Lecture 3: Return Predictability

- In the 1970s and 1980s, the prevalent view was that stock prices follow a random walk
- This is no longer the case; the emerging consensus is that stock returns are somewhat predictable
- In this lecture, we will discuss the evidence of return predictability, as well as some theory behind it and its implications for portfolio managers

Time-Varying Expected Returns

- Expected returns vs. realized returns
  - Expected return: $\mathrm{E}_t(R_{t+1})$
    - Return we expect to get in the future
    - Synonyms: ex ante return, required return, cost of capital, or discount rate

      For example, we may expect the stock market to return 15% over the next year.
  - Realized return: R_{t+1}
    - What actually happens
    - Synonyms: ex post return, actual return

      For example, the stock market may have returned -20% last year.
- Expected returns vary
  - Across assets
    - E.g., CAPM, APT $\Rightarrow$ different betas imply different expected returns
    - Will consider these differences in future classes
  - Across time
    - Predictability – focus of this lecture
    - Focus on the stock market as a whole

- Distinguish return predictability from random walk
  - If prices follow a random walk, then expected return is *constant*, $\mathrm{E}_t(R_{t+1}) = \mathrm{E}(R_{t+1})$
  - The statement "returns are predictable" is equivalent to saying "expected return *varies* over time"
- Expected returns and realized returns tend to change in *opposite* directions over time
  - This follows from the present value (PV) formula that you know from Investments
- To obtain the **present value formula**, begin by rearranging the definition of return:

$$1 + R_{t+1} = \frac{D_{t+1} + P_{t+1}}{P_t} \quad \Rightarrow \quad P_t = \frac{D_{t+1} + P_{t+1}}{1 + R_{t+1}}$$

Substituting

$$P_{t+1} = (D_{t+2} + P_{t+2})/(1 + R_{t+2}),$$

we obtain

$$P_t = \frac{D_{t+1}}{1 + R_{t+1}} + \frac{D_{t+2}}{(1 + R_{t+1})(1 + R_{t+2})} + \frac{P_{t+2}}{(1 + R_{t+1})(1 + R_{t+2})}$$

Substituting repeatedly for future prices, we obtain

$$\begin{aligned} P_t &= \frac{D_{t+1}}{1 + R_{t+1}} + \frac{D_{t+2}}{(1 + R_{t+1})(1 + R_{t+2})} + \frac{D_{t+3}}{(1 + R_{t+1})(1 + R_{t+2})(1 + R_{t+3})} + \ldots \\ &= \sum_{k=1}^{\infty} \frac{D_{t+k}}{(1 + R_{t+1}) \ldots (1 + R_{t+k})} \end{aligned}$$

- Some observations about the PV formula

$$P_t = \sum_{k=1}^{\infty} \frac{D_{t+k}}{(1+R_{t+1})\dots(1+R_{t+k})}$$

  - Price is the sum of all discounted future dividends, where the discount rate is the actual future return
  - Higher expected future dividends $\Rightarrow$ price up
    Higher expected future returns $\Rightarrow$ price down
    * That is, expected return $\uparrow\Rightarrow$ realized return $\downarrow$
  - This formula is true *mechanically* for all securities
    * The formula is always right, by definition, whether markets are rational or irrational.
  - No economic content without further structure
  - Special case: The "**Gordon model**"
    (Gordon, 1962; Williams, 1938)
    * Suppose next period's dividend is D, and dividends will grow forever at rate g. Let r denote the discount rate (i.e., expected return). Then

$$P = \frac{D}{r-g}.$$

    * If $r\uparrow$, then $P\downarrow$. Again, expected returns and realized returns move in opposite directions
    * In the bond market, bond prices and interest rates move in opposite directions

- Time variation in expected returns (return predictability) induces **mean reversion** in stock returns
  - Suppose expected return goes up (e.g., because we now perceive more risk in the economy). Prices fall immediately, but they are more likely to rise in the future because expected return has gone up.
  - And vice versa.
  - *Negative serial correlation* in returns (high returns followed by low returns), at some horizon
- Do stock returns exhibit mean reversion? Let's see.
  - Recall that multiperiod log returns can be computed by summing up one-period log returns:

    $$r_{1,T} = r_1 + r_2 + \ldots + r_T$$

    If returns r_t are independent over time, then

    $$\begin{aligned} \mathrm{Var}(r_{1,T}) &= \mathrm{Var}(r_1) + \mathrm{Var}(r_2) + \ldots + \mathrm{Var}(r_T) \\ &= T\sigma^2, \end{aligned}$$

    where σ^2 is the variance of r_t.
  - In reality, does the variance of multiperiod stock returns increase linearly with T?
    * If it increases slower (i.e., $\mathrm{Var}(r_{1,T}) < T\sigma^2$), then returns exhibit mean reversion
    * If it increases faster (i.e., $\mathrm{Var}(r_{1,T}) > T\sigma^2$), then returns exhibit mean aversion

– For any $T > 1$, we can estimate $\text{Var}(r_{1,T})/T$, and compare it with σ^2

  * Equivalently, we compare $\text{Std}(r_{1,T})/\sqrt{T}$ with σ

– Let's use annual 1802-2016 stock market returns

– Results (standard deviations in percent per year):

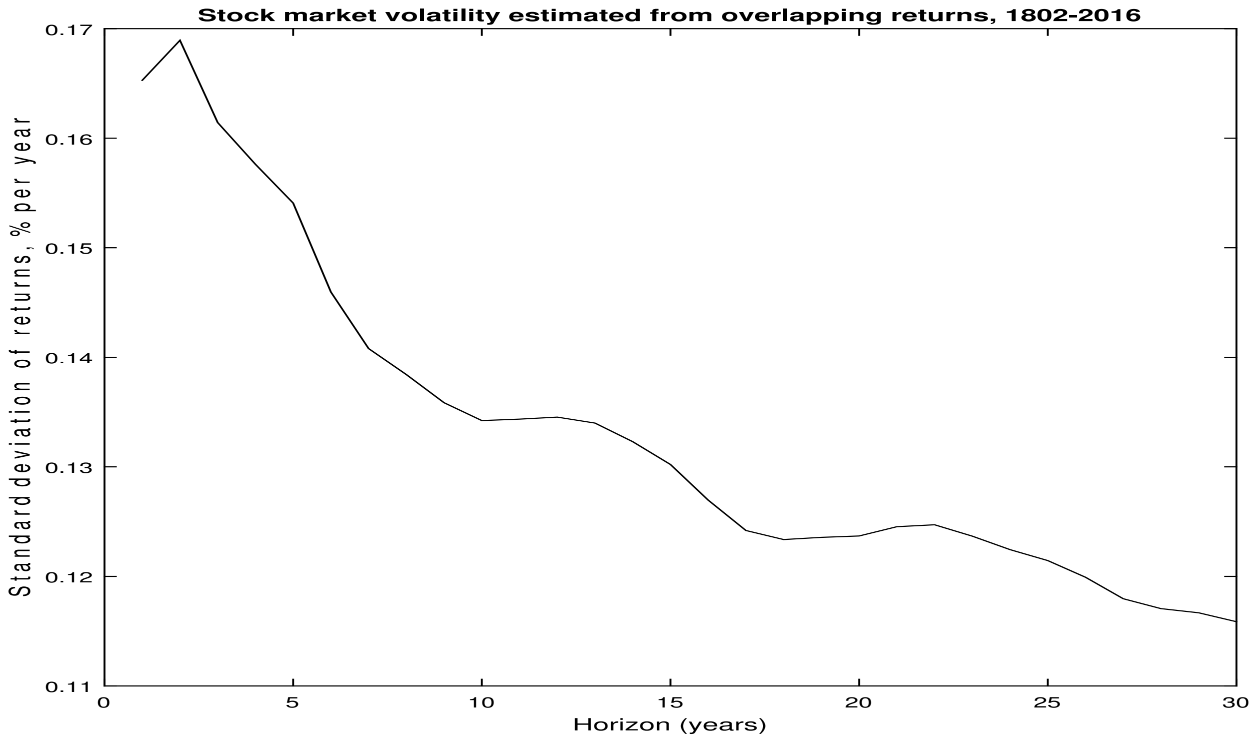
Horizon	1 yr	5 yrs	10 yrs	15 yrs	20 yrs	25 yrs	30 yrs
Std dev	16.5%	15.4%	13.4%	13.0%	12.4%	12.1%	11.6%

– Evidence of **mean reversion**

$\Rightarrow$ Stocks seem to be "safer" in the long run

– You can check this on your own with this code:

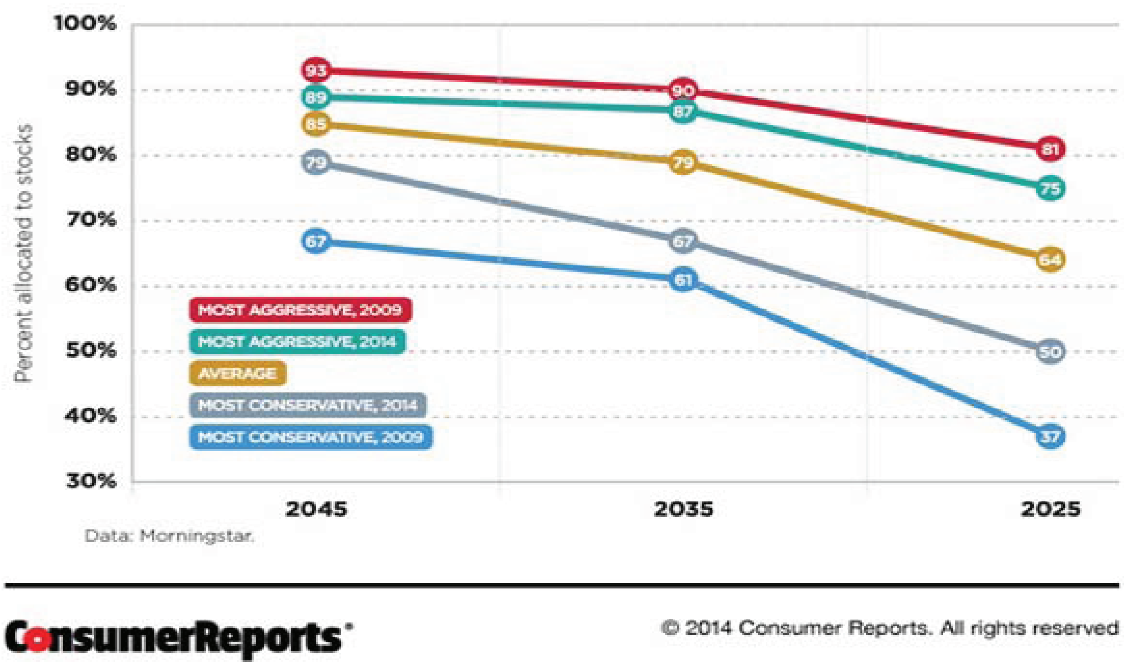
```
Ns = 1:30; % investment horizons
x = load('mkt_1802_2016.txt');
R = x(:,2); % 215x1, annual stock returns, 1802-2016
r = log(1+R);
sdret = -99*ones(30,1);
for j = 1:30
    N = Ns(j);
    nperiods = 213-N+1;
    ret = -99*ones(nperiods,1);
    for k = 1:nperiods
        ret(k) = sum(r(k:k+N-1));
    end
    sdret(j) = std(ret)/sqrt(N);
end
plot(Ns,sdret)
```



- So long-horizon investors should load up on stocks?
  - "Stocks for the long run" (e.g., Jeremy Siegel)
- Not necessarily; above results are based on historical estimates, but forward-looking investors must account also for uncertainty about these estimates
  - The equity premium is particularly uncertain
- Pastor and Stambaugh (2012) incorporate parameter uncertainty and find that stocks are actually more volatile in the long run from an investor's perspective
  - Their volatility estimates, which include uncertainty faced by investors, increase with horizon

Target-Date Funds

- A.k.a. age-based or life-cycle funds; growing recently
- Reduce the fraction invested in stocks as time passes



- The idea is that younger people should invest a larger fraction of their wealth in stocks
- Rationale?

- The Vanguard case study

Predicting Stock Market Returns

- Predictive regression:

$$r_{t+1} = a + bx_t + u_{t+1},$$

  where x_t is a predictor known at time t

  - We can predict total or excess returns
  - We can also predict returns several periods ahead

- If returns are not predictable (random walk), then $b = 0$ for every predictor, and expected return is constant:

$$\mathrm{E}_t(r_{t+1}) = a$$

- If returns are predictable ($b \neq 0$), then expected return is time-varying:

$$\mathrm{E}_t(r_{t+1}) = a + bx_t,$$

- Various predictors x_t have been identified, e.g.

  - Aggregate dividend-price ratio
    * Sum of dividends paid by all stocks over the past 12 months, divided by the sum of current prices
  - Aggregate earnings-price ratio
    * Sum of earnings of all stocks over the past 12 months, divided by the sum of current prices

- Default spread
  - E.g., difference between the yields of Moody's Aaa and Baa corporate bonds
- Term spread
  - E.g., difference between the yields on a 30-year government bond and a one-month T-bill
- Relative T-bill rate
  - Yield on a one-month T-bill in excess of its most recent 12-month moving average

- Here is the evidence for 1952Q1 – 2007Q4:
  - Each row is a separate regression of r_{t+1} on x_t, forecasting excess log returns one quarter ahead

Div Yield	Term spread	Def spread	Rel T-bill	R^2 (%)
0.011				1.798
(2.021)				
	0.007			0.774
	(1.319)			
		0.005		0.440
		(0.993)		
			-0.008	1.058
			(-1.544)	
0.012	0.006	-0.000	-0.005	3.198
(2.079)	(0.830)	(-0.027)	(-0.689)	

  - Some predictability, but the R^2 is small

- Why does the *dividend yield* predict stock returns?
  - D/P has been mean-reverting over a long time
  - When D/P is low relative to its long-term mean, it usually mean-reverts thanks to P coming down rather than D going up
  - When price (P) is high relative to the "fundamentals" (D), so that D/P is low, then price tends to come down (low future returns); mean reversion
    * This logic holds also for measures of fundamentals other than D, e.g., earnings, sales, etc.
    * In general, scaled prices are good predictors of stock market returns
- Why does the *default spread* predict stock returns?
  - Default spread is a business cycle indicator
  - Default spread changes in response to news about the strength of the economy
    * How?
  - Expected return is high in a weak economy
    * Why?

- Predictability is **stronger at longer horizons**
  - E.g., when predicting excess stock market returns by the dividend yield using post-war data,

Horizon	1 yr	2 yrs	3 yrs	5 yrs
b	5.3	10	15	33
t_b	(2.65)	(3.23)	(3.75)	(5.69)
R^2	0.15	0.23	0.37	0.60

  - Why does predictability get stronger with horizon?

- Predictor x_t is often modeled as an AR(1) process,

$$x_{t+1} = cx_t + v_{t+1},$$

because all predictors that have been found to work are highly persistent (c close to 1)

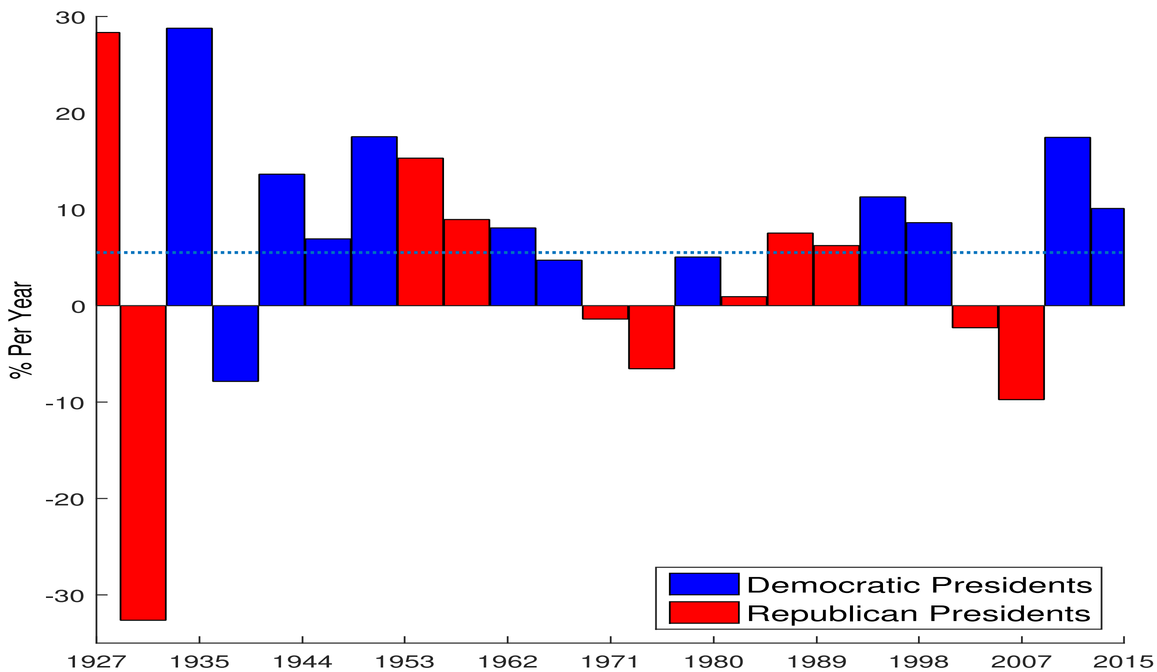
- Construct multiperiod log returns:

$$\begin{aligned}
r_{t+1} \; + \; r_{t+2} &= (a + bx_t + u_{t+1}) + (a + bx_{t+1} + u_{t+2}) \\
&= (a + bx_t + u_{t+1}) + (a + b\,(cx_t + v_{t+1}) + u_{t+2}) \\
&= b(1 + c)x_t + (2a + bv_{t+1} + u_{t+1} + u_{t+2}) \\
r_{t+1} \; + \; r_{t+2} + \ldots + r_{t+k} &= \\
&= b(1 + c + c^2 + c^3 + \ldots + c^{k-1})x_t + (\ldots),
\end{aligned}$$

so the slope coefficient on x_t increases with horizon

  - For $c \approx 1$, the slope in T-period prediction is about T times the slope in one-period prediction
  - R^2 increases with horizon for the same reason

- Predicting returns based on **presidential elections**
  - Stock market returns have been higher under Democratic presidents (Santa-Clara & Valkanov, 2003):



	Democrat	Republican	Difference
1927:01–2015:12	10.69	-0.21	10.90
	(4.17)	(-0.07)	(2.73)

  - What is going on? "Presidential puzzle."
  - Pastor and Veronesi (2017) argue this pattern is driven by voters' time-varying risk aversion
    - When risk aversion is high, we elect Democrats
    - When risk aversion is low, we elect Republicans

Pitfalls in Forecasting Market Returns

- Data mining
- Past is a good guide to the future
- In-sample vs. out-of-sample predictive power
  - The regression evidence we have looked at is *in-sample*; i.e., the computer uses the whole sample to estimate the predictive relation
  - Investor forecasting in real time cannot do this
  - To look *out of sample*, use rolling windows of data
    - e.g., use the Jan 1952 – Dec 1980 data to estimate the regression and predict 1981 returns
  - The out-of-sample predictive power is weak
    - e.g., Goyal and Welch (2008)
    - It is easy to predict the past. It is harder to predict the future.
  - That does not imply prediction is useless
    - Out-of-sample tests have low power
    - Simple modifications of standard predictive regressions improve out-of-sample performance
      - e.g., Campbell and Thompson (2008), Rapach, Strauss, and Zhou (2010)

"Never make forecasts, especially about the future."
Samuel Goldwyn, Hollywood producer

- The fact that returns are predictable implies that stock prices do not follow a random walk. Does this imply that **markets are inefficient?**
  - No! This is a common *fallacy*.
- Time variation in expected returns could be rational or irrational, and it's hard to tell which it is
  - Irrational:
    - Mispricing due to over-optimism and -pessimism
  - Rational:
    - Time-varying perceptions of risk
    - Time-varying attitudes/aversion toward risk
      - Expected return is high in "bad" times (e.g., in a recession, liquidity crisis, etc.)

  $\Longrightarrow$ Evidence of return predictability per se does not invalidate market efficiency
- The rational vs. irrational distinction has important implications for portfolio managers
  - Irrational: Opportunity for market timing
  - Rational: High expected return is compensation for high risk, no need to rebalance
    - Market timing might still work if the manager's investors are in a good position to bear this risk

Market timing

- Market timing, or "tactical asset allocation," is an active strategy that changes asset allocation depending on forecasts of stock market returns
  - Hold stocks in bull markets, cash in bear markets
- Ability to time the market can be valuable
  - Suppose you started in December 1925 with $1,000
    - If you invested it in T-Bills through December 2016, you would end up with a total of ......
    - If you invested it in a broad stock index, you would have ......
  - Now suppose you had perfect foresight and each month you could tell whether stocks were going to outperform T-Bills over the following month
    - If stocks were going to do better, you put all your money in stocks for that month
    - Otherwise, you put it all in T-Bills
    - How much did you accumulate by Dec 2016?

- However, the stock market is highly unpredictable at short horizons (recall the R^2 from the monthly predictive regressions), and few managers can afford to have 5- or 10-year investment horizons.

- One might think that a timing strategy can never do worse than a constant-mix strategy, as long as the average exposure to stocks is the same in both strategies. This is a *fallacy*. Market timing adds risk that must be offset with forecasting ability.

- **Example:** No Timing Ability.

  - Two assets:
    * Cash (T-bill), which returns $R_C = 5\%$ risk-free
    * Stocks, which return $R_S = 30\%$ or $R_S = -10\%$ with equal probability. Thus, $E_S = \mathrm{E}(R_S) = 10\%$ and $\sigma_S = \mathrm{Std}(R_S) = 20\%$
  - Two strategies (w_S denotes the weight in stocks):
    * Passive: A constant mix, with $w_S = 0.5$
    * Active: A variable mix, with $w_S = 0.75$ or 0.25, both equally likely
  - Passive strategy's return, R_P, has

$$\begin{aligned} E_P &= \mathrm{E}(R_P) = 0.5(10\%) + 0.5(5\%) = 7.5\% \\ \sigma_P &= \mathrm{Std}(R_P) = 0.5(20\%) = 10\% \end{aligned}$$

  - Active strategy's return, R_A, has a mean and variance that can be computed from the four possible outcomes (two choices for R_S, two choices for w_S). In the absence of timing ability, each outcome is equally likely:

Probability	R_S	R_C	w_S	$R_A = w_S R_S + (1 - w_S) R_C$
0.25	30%	5%	0.75	23.75%
0.25	30%	5%	0.25	11.25%
0.25	-10%	5%	0.75	-6.25%
0.25	-10%	5%	0.25	1.25%

– Therefore, active strategy's return moments are

$$\begin{aligned} E_A &= 0.25(23.75 + 11.25 - 6.25 + 1.25) = 7.5\% \\ \sigma_A^2 &= 0.25\left[(23.75 - 7.5)^2 + (11.25 - 7.5)^2 + \dots \right. \\ &\quad \left. + (-6.25 - 7.5)^2 + (1.25 - 7.5)^2\right] = 126.6(\%)^2 \\ \sigma_A &= \sqrt{126.6(\%)^2} = 11.25\% \end{aligned}$$

– Compare the active and passive strategies:

$$\begin{aligned} E_A &= 7.5\% = E_P \\ \sigma_A &= 11.25\% > 10\% = \sigma_P \end{aligned}$$

– **Lesson:** With no timing ability, market timing increases risk without increasing expected return

– What is the effect of *trading costs*?

  * Anytime you switch from stocks to cash or vice versa, you incur trading costs, say 1%
  * Probability of switching: 0.5, assuming forecasts are independent over time
  * Therefore, E_A is reduced by 0.5(1%) = 0.5%, from 7.5% to 7%

– Timing ability must outweigh both added volatility and trading costs

- Mechanics of market timing
  - Forecast returns and perhaps also volatility, combine them to form an optimal portfolio
  - Or simple switch, say between 70-30 and 30-70, based on judgment
  - Or rebalancing into constant weights
- Dangers of market timing
  - Successful market timing is contrarian:
    You're in when everyone else is out, and
    you're out when everyone else is in
  - This can be dangerous careerwise
    * "Worldly wisdom teaches that it is better for reputation to fail conventionally then to succeed unconventionally." (John Maynard Keynes)