Lecture 7B

Time Series Variation in Returns

Predicting the Overall Market

We have so far discussed equity returns in the cross section: picking out stocks that outperform others in the future on a risk-adjusted basis

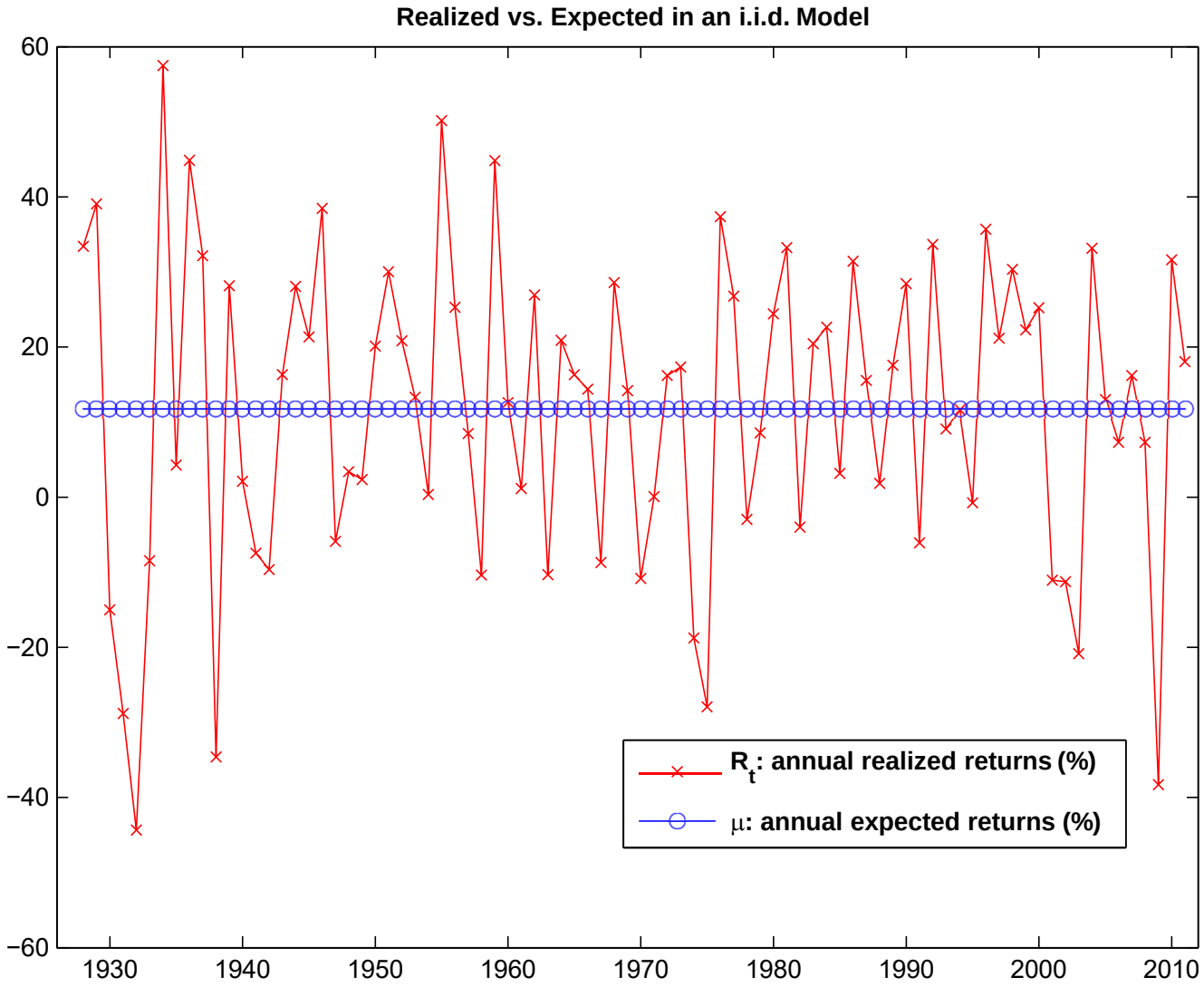
Now, we turn to equity returns in the time series: can you predict the market return itself?

The alpha of a quant strategy based on cross-sectional evidence is obtained from constructing a long-short position which is market neutral

Most investors bear substantially market risk

What do we know about predicting the market (or a part of the market)?

- Can investors successfully time the market?
- How do professional investors view market timing?

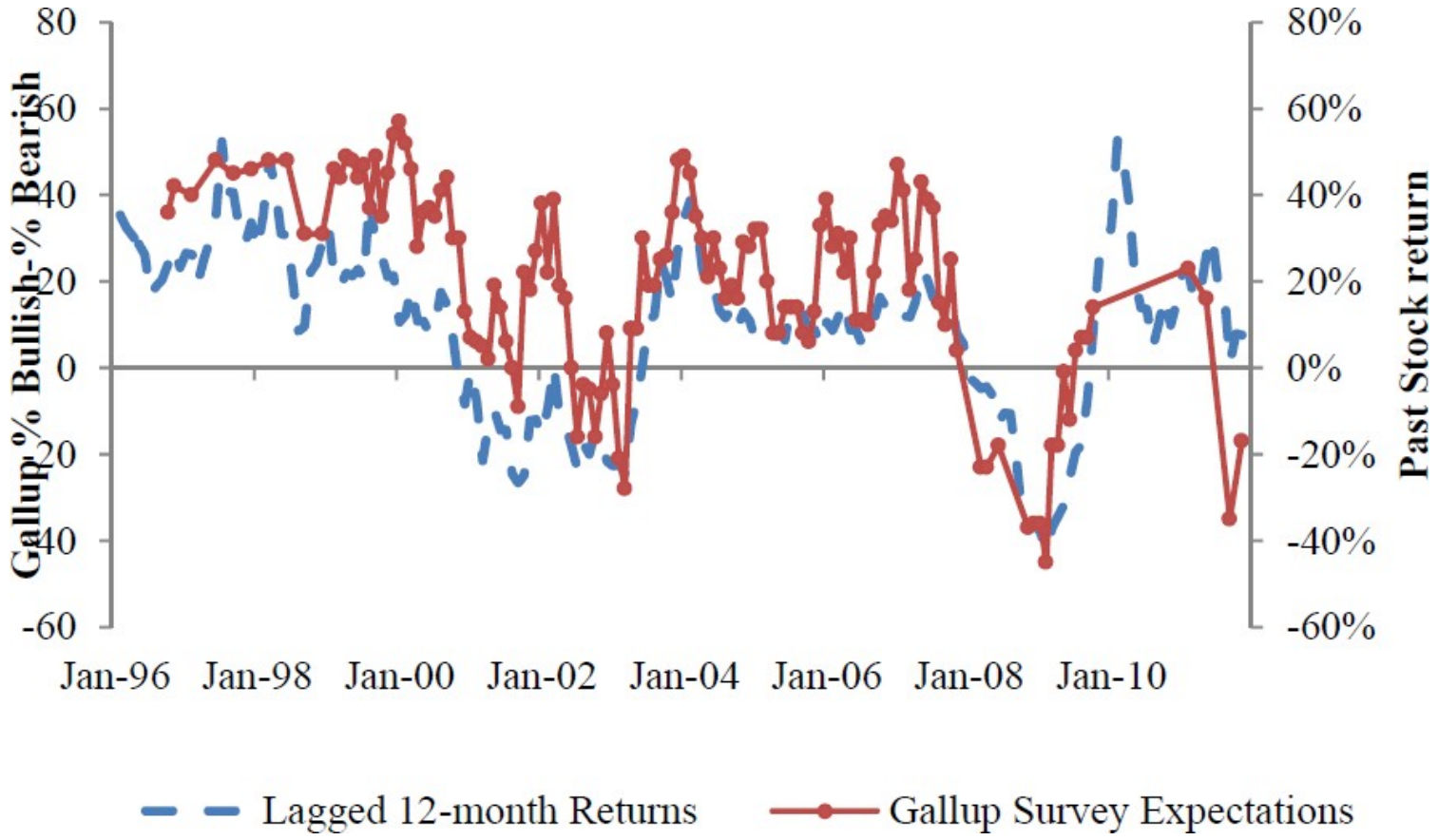

Realized vs. Expected in an i.i.d. Model
60
40
20
0
−20
−40
−60
1930
1940
1950
1960
1970
1980
1990
2000
2010
R_t: annual realized returns (%)
μ: annual expected returns (%)

Views on Market Timing

Excerpts from “Pioneering Portfolio Management” by David Swensen

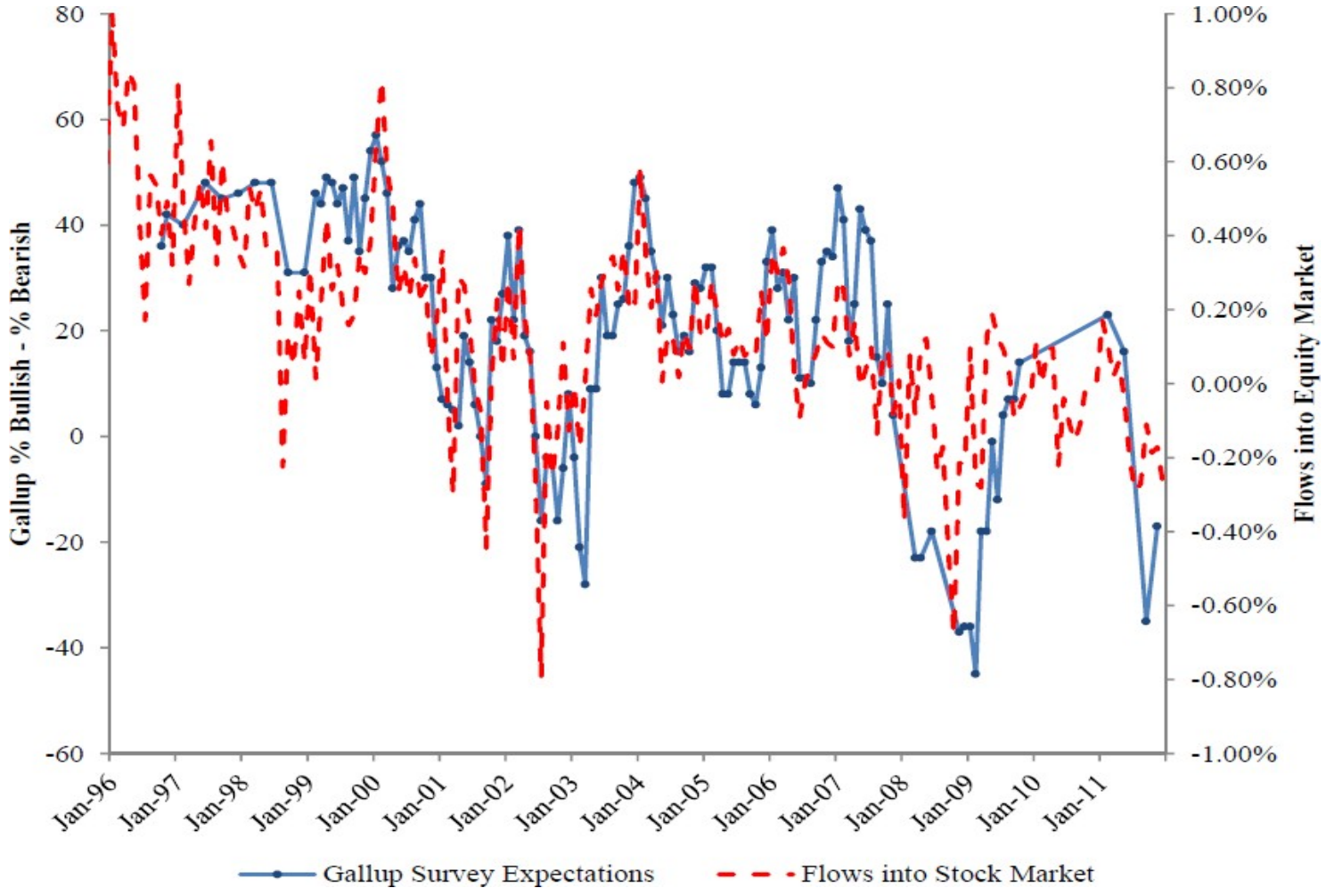
- Investment returns stem from decisions regarding three tools of portfolio management: Asset Allocation, Market Timing, and Security Selection.
- Careful investors consciously construct portfolios to reflect the expected contribution of each portfolio management tool.
- Market timing, according to Charles Ellis, represents a losing strategy: “There is no evidence of any large institutions having anything like consistent ability to get in when the market is low and get out when the market is high. Attempts to switch between stocks and bonds, or between stocks and cash, in anticipation of market moves have been unsuccessful much more often than they have been successful.”
- “Serious investors avoid timing markets.”

Investor Expectations and Past Stock Returns



Source: "Expectations of Returns and Expected Returns" by Greenwood and Shleifer (2012)

Investor Expectations and Equity Mutual Fund Flows



Running a Predictive Regression:

- Let I_t be a candidate predictor, observable at time t:

$$R_{t+1} = a + \mathbf{b}\, I_t + \epsilon_{t+1}\,,$$

  where ϵ_{t+1} is the *unpredictable* component of the stock return.

- If $\mathbf{b}$ is statistically significant, then we have a potentially useful predictor.

Can Past Returns Predict Future Returns? – Monthly Evidence

$$R_{t+1} = a + \rho R_t + \epsilon_{t+1}$$

	rho (decimal)	trad. t-stat	newey t-stat (lag 6)	R square	Years
CRSP VW Mkret	0.104	3.51	1.84	0.0108	1926-2019
CRSP EW Mkret	0.206	7.08	2.94	0.0426	1926-2019
CRSP VW Mkret	0.133	2.71	1.47	0.0177	1926-1959
CRSP EW Mkret	0.205	4.22	1.88	0.0422	1926-1959
CRSP VW Mkret	0.064	1.74	1.49	0.0042	1960-2019
CRSP EW Mkret	0.207	5.67	5.35	0.0429	1960-2019

- Rho (ρ) measures the *auto-correlation* in the monthly stock returns.
- In Econometrics, this model is called AR(1), with AR for auto-regressive.
- The average rho for individual stocks is *negative* but insignificant.

Can Past Returns Predict Future Returns – Daily Evidence

$$R_{t+1} = a + \rho R_t + \epsilon_{t+1}$$

	rho (%)	t-stat	R-sqr (%)	sample period
S&P 500	2.0	2.28	0.04	1962-2015
S&P 500	-3.3	-3.02	0.11	1982-2015
S&P 500	-7.7	-4.93	0.60	2000-2015

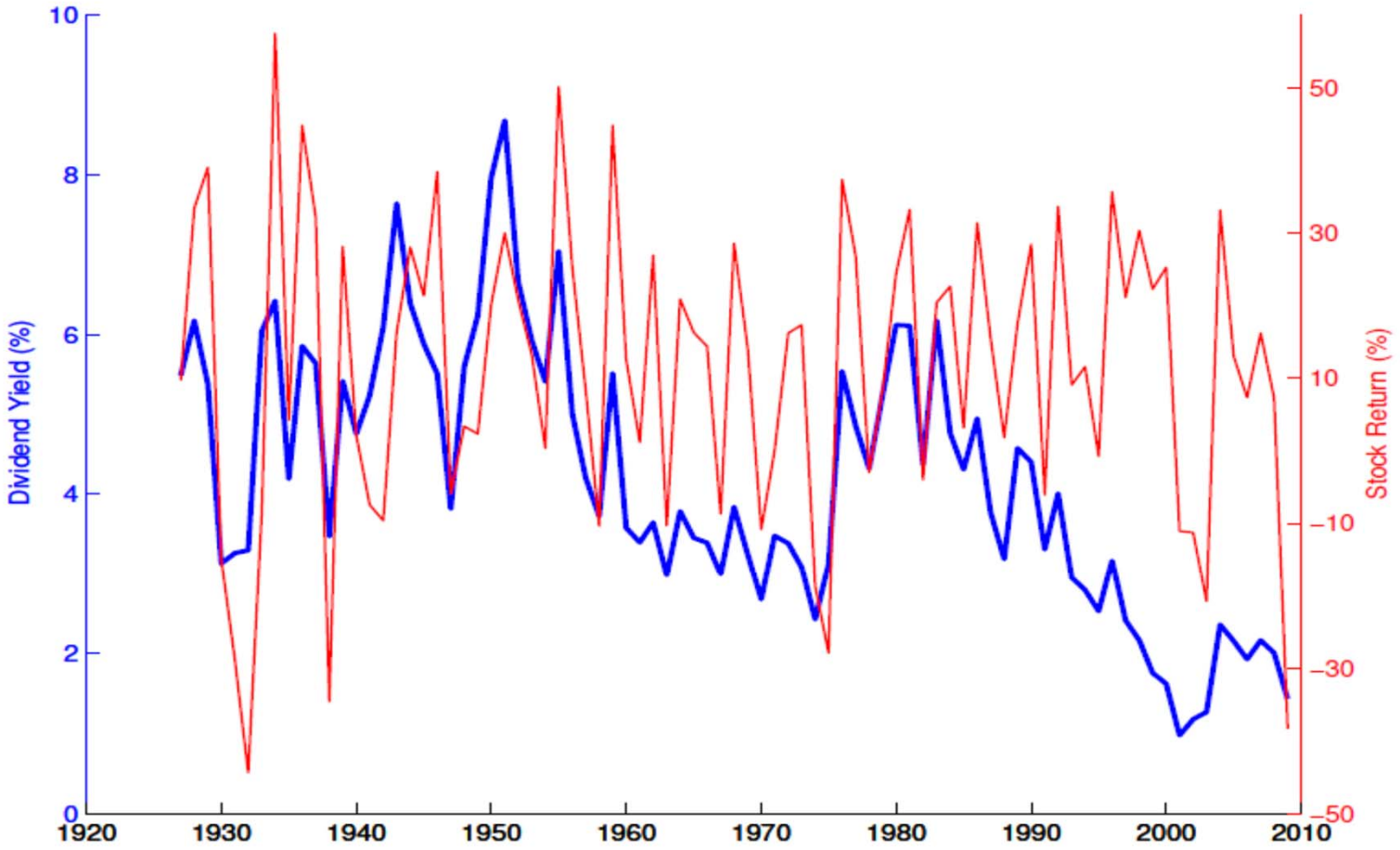
Predictors that are related to business conditions

- Default Spreads: *differences in yields between defaultable bonds and treasury bonds with similar maturities.* When the business condition is bad, the systematic default risk increases, widening the default spread.

- Term Premiums: *differences in yields between long- and short-term treasury bonds.* This is a forward-looking variable predictive of future inflation and is found to be important in forecasting real economic activity.

- Financial Ratios: *dividend-price ratio.* Variables that are important in fundamental valuation. Could be proxies for systematic risks that are higher when times are poor, and lower when times are good.

Stock Return and Dividend-Price Ratio



Use Dividend-Price Ratio to Predict Stock Returns

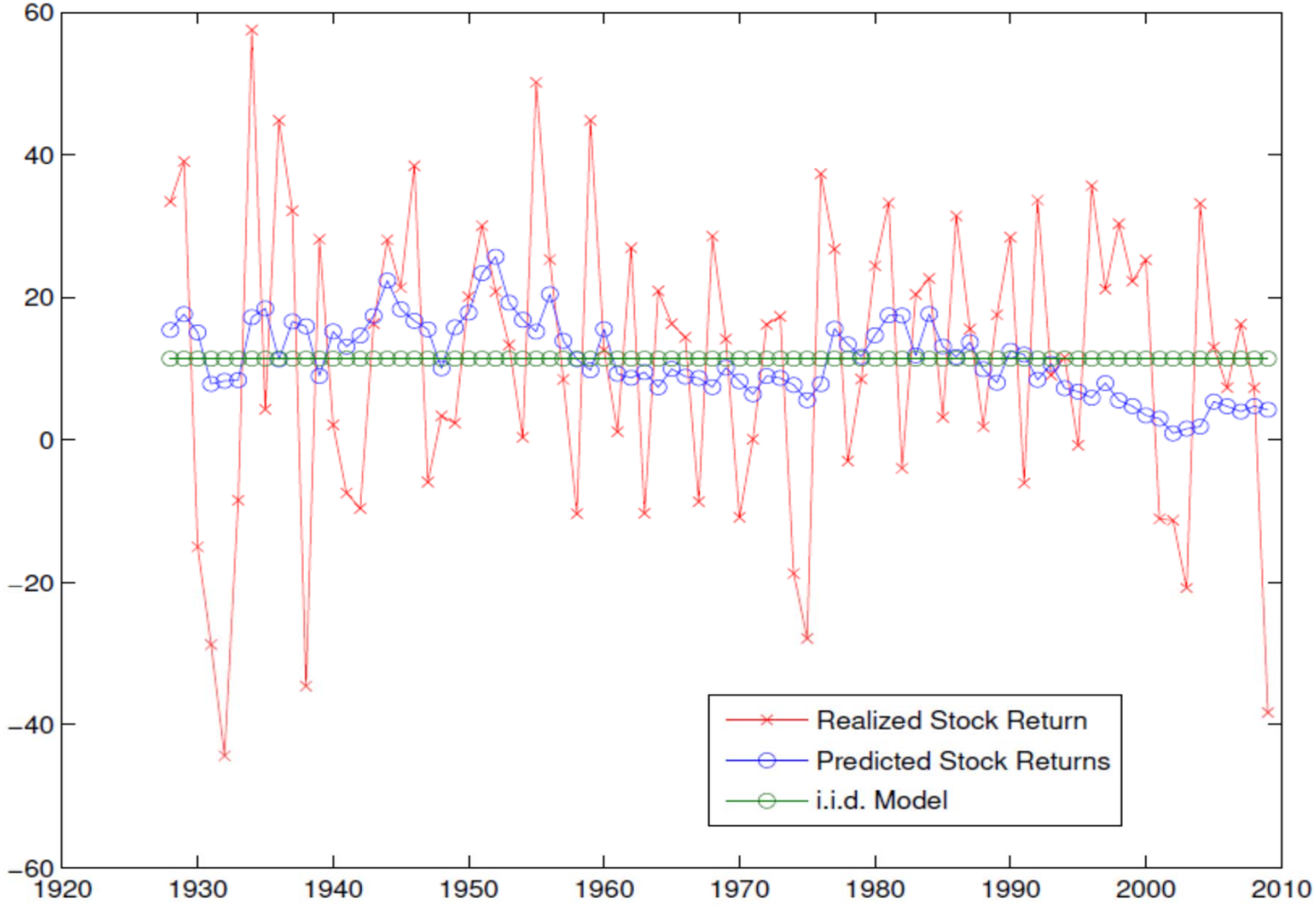
$$R_{t+1} = a + b\left(\frac{D}{P}\right)_t + \epsilon_{t+1}$$

- R_t: annual stock return realized in year t.
- $(D/P)_t$: dividend-price ratio realized in year t.

1927-2008	a	b
estimate	-0.02	3.22
standard error	0.06	1.34
t-stat	-0.36	2.40

- The R-squared of the regression: 6.63%.
- The sample standard deviation of D/P is 1.68%.

Realized vs. Expected Returns



Getting More Into the Regression Details

- A typical way to test predictability is to run the regression

$$r_{t+1} = \alpha + \beta x_t + \epsilon_{t+k}$$

- If we are interested in long-term predictability, it's common to use overlapping data and run

$$r_{t \to t+k} = \alpha + \beta x_t + \epsilon_{t+k}$$

where $r_{t \to t+k}$ is the total return from t to $t+k$. Could also label it as $r_{t,t+k}$.
Does x_t predict returns from t to $t+k$?

- Overlapping data induces/magnifies correlations in the errors ϵ. For example, if May 2010 return has an unusual shock and you 3-month cumulative returns, this month will affect three data points: May, June and July 2010. Therefore, standard errors must be adjusted for serial correlation [e.g., by Newey-West or even more general/conservative procedures (Hodrick standard-errors)]).

- Alternatively, you could run regressions without overlapping data, by using longer/coarser time intervals.

Dividend yield as predictor

- Under the Dividend Discount Model, $P_0 = \frac{D_1}{r-g}$. So the expected return $r = \frac{D_1}{P_0} + g$
- A higher D_1/P_0 predicts either a higher expected return or a lower dividend growth rates to balance that equation
- There is a more rigorous/general derivation without relying on this simplified version of Dividend Discount Model.

Table I

Return-Forecasting Regressions

The regression equation is $R^e_{t\to t+k} = a + b \times D_t/P_t + \varepsilon_{t+k}$. The dependent variable $R^e_{t\to t+k}$ is the CRSP value-weighted return less the 3-month Treasury bill return. Data are annual, 1947–2009. The 5-year regression t-statistic uses the Hansen–Hodrick (1980) correction. $\sigma[E_t(R^e)]$ represents the standard deviation of the fitted value, $\sigma(\hat{b} \times D_t/P_t)$.

Horizon k	b	$t(b)$	R^2	$\sigma[E_t(R^e)]$	$\frac{\sigma[E_t(R^e)]}{E(R^e)}$
1 year	3.8	(2.6)	0.09	5.46	0.76
5 years	20.6	(3.4)	0.28	29.3	0.62

Source: Cochrane (2011)

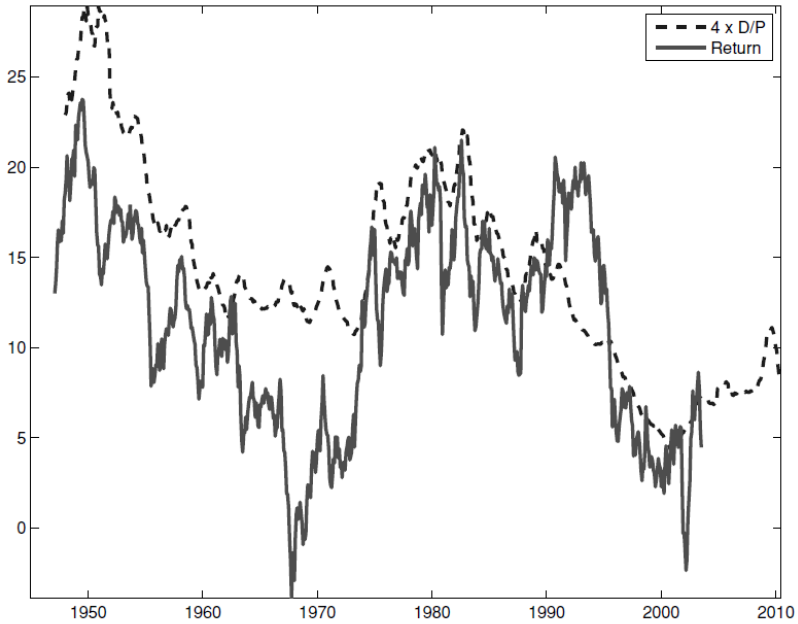


Figure 1. Dividend yield and following 7-year return. The dividend yield is multiplied by four. Both series use the CRSP value-weighted market index.

Predictability of different variables at different horizons

		1 Qtr	*1 Year*	*2 Years*	*5 Years*	*Sample*	*Source*
Dividend Yield	Correlation	0.12	0.23	0.33	0.49	Jan 1926 - Dec 2011	CRSP
	t-stat	(1.12)	(1.25)	(1.48)	(1.95)		
(10-Yr) Earnings Yield	Correlation	**0.18**	**0.33**	**0.41**	**0.48**	Jan 1926 - Dec 2011	Shiller (2000) updated
	t-stat	**(2.23)**	**(2.55)**	**(2.79)**	**(2.31)**		
Volatility VIX	Correlation	0.12	0.10	0.13	–0.16	Jan 1986 - Dec 2011	CBOE
	t-stat	(0.96)	(0.63)	(0.75)	(–0.47)		
Past Volatility [Over Last Quarter]	Correlation	0.05	0.09	0.13	0.06	Sep 1963 - Dec 2011	CRSP
	t-stat	(0.55)	(0.65)	(0.78)	(0.17)		
Lagged 1-Year Return [Past 12 Mths to Past 1 Mth]	Correlation	–0.01	–0.05	–0.13	–0.26	Dec 1926 - Dec 2011	CRSP
	t-stat	(–0.12)	(–0.26)	(–0.55)	(–1.39)		
T-Bill Rate	Correlation	–0.07	–0.12	–0.15	–0.22	Sep 1926 - Dec 2011	Ibbotson
	t-stat	(–1.23)	(–1.17)	(–1.05)	(–0.97)		
Consumption-Wealth Ratio	Correlation	**0.16**	**0.30**	**0.42**	0.53	Mar 1953 - Dec 2011	Lettau and Ludvigson (2001a) updated
	t-stat	**(2.92)**	**(2.62)**	**(2.23)**	(1.34)		
Term Spread [10 Yr Tsy minus 3 Mth T-bill]	Correlation	0.11	0.23	0.27	0.35	Mar 1953 - Dec 2011	Federal Reserve Bank of St Louis
	t-stat	(1.60)	(1.84)	(1.66)	(1.61)		
Credit Spread [AAA minus BAA]	Correlation	0.02	0.08	0.12	0.20	Dec 1918 - Dec 2011	Federal Reserve Bank of St Louis
	t-stat	(0.15)	(0.34)	(0.44)	(0.67)		
GDP Growth [Past 1 Year]	Correlation	0.01	–0.13	–0.11	–0.08	Jun 1947 - Dec 2011	BEA
	t-stat	(0.17)	(–1.37)	(–1.25)	(–0.84)		
Inflation [Past 1 Year]	Correlation	–0.07	–0.12	–0.10	–0.03	Mar 1914 - Dec 2011	Federal Reserve Bank of St Louis
	t-stat	(–1.07)	(–0.94)	(–0.58)	(–0.09)		
Industrial Production [Past 1 Year]	Correlation	–0.01	–0.04	0.02	–0.04	Dec 1919 - Dec 2011	Federal Reserve Bank
	t-stat	(–0.06)	(–0.25)	(0.08)	(–0.20)		
Oil Price [Past 1-Year Change]	Correlation	–0.10	–0.18	–0.16	–0.11	Dec 1945 - Dec 2011	Federal Reserve Bank of St Louis
	t-stat	(–1.20)	(–1.20)	(–1.08)	(–0.78)		
Unemployment Rate	Correlation	0.12	0.22	0.19	0.22	Dec 1947 - Dec 2011	Bureau of Labor Statistics
	t-stat	(1.86)	(1.85)	(1.08)	(0.75)		

Source – Ang Book – Chapter 8

Out-of-sample Predictability

- You have discovered a variable x_t that seems to predict returns r_{t+1} in sample. How do you judge if it works out of sample?

- Out-of-sample R^2 statistic:

$$R^2_{OS} = 1 - \frac{\sum_{t=1}^{T}(r_t - \hat{r}_t)^2}{\sum_{t=1}^{T}(r_t - \bar{r}_t)^2}$$

where $\hat{r}_t$ is the fitted value from a predictive regression estimated through period $t-1$ and $\bar{r}_t$ is the historical average return estimated through period $t-1$.

That is, $\bar{r}_t = \frac{1}{t-1}\sum_{j=1}^{t-1} r_j$. To get $\hat{r}_t$, run the regression $r_j = \alpha + \beta x_{j-1} + \epsilon_j$ for $j = 1,2,\dots,t-1$. Get the estimated $\hat{\alpha}, \hat{\beta}$. Then $\hat{r}_t = \hat{\alpha} + \hat{\beta} x_{t-1}$. These steps are repeated for each t.

There should be historical data before the start of forecast ($t = 1$) to calculate $\bar{r}_t$ and $\hat{r}_t$.

If $R^2_{OS} > 0$, then the predictor x performs better than the historical average out of sample.
If $R^2_{OS} < 0$, then the predictor x performs worse than the historical average out of sample.

Evidence on predictability is even weaker when considering out of sample performance [Goyal and Welch (2008)]

Interpreting Time-Varying Expected Returns

- Only in an i.i.d. world does predictability imply market inefficiency
- Otherwise, having a predictive component in market returns does not necessarily mean that markets are inefficient
- The predictive component could be interpreted as time-varying expected returns
- For example, time-varying business conditions or time-varying risk appetite could both be a cause for time-varying expected returns
- This is reminiscent of the cross-sectional arguments regarding predictors of cross-sectional equity returns as measures of systematic risk

Final Thoughts on Time-Series Predictability

- Use conservative standard errors
- Economic models may help
- Watch out for look-ahead bias in implementing an actual strategy
- Assuming i.i.d. and using historical average should be default prediction
- Structural breaks/parameter instability make the problem even harder