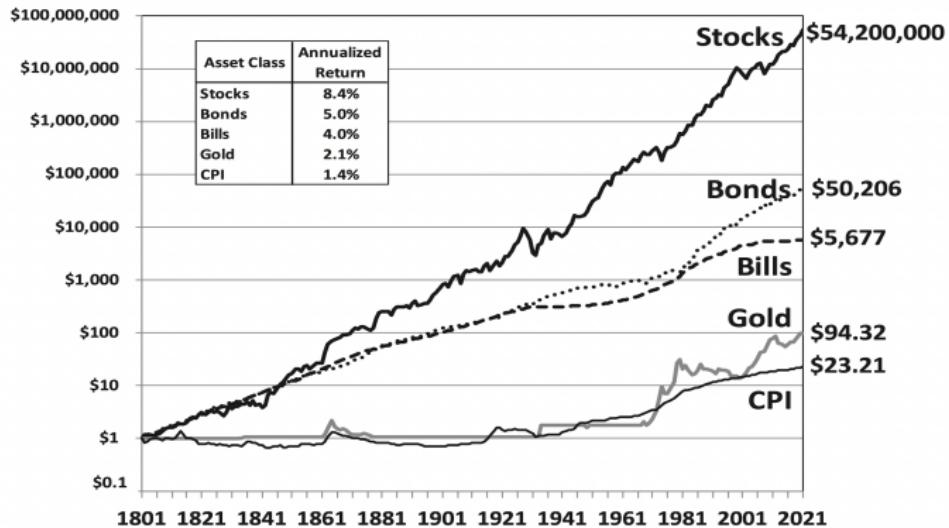
$$\begin{aligned}r_A &= \frac{-0.5 + 1}{2} \\&= 0.25, \\r_G &= (1 - 0.5)(1 + 1) - 1 \\&= 0\end{aligned}$$

Over two years, the average return can be turned into a compound or total return only by successfully “timing” the market, specifically increasing the funds invested in the second year, hoping for a recovery in stock prices.

Asset Returns Since 1802

★ Financial Market Data from 1802 to 2021

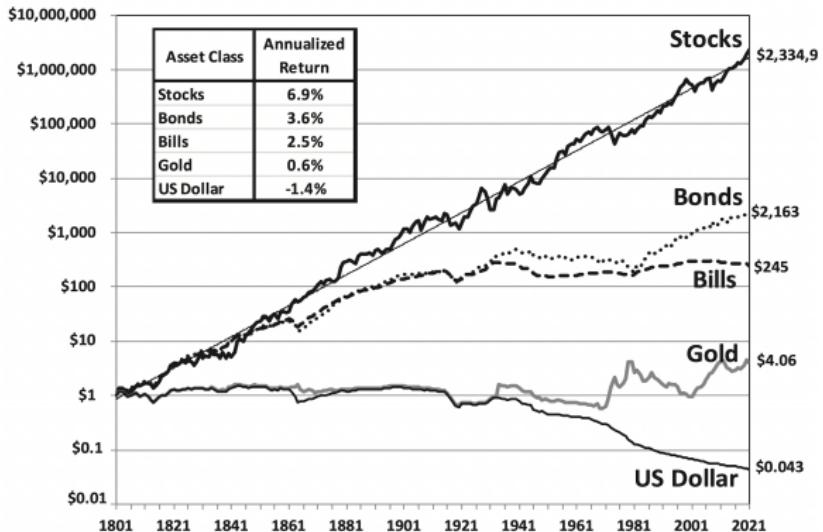
Fig 1 Total nominal return indexes (1802-2021)



It depicts the total nominal return indexes for stocks, long- and short-term government bonds, gold, and commodities from 1802 through 2021. Total return includes changes in the capital value plus interest or dividends and assumes that all these cash flows are automatically reinvested in the asset over time.

Asset Returns Since 1802

Fig 2 Total real return indexes (1802-2021)



It traces year by year how real wealth has accumulated for a hypothetical investor who put a dollar in (1) stocks, (2) long-term government bonds, (3) US Treasury bills, (4) gold, and (5) US currency over the past two centuries.

Asset Returns Since 1802

The data are divided into three sub-periods by historical significance and breaks in the quality and comprehensiveness of the data:

1 1802-1870

The US made a transition from an agrarian to an industrialized economy, comparable to the changes that many “emerging markets” of Latin America and Asia have made over the past half century.

2 1871-1925

The US became the foremost political and economic power in the world.

3 1926-2021

Covers the Great Depression, the postwar expansion, the tech bubble, the financial crisis, and the 2020 Covid-19 pandemic.

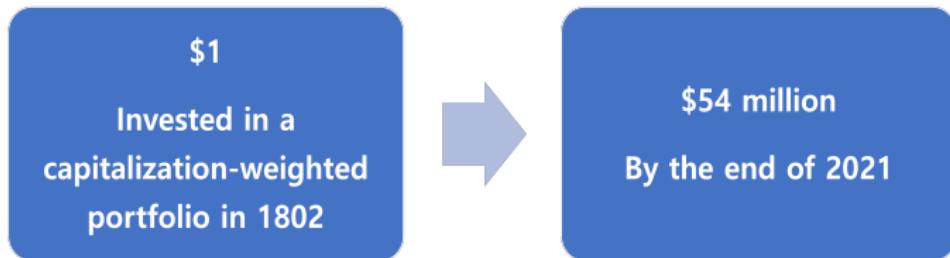
Asset Returns Since 1802

- Over the 220 years, the average compound annual real return on a broadly diversified portfolio of stocks has averaged 6.9 percent per year.
- The real return on fixed-income investments has averaged far less; on long-term government bonds.
- In the long run, gold prices have risen just ahead of the inflation rate.
- The dollar has lost on average 1.4 percent per year of purchasing power since 1802, with most of the depreciation coming after World War II.
- In the short run: stock returns are very volatile and are driven by changes in earnings, interest rates, risk, and uncertainty as well as psychological factors (optimism and pessimism).

- How economists, investment professionals, and market pundits have viewed the investment value of stocks?
- How the great bull and bear markets impact both the media and investors.?

Asset Returns Since 1802

Over the past two centuries the total return on equities dominates all other assets.



The longest period of time investors typically hold assets, without touching the principal and income, occurs when they are accumulating wealth in pension plans for their retirement or in insurance policies that are passed on to their heirs. The stock market has the power to turn a single dollar into millions by the forbearance of generations—but few will have the patience to endure the wait.

Asset Returns Since 1802

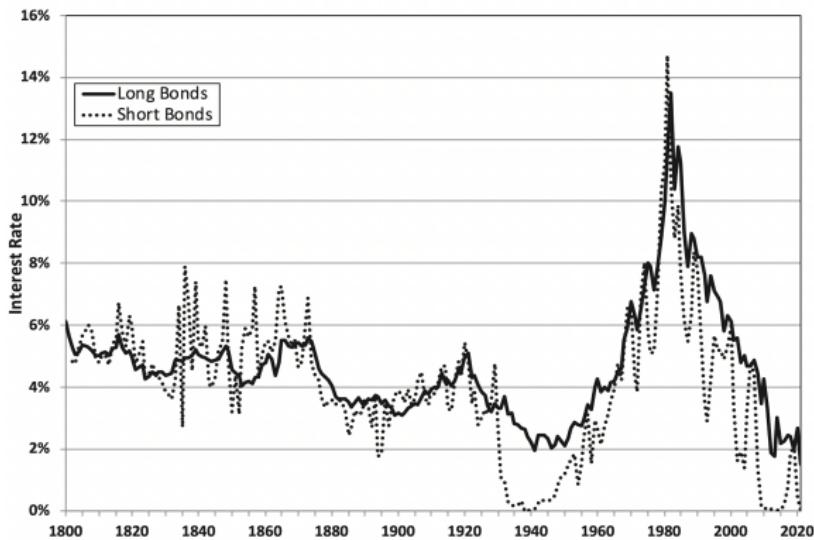
★ The Long-Term Returns of Bonds

Fixed-income investments are the largest and most important financial asset competing with stocks. Bond promise fixed monetary payments over time. In contrast to equity,

- The cash flows from bonds have a maximum monetary value set by the terms of the contract.
- Bond returns do not vary with the profitability of the firm (except in the case of default).

Asset Returns Since 1802

Fig 3 US short- and long-term interest rates, 1800-2021



1800-1920: Interest rate fluctuations remained within a narrow range.

1926-2021: The behavior of both long- and short-term interest rates changed dramatically.

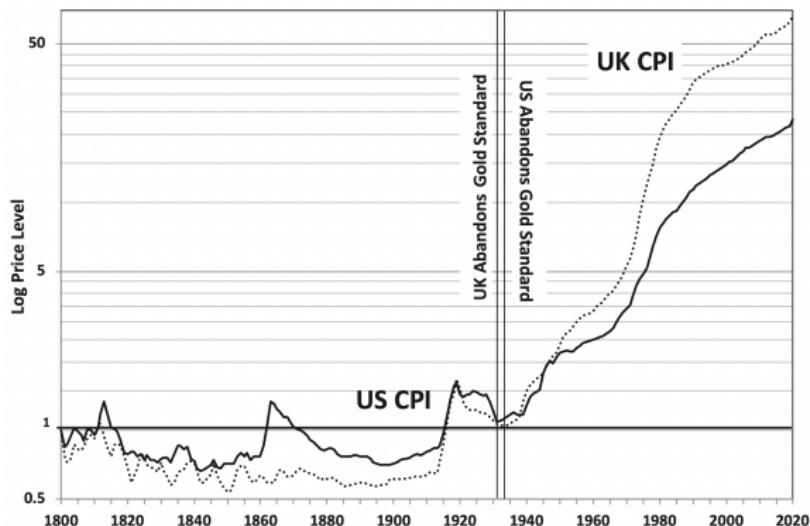
1930: Short-term rates go to near zero due to the Great Depression.

1970s: Rates to surge due to the inflation. 2019-2021: Interest rates continued to fall, interest rates record reaching low levels.

Asset Returns Since 1802

★ Gold, The Dollar, and Inflation

Fig 4 US and UK consumer price indexes, 1800-2021



The price level at the beginning of World War II was essentially the same as it was 150 years earlier. But the price level rose almost continuously after World War II, and sometimes at double-digit rates as in the 1970s. Excluding wartime, the 1970s witnessed the first rapid and sustained inflation ever experienced in US or British history.

Asset Returns Since 1802

The dramatic changes in the inflationary trend can be explained by the change in the monetary standard.

- The 19th - early 20th centuries, the industrialized world were on a gold standard.
 - The gold standard restricts the supply of money and thus the inflation rate.
- The Great Depression - World War II, the world shifted to a paper money standard.
 - There is no legal constraint on the issuance of money, so inflation is subject to political as well as economic forces.

Price stability depends on the desire of central banks to limit the growth of the supply of money in order to counteract deficit spending and other inflationary forces that result from government spending and regulation.

Asset Returns Since 1802

★ Total Real Returns

Table 1 Stock market return

		Total Nominal Return		Nominal Capital Appreciation	Dividend Yield	Total Real Return %		Real Capital Appreciation		Real Gold Retn	Price Inflation
		Return	Risk			Return	Risk	Return	Risk		
	1802-2021	8.4	17.5	3.3	17.1	4.9	6.9	17.8	1.9	17.8	0.6
	1871-2021	9.2	18.7	4.7	18.2	4.2	7.0	18.8	2.6	18.8	0.8
Major Sub-Periods	I 1802-1870	6.9	14.5	0.4	14.0	6.4	6.7	15.4	0.3	15.4	0.2
	II 1871-1925	7.3	16.5	1.9	15.9	5.3	6.6	17.4	1.3	17.4	-0.8
	III 1926-2021	10.2	19.7	6.4	19.2	3.6	7.1	19.6	3.4	19.6	1.8
Postwar Periods	1946-2021	11.3	17.0	7.7	16.5	3.3	7.3	17.3	3.9	17.3	1.6
	1946-1965	13.1	16.5	8.2	15.7	4.6	10.0	18.0	5.2	18.0	-2.7
	1966-1981	6.9	19.8	2.9	19.0	3.9	-0.1	19.0	-3.8	19.0	8.8
	1982-1999	17.5	12.7	14.1	12.6	3.0	13.8	12.8	10.5	12.8	-4.9
	2000-2021	7.8	18.2	5.9	17.8	1.8	5.2	17.6	3.5	17.6	6.3

Note: Return: compound annual return, Risk: standard deviation of arithmetic returns. All data in percent (%).

Note the extraordinary stability of the real return on stocks over all major subperiods: 6.7% percent per year from 1802 through 1870, 6.6 percent from 1871 through 1925, and 7.1 percent per year from 1926 through 2021, a return which is brought down to 6.76% if we include the bear market in the first half of 2022.

Asset Returns Since 1802

★ Real Returns on Fixed-Income Assets

Table 2 Fixed income return

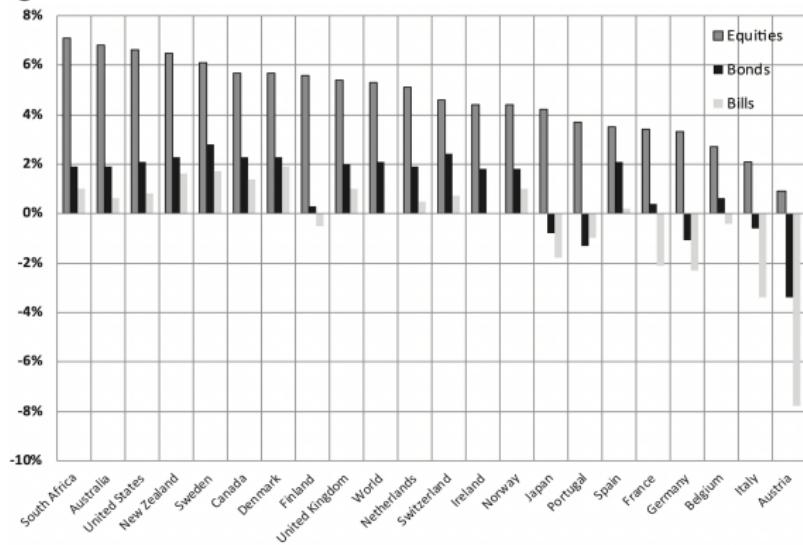
		Coupon Rate	Long Term Governments				Short Term Governments			Price Inflation	
			Nominal Return		Real Return		Nominal Rate	Real Return			
			Return	Risk	Return	Risk		Return	Risk		
	1802-2021	4.6	5.0	6.8	3.6	9.1	4.0	2.5	5.9	1.4	
	1871-2021	4.5	5.1	8.0	3.0	9.4	3.4	1.4	4.4	2.1	
Major Sub-Periods	I 1802-1870	4.9	4.9	2.8	4.8	8.3	5.2	5.1	7.7	0.1	
	II 1871-1925	4.0	4.3	3.0	3.7	6.4	3.8	3.1	4.8	0.6	
	III 1926-2021	4.9	5.6	9.8	2.6	10.8	3.3	0.4	3.8	2.9	
Postwar Periods	1946-2021	5.4	5.8	10.7	2.0	11.4	3.9	0.2	3.1	3.7	
	1946-1965	3.1	1.6	4.9	-1.2	7.1	2.0	-0.8	4.3	2.8	
	1966-1981	7.2	2.5	7.1	-4.2	8.1	6.8	-0.2	2.1	7.0	
	1982-1999	8.5	12.1	13.8	8.5	13.6	6.3	2.9	1.8	3.3	
	2000-2021	3.6	7.0	11.4	4.6	11.5	1.5	-0.8	1.9	2.3	

The real return on Treasury bills has dropped precipitously from 5.1% in the early part of the 19th century to a bare 0.4 % since 1926, a return only slightly above inflation. Bond returns fell from a generous 4.8% in the first subperiod to 3.7% in the second, and then to only 2.6% in the third. For the period 1946-1981, the real return on Treasury bonds was negative – the coupon on the bonds did not offset the decline in bond prices brought about by rising interest rates and inflation. Although bond returns fell well short of equities during the mega bull market in stocks from 1981 through 1999, bonds easily outpaced stocks in the following decade.

Asset Returns Since 1802

★ Worldwide Equity and Bond Returns

Fig 5 Average annual real stock, bond bill returns of 21 countries, 1900-2020

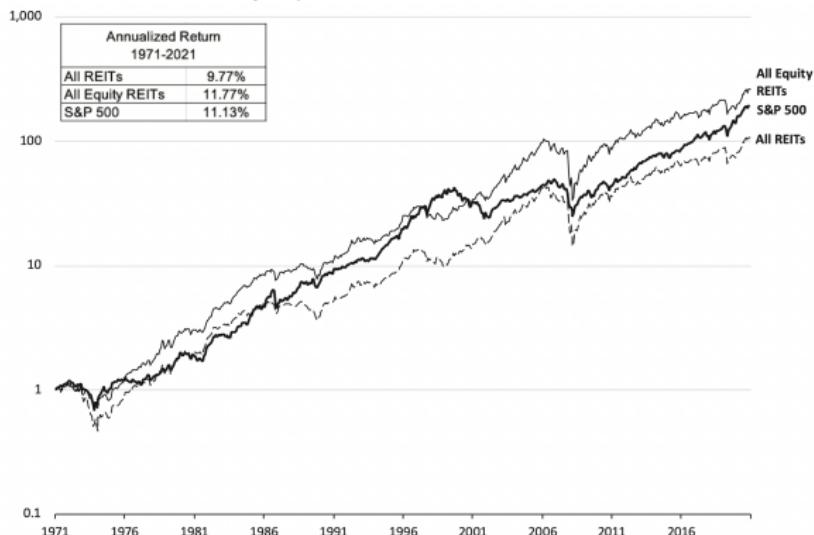


Over the entire 121 years, the equity risk premium, or return on stocks over long-term bonds, was 4.4%p in US, 3.7%p when averaged over all markets and 3.2% for the world market.

Asset Returns Since 1802

★ Real Estate Returns

Fig 6 Total REIT, All Equity REIT, and S&P 500 returns, 1971-2021



REIT: real estate investment trust – securities that represent real estate assets that are traded on organized exchanges.

1971 - 2020, the All REIT index returned 9.8% per year. REITs do allow stockholders to access nonresidential real estate, which allows investors to effectively diversify their asset holdings.

Asset Returns Since 1802

★ Stocks for the Long Run

- Over the past 220 years, the compound annual real return on a diversified portfolio of common stock in the United States has been nearly 7%.
- The returns on stocks are dependent on the quantity and quality of capital, productivity, and the return to risk taking. But the ability to create value also springs from skillful management, a stable political system that respects property rights, and the capacity to provide value to consumers in a competitive environment.
- Swings in investor sentiment resulting from political or economic crises can throw stocks off their long-term path, but the fundamental forces producing economic growth have always enabled equities to regain their long-term trend.

Risk, Return, and Portfolio Allocation

Risk, Return, and Portfolio Allocation

★ Measuring Risk and Return

Risk and return are the building blocks of finance and portfolio management. Once the risk, expected return, and correlations between asset classes are specified, modern financial theory can help investors determine the best portfolios.

Q. How should we invest our wealth?

Portfolio theory provides an answer to this question based upon following principles:

- ▶ We want to maximize the expected return.
- ▶ We want to minimize the risk (variance or standard deviation of the return).

Riskier assets generally have a higher expected return, since investors demand a reward for bearing risk. The difference between the expected return of a risky asset and the risk-free rate of return is called the *risk premium*. Without risk premium, few investors would invest in risky assets.

- ▶ How to maximize expected return subject to an upper bound on the risk?
- ▶ How to minimize the risk subject to a lower bound on the expected return?

Risk, Return, and Portfolio Allocation

One Risky Asset and One Risk-Free Asset

Expected return: 0.15

Standard deviation of the return: 0.25

Risk-free asset's (90-day T-Bill) risk-free rate: 0.06

Standard deviation of the return on the risk-free asset: 0

The rates and returns are annual. We will hold for one time period – called the *holding period*. At the end of the holding period, we might want to readjust the portfolio. Suppose that a fraction w of our wealth is invested in the risky asset and the remaining fraction $1 - w$ is invested in the risk-free asset. Then the expected return is

$$E(R) = w(0.15) + (1 - w)(0.06) = 0.06 + 0.09w, \quad (3)$$

the variance and standard deviation of the return is

$$\begin{aligned}\sigma_R^2 &= w^2(0.25)^2 + (1 - w)^2(0)^2 = w^2(0.25)^2, \\ \sigma_R &= 0.25|w|.\end{aligned} \quad (4)$$

Risk, Return, and Portfolio Allocation

Example. Finding w to achieve a targeted value-at-risk

Suppose that a firm is planning to invest \$1,000,000 and has capital reserves that could cover a loss of \$150,000 but no more – if there is a loss, it is no more than 15% and R is greater than -0.15. Suppose that R is normally distributed. Then the only way to guarantee that R is greater than -0.15 with probability equal to 1 is to invest entirely in the risk-free asset. The firm might instead be more modest and require only that $P(R < -0.15)$ be small. Therefore, the firm should find the value of w such that

$$P(R < -0.15) = \Phi\left(\frac{-0.15 - (0.06 + 0.09w)}{0.25w}\right) = 0.01.$$

The solution is

$$w = \frac{-0.21}{0.25\Phi^{-1}(0.01) + 0.9} = 0.4264,$$

where, Φ denotes the quantile function of the standard normal distribution.

Risk, Return, and Portfolio Allocation

Generally, if the expected returns on the risky and risk-free assets are μ_1 and μ_f and if the standard deviation of the risky asset is σ_1 , then the expected return on the portfolio is $w\mu_1 + (1 - w)\mu_f$ while the standard deviation of the portfolio's return is $|w|\sigma_1$.

Finding an optimal portfolio can be achieved in two steps:

1. Finding the “optimal” portfolio of risky assets, called the “tangency portfolio”
2. Finding the appropriate mix of the risk-free asset and the tangency portfolio

Q. How find the tangency portfolio?

Risk, Return, and Portfolio Allocation

★ Two Risky Assets

Suppose the two risky assets have returns R_1 and R_2 and that we mix them in proportions w and $1 - w$, respectively. The return on the portfolio is $R_p = wR_1 + (1 - w)R_2$. Let ρ_{12} be the correlation between the returns on the two risky assets. The variance of the return on the portfolio is

$$\sigma_R^2 = w^2\sigma_1^2 + (1 - w)^2\sigma_2^2 + 2w(1 - w)\rho_{12}\sigma_1\sigma_2. \quad (5)$$

Note that $\rho_{12}\sigma_1\sigma_2 = \sigma_{R_1, R_2}$.

Risk, Return, and Portfolio Allocation

Example The expectation and variance of the return on a portfolio with two risky assets

Suppose that $\mu_1 = 0.14$, $\mu_2 = 0.08$, $\sigma_1 = 0.2$, $\sigma_2 = 0.15$, and $\rho = 0$. Then

$$E(R_P) = 0.08 + 0.06w,$$

and because $\rho_{12} = 0$ in this example,

$$\sigma_{R_P}^2 = (0.2)^2 w^2 + (0.15)^2 (1 - w)^2.$$

Using differential calculus, one can easily show that the portfolio with the minimum risk is $w = 0.045/0.125 = 0.36$. For this portfolio $E(R_P) = 0.08 + (0.06)(0.36) = 0.1016$ and $\sigma_{R_P} = \sqrt{(0.2)^2(0.36)^2 + (0.15)^2(0.64)^2} = 0.12$.

Risk, Return, and Portfolio Allocation

Example The expectation and variance of the return on a portfolio with two risky assets

Suppose that $\mu_1 = 0.14$, $\mu_2 = 0.08$, $\sigma_1 = 0.2$, $\sigma_2 = 0.15$, and $\rho = 0$. Then

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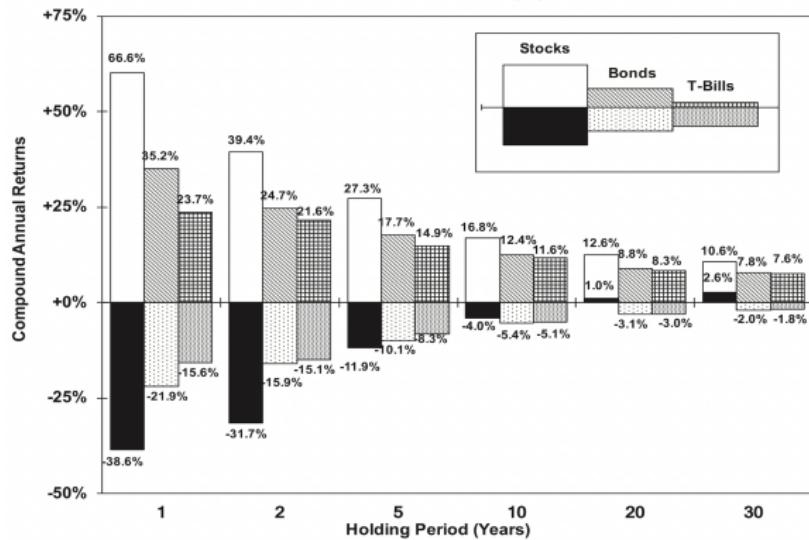
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Risk, Return, and Portfolio Allocation

★ Risk and Holding Period

For many investors, the most meaningful way to describe risk is by portraying a worst-case scenario. The best and worst after-inflation returns for stocks, bonds, and bills from 1802 over holding periods ranging from 1 to 30 years are displayed in Fig 6.

Fig 6 Maximum and minimum real holding period returns, 1802-2021



Risk, Return, and Portfolio Allocation

- Stocks are unquestionably riskier than bonds or Treasury bills over one- and two-year periods.
- For 10-year holding periods, the worst stock performance has actually been better than that for bonds or bills.
- For 20-year holding periods, stock returns have never fallen below inflation, but returns for bonds and bills fell more than 3% per year below the inflation rate from 1961–1981.

Some investors question whether holding periods of 20 years, 30 years, or even longer are relevant to their planning horizon, but one of the greatest mistakes that investors make is to underestimate their holding period. This is because many investors think only about the holding periods of a particular stock, bond, or mutual fund. However, the holding period that is most relevant for portfolio allocation is the length of time the investors hold any stocks or bonds, no matter how many changes are made among the individual issues in their portfolio.

Risk, Return, and Portfolio Allocation

★ Correlation between Stock and Bond Returns

An asset might be suitable for investment from a risk perspective.

- Diversifier: An asset that has a weak positive correlation with another asset on average.
- A weak (strong) hedge: An asset that is uncorrelated (negatively correlated) with another asset on average.
- A weak (strong) safe haven: An asset that is uncorrelated (negatively correlated) with another asset on average during times of stress.

Risk, Return, and Portfolio Allocation

★ Correlation between Stock and Bond Returns

Although the returns on bonds fall short of those on stocks, bonds may still serve to diversify a portfolio and lower overall risk of the portfolio, especially in the short run. The diversifying strength of an asset is measured by the correlation coefficient.

- The lower the correlation coefficient, the better the asset serves as a portfolio diversifier.
- Assets with zero, or particularly negative, correlations with stocks are particularly good diversifiers.
- As the correlation coefficient between the asset and portfolio returns increases, the diversifying quality of the asset declines.

Risk, Return, and Portfolio Allocation

Fig 7 Correlation between stock and bond returns

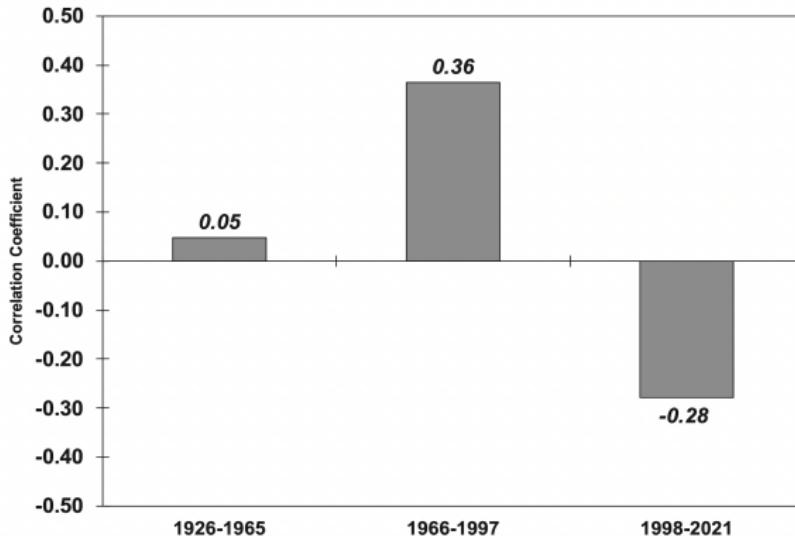


Fig 7 displays the correlation coefficient between annual stock and bond returns for three subperiods between 1926 and 2021.

Risk, Return, and Portfolio Allocation

- 1926:1965: Correlation was only slightly positive—bonds were fairly good diversifiers for stocks. These periods included the Great Depression, which was characterized by falling economic activity and consumer prices, a situation that was bad for stocks, but good for US government bonds.
- 1966-1997: Bad economic times were more likely to be associated with inflation those caused by oil price hikes engineered by OPEC oil restrictions, with more expansionary monetary policy, adding fuel to the inflationary economy. Under these circumstances stock and bond prices tend to move together, reducing the diversifying qualities of government bonds.
- 1998-2021: The world markets were roiled by economic and currency upheavals in Asia, the deflationary economy in Japan, and then the terrorist events of September 11, 2001. The 2008 financial crisis stoked fears of the 1930s, when deflation ruled and government bonds were the only appreciating asset. These events led the US government bond market to once again become a safe haven for those investors fearing more economic turmoil and lower stock prices.