

# Lecture 7: Forecasts

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# Outline

Forecasting Regressions

Dividend-Yield Forecasting



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# Risk premia across assets

The **risk premium** of an asset,  $i$ , is defined as the **expected** excess return,

$$\mathbb{E}[\tilde{r}^i]$$

- ▶ **Linear Factor Models** (LFM's) describe how risk premia vary across assets.
- ▶ Most theories attribute the variation to difference in risks.



## Example: CAPM

The CAPM says risk premia across different assets  $i$  are:

$$\mathbb{E}[\tilde{r}^i] = (\beta^{i,m}) \lambda_m$$

All risk premia are proportional (by beta) to the market risk premium.

- ▶ But the above form does not condition on time.
- ▶ The beta and both risk premia are estimated as stationary time series averages.



# Risk premia over time

So how do risk premia change over time?

$$\mathbb{E}_t [\tilde{r}_{t+1}^i]$$

- ▶ Is the expected excess return of asset  $i$  always the same, no matter what period the investor considers?

$$\mathbb{E}_t [\tilde{r}_{t+1}^i] = \mathbb{E} [\tilde{r}^i]$$

- ▶ Or is the risk premium of an asset a function of time-varying factors,  $x_t$ ?

$$\mathbb{E}_t [\tilde{r}_{t+1}^i] = f(x_t)$$



# Linear methods

If we believe risk premia vary over time, we must specify a functional form for  $f(x)$  in

$$\mathbb{E}_t [\tilde{r}_{t+1}^i] = f(x_t)$$

as well as specifying the factor(s),  $x_t$ .

- ▶ If we specify a linear function, the statistics/numerics are much easier.
- ▶ Recall that a linear regression gives the best linear estimator of such a function  $f(x)$ .



# Regressions to measure conditional expectations

Suppose

$$y = \alpha + \beta x + \epsilon$$

Then the expectation of  $y$  conditional on  $x$  is

$$\mathbb{E}[y | x] = \alpha + \beta x$$

Thus, if  $\beta \neq 0$ , the conditional expectation varies as  $x$  varies.



# Forecasting regressions

A **forecasting** regression for returns is of the form:

$$\tilde{r}_{t+1}^i = \alpha + \beta x_t + \epsilon_{t+1}$$

- ▶ If  $\beta \neq 0$ , then the conditional expectation of  $\tilde{r}_{t+1}^i$  varies over time as  $x_t$  varies.

$$\mathbb{E} [\tilde{r}_{t+1}^i | x_t] = \alpha + \beta x_t$$

- ▶ We similarly used regressions in LFM's to discover variation in risk premia across assets.





# Classic view

The **classic view** says risk premia are constant over time.

- ▶ Thus, in any forecasting regression of returns,  $\beta = 0$ .

$$\tilde{r}_{t+1}^i = \alpha + \beta x_t + \epsilon_{t+1}$$

- ▶ The classic view also says price growth is a **random walk** (with drift.)

$$\log P_{t+1} - \log P_t = \text{constant} + \epsilon_{t+1}$$

$$\text{So } \mathbb{E}_t \left[ \frac{P_{t+1}}{P_t} \right] = \text{constant}.$$



# Testing the classic view

Test the classic view on the risk premium of the market index,  $\lambda_m$ .

- ▶ Consider using this period's return to forecast that of next period:

$$\tilde{r}_{t+1}^m = a + \beta \tilde{r}_t^m + \epsilon_{t+1}$$

- ▶ This test of the classic view of market return predictability uses the lagged return as the predictor variable.



# Evidence: Is the market return autocorrelated?

$$r_{t+1} = a + \beta r_t + \epsilon_{t+1}$$

**Table:** Auto-regression estimates for market returns, excess market returns.

	Monthly		Annual	
	$r^m$	$\tilde{r}^m$	$r^m$	$\tilde{r}^m$
$b$	0.11	0.12	0.01	0.02
$t(b)$	2.02	2.05	0.09	0.15
$R^2$	0.01	0.01	0.00	0.00

- ▶ CRSP value-weighted equity markets, 1927-2010.
- ▶ CRSP 3-month U.S. treasury bill.
- ▶ GMM standard errors.



# Evidence: Is the risk-free return autocorrelated?

$$r_{t,t+1}^f = a + \beta r_{t-1,t}^f + \epsilon_{t+1}$$

**Table:** Auto-regression estimates for the risk-free return.

	Monthly	Annual
$b$	0.89	0.92
$t(b)$	30.38	13.31
$R^2$	0.80	0.83

- ▶ CRSP value-weighted equity markets, 1927-2010.
- ▶ CRSP 3-month U.S. treasury bill.
- ▶ GMM standard errors.



## Conclusions from the return auto-regressions

The excess market return has a regression coefficient near zero, which fits the classic view of risk premia.

- ▶ High returns do not indicate particularly high or low returns going forward.
- ▶ The annual data estimates suggest stock returns, particularly excess returns, are i.i.d.
- ▶ The monthly data shows some autocorrelation, but not much explanatory power.
- ▶ Furthermore, trading costs would seem to make this small predictability a novelty of no economic importance.



## Other Ways to See Predictability?

For many years, academics and practitioners have found these same results.

- ▶ This reinforced classic view that returns are unpredictable—that prices are essentially a random walk.
- ▶ But even if past returns do not predict future returns, how about some other predictor,  $x_t$ ?
- ▶ How about forecasting at longer horizons?



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# Signals

Notwithstanding the “classic” view, asset managers use many signals to try to forecast returns with linear regression.

- ▶ Macroeconomic signals
- ▶ Asset return signals
- ▶ Short-term signals / forecast horizons
- ▶ Long-term signals / forecast horizons

The dividend-price ratio, (also known as the dividend-yield,) is one of the most famous examples.





# Dividend-yield

The **dividend-yield**  $DP_t$  refers to the **dividend-price** ratio,  $\frac{D_t}{P_t}$ .

- ▶ Other common cash-flow-to-value measures include earnings-price and book-price (book-market) ratios.
- ▶ Obviously, using value-to-cashflow ratios such as dividend-price works the same.
- ▶ For an individual stock, dividends are not paid continuously, but for the market index, there is a steady stream for analysis.



# Returns and the dividend yield

By definition, stock returns are

$$R_{t+1} \equiv \frac{P_{t+1} + D_{t+1}}{P_t}$$
$$R_{t+1} \equiv \left( \frac{D_t}{P_t} \right) \frac{D_{t+1}}{D_t} + \frac{P_{t+1}}{P_t}$$

This identity holds for horizon,  $t + k$ , and in expectation:

$$\mathbb{E}_t [R_{t,t+k}] = \text{DP}_t \mathbb{E}_t \left[ \frac{D_{t+k}}{D_t} \right] + \mathbb{E}_t \left[ \frac{P_{t+k}}{P_t} \right]$$



# Classic view of dividend yield

In the classic view of risk premia,

- ▶ Expected returns are constant:  $\mathbb{E}_t \left[ r_{t,t+k} \right] = \theta_r$ .
- ▶ Price appreciation is a random walk,  $\mathbb{E}_t \left[ \frac{P_{t+k}}{P_t} \right] = \theta_p$ .

$$\theta_r = DP_t \mathbb{E}_t \left[ \frac{D_{t+k}}{D_t} \right] + \theta_p$$

So under the classic view,

- ▶ An increase in the dividend-yield is offset by a decrease in expected dividend growth.



# Evidence: Stock-market Predictability

$$\tilde{r}_{t,t+k}^m = a + \beta DP_t + \epsilon_{t+k}$$

**Table:** Stock Return Predictability Regressions.

	Horizon		
	1 month	1 year	5 years
$b$	0.25	4.08	21.27
$t(b)$	1.01	2.45	4.43
$R^2$	.01	.09	.31

Regression of cumulative excess returns on dividend-price ratio.

- ▶ NYSE/AMEX/NASDAQ value-weighted equity markets.
- ▶ Monthly data, 1927-2010.
- ▶ GMM standard errors.



# Interpreting the regression estimates

## At a one-month horizon,

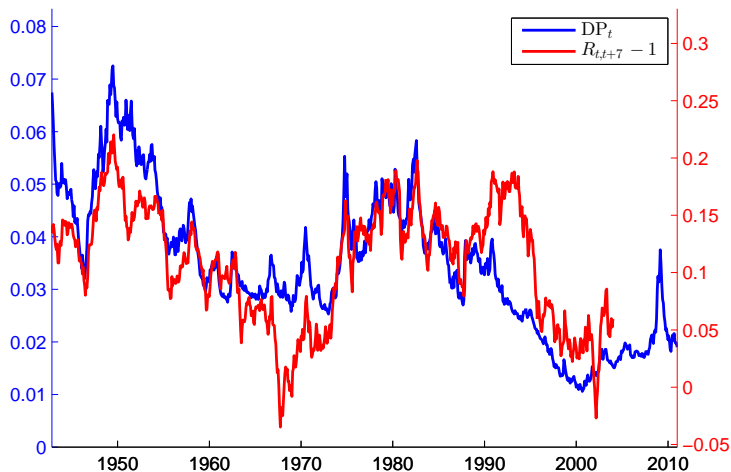
- ▶ Slope coefficient is insignificant—statistically and economically.
- ▶ Agrees with the implications of the auto-regression.
- ▶ More evidence seemingly supportive of the classic view.

## At longer horizons,

- ▶ Coefficient is economically significant.
- ▶ At one-year, a one-point increase in dividend-price forecasts a four-point increase in returns!



# Illustration of return predictability



**Figure:** Market dividend-price ratio plotted against the next seven years cumulative return. CRSP monthly data, 1927-2010.



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# Modern view of dividend yield

The empirical evidence above shows:

- ▶ Expected returns increase one-for-one with the dividend-yield.
- ▶ This is not offset by dividend growth or price appreciation.
- ▶ Instead, estimates show prices move the wrong way—increase expected returns even more.

$$\mathbb{E}_t [R_{t,t+k}] = DP_t \mathbb{E}_t \left[ \frac{D_{t+k}}{D_t} \right] + \mathbb{E}_t \left[ \frac{P_{t+k}}{P_t} \right]$$



When prices are low, we (used to / now) expect...

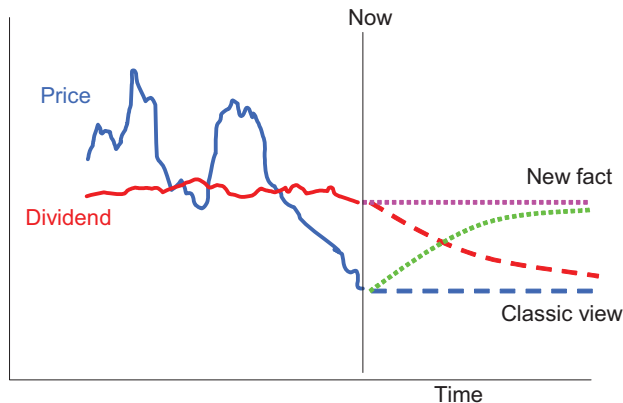


Figure: Source: Cochrane (2012)



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# Long Horizons as a Way to See Predictability

Predictability of market returns by dividend-yield only seen in long horizons regressions.

- ▶ Due to persistent nature of the forecasting variable,  $DP_t$ .
- ▶ Autoregressive coefficient at a monthly frequency is about .98!

$$DP_{t+1} = a + b DP_t + \epsilon_{t+1}$$



# Other Forecasting Variables?

Other variables seem to have similar ability to forecast returns.

- ▶ Cyclically-adjusted price-earnings ratios
- ▶ Macro-economic indicators. (Investment, consumption, etc.)
- ▶ Inflation and rates. (The “Fed Model”)



# Statistical concerns

The dividend-price predictability is controversial.

- ▶ DP is a persistent variable, (high autocorrelation.)
- ▶ Regressions where  $x$  has high autocorrelation can be biased or mis-specified.

This is a very active area of research to find the best predicting variables and models.



# References

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