“Superstitious” Investors

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Introduction

The volatility of stock returns on the aggregate market is a puzzle (Campbell & Shiller, 1988).

- US. aggregate stock market volatility is about 20% per annum.
- Riskfree rate volatility is low: 2% per annum is probably an upper bound for the short-term US real rate.
- Consumption volatility is also low: 1–2% per annum in postwar US data.
- An influential research agenda seeks to explain these fluctuations primarily through discount rates.

Introduction (cont.)

Problems with the discount-rate-based explanation:

- Decades of empirical research has failed to uncover a robust relation between risk and expected returns.
- Leading candidates predict term structures of returns that are too steep in one direction or another.

Introduction (cont.)

- We assume that investors hold biased beliefs that are nonetheless reasonable given past data.
- Motivation: the classic animal learning study of Skinner (1948)
  - Pigeons "learned" to associate certain behaviors with the arrival of food.
- The pigeons thought that the something random (food arrival) was predictable.
- People, too, tend to place structure on randomness.
  - Even trained subjects cannot generate random sequences (Bar Hillel and Wagenaar, 1991; Neuringer, 1986).

This paper

- Growth rates are iid lognormal.
  - Investors, however, believe that they can forecast the growth rate.
- We implement biased beliefs in a simple way.
- Biased beliefs are isomophic to prices of risk (if sufficiently flexible), though the interpretation is different.
- And extended across asset classes, and to the cross-section.
- Unlike previous literature, we do not use belief biases to explain the equity premium.

Model

- Aggregate dividends D_t
- Investor's subjective process for dividend growth:

$$\begin{aligned} \Delta d_{t+1} &= x_t + u_{t+1} \\ x_{t+1} &= \phi x_t + v_{t+1}, \end{aligned}$$

$$\begin{bmatrix} u_t \\ v_t \end{bmatrix} \overset{iid}{\sim} N\left(0, \begin{bmatrix} \sigma_u^2 & 0 \\ 0 & \sigma_v^2 \end{bmatrix}\right)$$

- Value of the aggregate market

$$P_t = E_t^* \sum_{n=1}^{\infty} \delta^n D_{t+n}$$

where δ is the discount factor.

Prices and returns

- Price of a dividend strip:

$$\begin{aligned} P_{nt} &= E_t^*[\delta^n D_{t+n}] \\ &= D_t e^{a_n + b_n x_t} \end{aligned}$$

- Returns up to a constant:

$$\begin{aligned} \log(1 + R_{n,t+1}) &= \log \frac{P_{n-1,t+1}}{D_{t+1}} - \log \frac{P_{n,t}}{D_t} + \log \frac{D_{t+1}}{D_t} \\ &= k + b_{n-1} x_{t+1} - b_n x_t + \Delta d_{t+1} \\ &= k + (b_{n-1}\phi - b_n) x_t + b_{n-1} v_{t+1} + \Delta d_{t+1} \\ &= k - x_t + b_{n-1} v_{t+1} + \Delta d_{t+1} \end{aligned}$$

- If investors are correct, expected returns are constant.
- But if Δd_{t+1} is unpredictable, then they contain x_t.

Where does volatility come from?

- When the physical and the subjective distributions coincide:

$$\mathrm{Var}(\log(1 + R_{nt})) = b_{n-1}^2 \sigma_v^2 + \sigma_u^2,$$

- When the investors exhibit superstition:

$$\mathrm{Var}(\log(1 + R_{nt})) = \sigma_x^2 + b_{n-1}^2 \sigma_v^2 + \sigma_u^2,$$

where

$$\sigma_x^2 \equiv \frac{\sigma_v^2}{1 - \phi^2}.$$

- It turns out that $\sigma_x^2 << b_{n-1}^2 \sigma_v^2$, for n large.
- The model for superstitious investors does not (much) produce more volatility than the full information model.

Predictive Dividend Growth Regressions

	Horizon in Years					
	1	2	4	6	8	10
Panel A: Data 1948-2017						
β	-0.01	-0.01	-0.04	-0.08	-0.09	-0.12
t-stat	[-0.59]	[-0.29]	[-0.72]	[-1.00]	[-0.83]	[-0.86]
R^2	0.01	0.00	0.01	0.04	0.05	0.06
Panel B: Disaster Model No Realization						
β	-0.00	-0.00	-0.00	0.00	-0.01	-0.01
5th percentile	-0.07	-0.15	-0.29	-0.41	-0.52	-0.61
95th percentile	0.08	0.15	0.28	0.42	0.52	0.63
R^2	0.01	0.01	0.03	0.04	0.05	0.06

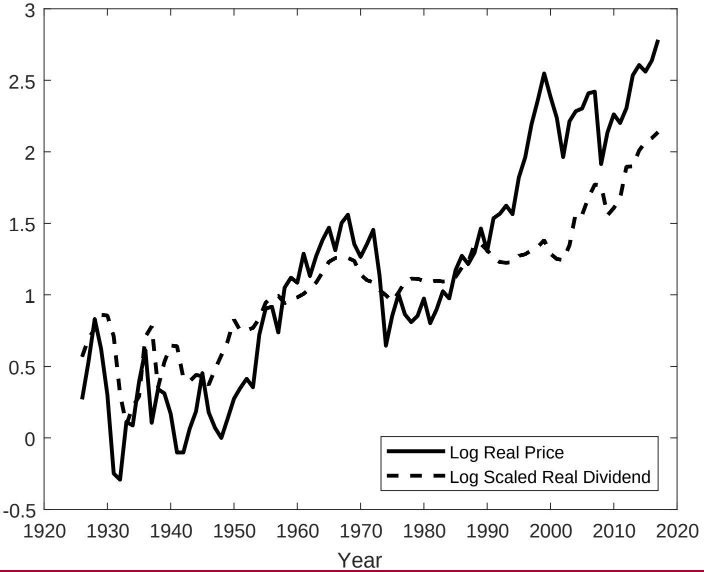
- Data are annual, 1947–2017

Predictive Regressions: Excess Stock Market Returns

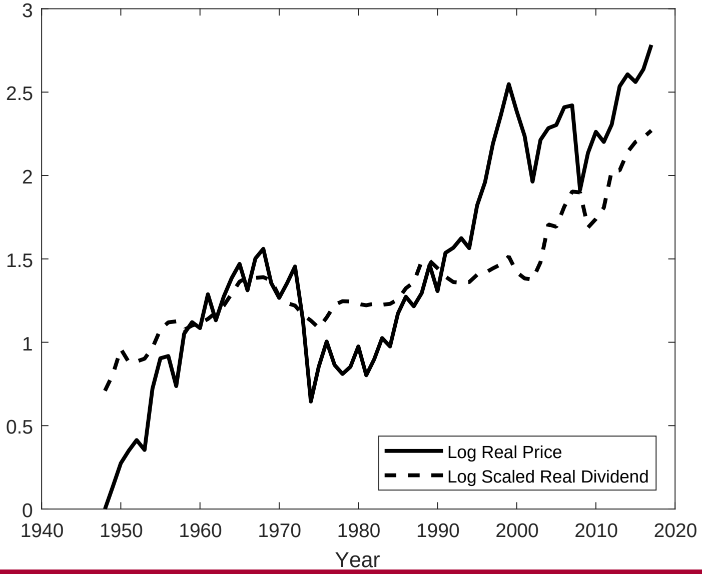
	Horizon in Years					
	1	2	4	6	8	10
Panel A: Data 1948-2017						
β	0.10	0.20	0.28	0.40	0.51	0.59
t-stat	[2.27]	[2.59]	[2.90]	[2.91]	[2.87]	[2.71]
R^2	0.07	0.13	0.16	0.22	0.27	0.31
Panel B: Disaster Model No Realization						
β	0.12	0.24	0.44	0.62	0.77	0.89
5th percentile	0.03	0.06	0.11	0.13	0.16	0.16
95th percentile	0.30	0.55	0.95	1.28	1.53	1.74
R^2	0.05	0.09	0.18	0.24	0.30	0.34

- Data are annual, 1947–2017

Prices and dividends in the data



Prices and dividends in the data (postwar)



How irrational are these beliefs?

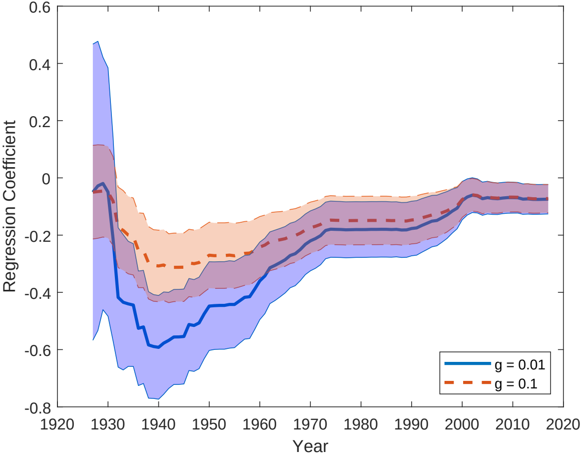
- The investor's beliefs imply dividend growth is predictable.
- If an econometrician started in 1927 with the beliefs that we assign to our investors, what would she think at the end of the sample?
- Consider the following predictive system:

$$\Delta d_{t+1} = \beta \hat{x}_t + u_{t+1}$$
$$\hat{x}_{t+1} = \hat{\phi} \hat{x}_t + \hat{v}_{t+1},$$

where $\hat{x}_t = p_t - d_t$, the log price-dividend ratio, and where

$$\begin{bmatrix} u_t \\ \hat{v}_t \end{bmatrix} \overset{iid}{\sim} N\left(0, \begin{bmatrix} \sigma_u^2 & 0 \\ 0 & \hat{\sigma}_v^2 \end{bmatrix}\right).$$

Posterior Mean of the Regression Coefficient



Notes: We regress log dividend growth on the log of the dividend-price ratio. g represents the strength of the prior. Shaded

Extensions

1. Value premium
2. Violations of the expectations hypothesis of interest rates [bond return predictability]
3. Violations of uncovered interest rate parity [predictability in currency returns]

- There are many examples of time series and cross-sectional predictability. The predictability appears to be asset-specific.

Explaining the Value Premium

- Sort stocks on the basis of book-to-market, earnings-to-price, or similar scaling.
- The value premium is the finding that assets with high values of these ratios (namely prices are low relative to fundamentals) have high expected returns.
- What makes the value premium into a puzzle is that expected returns are not related to beta.

Explaining the value premium (cont.)

- Asset-specific dividend growth:

$$\Delta d_{j,t+1} = x_t + \beta_{zj} z_t + u_{j,t+1},$$

where

$$x_{t+1} = \phi_x x_t + v_{x,t+1}$$
$$z_{t+1} = \phi_z z_t + v_{z,t+1},$$

- Assume all shocks are iid with variance σ_u^2, σ_{vx}^2 and σ_{vz}^2.
- So that x_t has the interpretation of the market shock, $\sum_j \beta_{z,j} = 0$.

Explaining the value premium (cont.)

- Prices on a dividend strip:

$$P_t^j = D_t^j e^{a_{j,n} + b_{x,n} x_t + \beta_{z,j} b_{z,n} z_t},$$

- Assume $z_t > 0$: High PD (growth firms) $\Leftrightarrow$ firms with high $\beta_{z,j}$
- Returns up to a constant

$$\begin{aligned}\log(1 + R_{n,t+1}^j) &= \log \frac{P_{n-1,t+1}^j}{D_{j,t+1}} - \log \frac{P_{n,t}^j}{D_{jt}} + \log \frac{D_{j,t+1}}{D_{jt}} \\ &= k - x_t - \beta_{zj} z_t + b_{x,n-1} v_{x,t+1} + \beta_{zj} b_{z,n-1} v_{z,t+1}\end{aligned}$$

- Expected return differential if dividends were unpredictable:

$$\log E_t \left[1 + R_{n,t+1}^j \right] - \log E_t \left[1 + R_{n,t+1}^k \right] = (\beta_{z,k} - \beta_{z,j}) z_t$$

Return statistics for value and growth portfolios

	1 (Low)	2	3	4	5 (High)	5 - 1
			Panel A: Data 1952-2017			
$E[R]$	6.46	7.61	8.96	11.34	13.65	7.19
t-stat	[2.72]	[3.73]	[4.25]	[4.86]	[4.79]	[3.46]
$\sigma(R)$	19.29	16.60	17.13	18.97	23.17	16.87
α	-2.05	-0.05	1.20	2.96	3.77	5.82
t-stat	[-1.99]	[-0.09]	[1.59]	[2.74]	[2.72]	[2.58]
β_{mkt}	1.03	0.93	0.94	1.01	1.19	0.17
			Panel B: Model			
$E[R]$	-0.14	-0.14	0.39	1.37	2.67	2.83
$\sigma(R)$	21.63	17.65	16.19	17.00	19.51	25.18
α	-1.01	-1.01	-0.42	0.57	1.89	2.93
β_{mkt}	1.07	1.02	0.99	0.97	0.95	-0.12

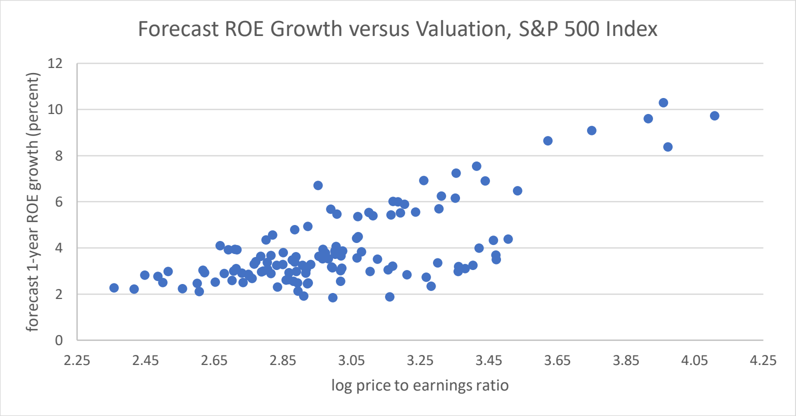
- Portfolios are formed by sorting on earnings-to-price ratios. Data are annual, 1952–2017

Abnormal returns relative to a two-factor model

	1 (Low)	2	3	4	5 (High)
Panel A: Data 1952-2017					
α	0.27	0.08	-0.05	0.95	0.27
t-stat	[0.57]	[0.12]	[-0.09]	[1.47]	[0.57]
β_{mkt}	1.10	0.93	0.90	0.96	1.10
β_{hml}	-0.40	-0.02	0.22	0.35	0.60
Panel B: Model					
α	0.49	-0.30	-0.48	-0.18	0.49
β_{mkt}	1.01	1.00	1.00	1.00	1.01
β_{hml}	-0.52	-0.24	0.02	0.26	0.48

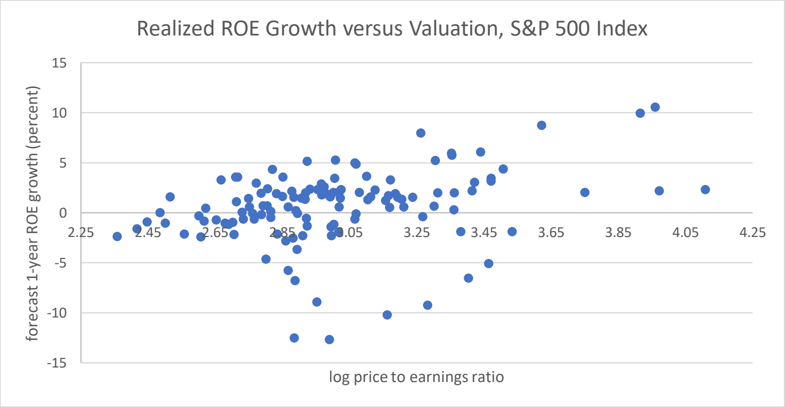
- Portfolios are formed by sorting on earnings-to-price ratios. Data are annual, 1952–2017

Valuation versus forecasted earnings growth



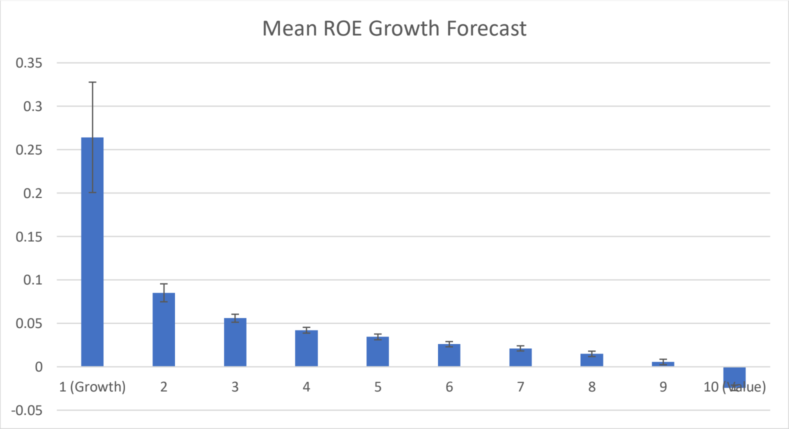
- Correlation $= 0.8$

Valuation versus realized earnings growth

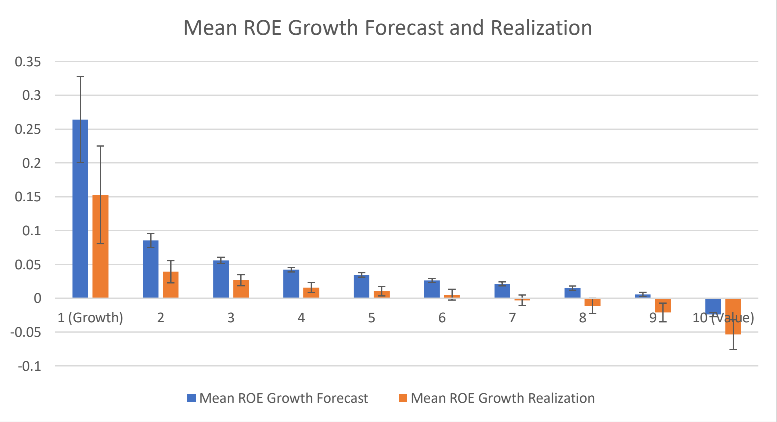


- Correlation $= 0.3$

Valuation versus forecasted earnings growth: Cross-section



Valuation versus forecast error



Conclusions

- Like the pigeons in Skinner's classic (1948) experiment, investors discover meaning in randomness.
- We show that this simple insight has far-reaching consequences for asset pricing.
- When incorrect information is embedded into prices, prices adjust to meet cash flows, rather than the other way around.
- We find evidence for this in IBES analyst forecasts
- We apply this insight to explain:
  - Excess volatility and predictability in aggregate stock returns
  - The value puzzle
  - The failure of the expectations hypothesis of interest rate
  - The failure of uncovered interest rate parity (the forward premium puzzle)