Asset Pricing with Return Extrapolation

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Overview

• there is growing interest in “return extrapolation”
  – the idea that investors’ beliefs about an asset’s future return are a positive function of the asset’s recent past returns

• models with return extrapolation offer two appealing features
  – they are consistent with survey evidence on the beliefs of real-world investors
  – they show promise in matching important asset pricing facts
    ○ momentum and reversals in the cross-section
    ○ volatility and predictability in the aggregate market
    ○ bubbles
Overview, ctd.

- existing models of return extrapolation can only be compared to the data in a *qualitative* way

- early models, such as Cutler, Poterba, and Summers (1990) and De Long, Shleifer, Summers, and Waldmann (1990), highlight the conceptual importance of return extrapolation

  - but they are not designed to match asset pricing facts quantitatively
Overview, ctd.

- Barberis, Greenwood, Jin, and Shleifer (2015) is a dynamic model that tries to make sense of both survey expectations and aggregate stock market prices

  - however, their simplifying assumptions of CARA preferences and a constant interest rate make it difficult to evaluate the model’s fit with the empirical facts

  - the ratio-based quantities at the heart of asset pricing (e.g. the $P/D$ ratio) do not have well-defined distributions
Overview, ctd.

• in this paper, we propose a new model of aggregate stock market prices based on return extrapolation that overcomes this limitation

• a representative-agent Lucas-type equilibrium model with Epstein-Zin preferences

• goal of the paper is to
  – see if the model can match important facts about the aggregate stock market
    - when the agent’s beliefs are calibrated to match survey expectations of investors
  – compare the model in a quantitative way to rational expectations models of the stock market
Overview, ctd.

• we consider a Lucas economy in continuous time

• three tradeable assets
  – a Lucas tree: a claim to an aggregate consumption process which follows a geometric Brownian motion
  – the stock market: a claim to an aggregate dividend process whose growth rate is positively related with consumption growth
  – a riskfree asset: in zero net supply with its interest rate determined in equilibrium

• a representative agent who has Epstein-Zin preferences and extrapolative beliefs
  – she perceives that the expected growth rate of stock market prices is governed by a switching process between two regimes
Overview, ctd.

• we calibrate the agent’s beliefs to match the survey expectations of investors studied in Greenwood and Shleifer (2014)

• the model *quantitatively* matches important facts about stock market prices and returns
  – excess volatility, predictability, equity premium, low interest rate volatility

• the model allows for a direct comparison with rational expectations models
  – the model produces expectations that robustly match survey data
  – the model also generates asset prices that differ from rational expectations models
Overview, ctd.

*Model intuition for excess volatility*

Suppose the stock market has had high past returns

- return extrapolation leads the agent to forecast high future returns

- under Epstein-Zin preferences, the separation between the elasticity of intertemporal substitution and risk aversion gives rise to a strong intertemporal substitution effect

- so, the agent’s forecast of high future returns leads her to push up the current price
Overview, ctd.

*Model intuition for the high equity premium*

Three factors affect the long-run equity premium *perceived* by the agent

- excess volatility interacts with the agent’s risk aversion and causes the perceived equity premium to increase

- return extrapolation gives rise to *perceived* persistence of the aggregate dividend process, which, under Epstein-Zin preferences, is significantly priced

- the separation between the elasticity of intertemporal substitution and the relative risk aversion helps to keep the equilibrium interest rate low
Overview, ctd.

*Model intuition for the high equity premium*

The true long-run equity premium is significantly *higher* than the perceived long-run equity premium

- the agent’s beliefs mean-revert faster than what she perceives
- given this, she underestimates short-term stock market fluctuations and hence the risk associated with the stock market
- that is, an infinitesimal rational agent who enters our economy would have demanded a higher equity premium
Overview, ctd.

- the model also points to some challenges
  - when calibrated to the survey expectations data, the model predicts a persistence of the price-dividend ratio that is lower than its empirical value
  - to match the empirical persistence of the price-dividend ratio, investors need to form beliefs about future returns based on many years of past returns
  - however, the available surveys suggest that they focus on just the past year or two

- after presenting the model, we compare it to the standard rational expectations models
  - we focus on the long-run risks models and document some different implications

- we also compare our model to a model with *fundamental* extrapolation
Related literature

• theories that study the role of belief formation in driving the behavior of asset prices and macroeconomy
  – fundamental extrapolation: Fuster, Hubert, and Laibson (2011); Choi and Mertens (2013); Alti and Tetlock (2014); Hirshleifer, Li, and Yu (2015)
  – return extrapolation: Barberis et al. (2015)
  – default extrapolation: Greenwood, Hanson, and Jin (2016)
  – learning about fundamentals and model uncertainty: Collin-Dufresne, Johannes, and Lochastoer (2016a, b); Bidder and Dew-Becker (2016)

• source of stock price movements
  – Cochrane (2008, 2011); Chen, Da, and Zhao (2013); De La O and Myers (2017)
Roadmap

• model setup

• model parameterization

• model implications

• comparison with rational expectations models

• conclusion
The model: Setup

**Assets**

- a Lucas tree with the aggregate consumption process
  \[ \frac{dC_t}{C_t} = g_C dt + \sigma_C d\omega_t^C \]

- the aggregate dividend process for the stock market
  \[ \frac{dD_t}{D_t} = g_D dt + \sigma_D d\omega_t^D \]
  
  with \( \mathbb{E}_t[d\omega_t^C \cdot d\omega_t^D] = \rho dt \)

- an instantaneous riskless asset in zero net supply with an equilibrium shadow interest rate \( r_t \)
Setup, ctd.

Agent: Preferences

- the representative agent has recursive intertemporal utility

\[ U_t = \left[ (1 - e^{-\delta dt})C_t^{1-\psi} dt + e^{-\delta dt} \left( \mathbb{E}^e_t[\tilde{U}_{t+dt}^{1-\gamma}] \right)^{(1-\psi)/(1-\gamma)} \right]^{1/(1-\psi)} , \]

where \( \delta \) is the time discount rate, \( \gamma \) is the coefficient of relative risk aversion, and \( \psi \) is the reciprocal of \( EIS \)

- the subjective Euler equation is

\[
\mathbb{E}^e_t \left[ e^{-\delta(1-\gamma)dt/(1-\psi)} \left( \frac{\tilde{C}_{t+dt}}{C_t} \right)^{-\psi(1-\gamma)/(1-\psi)} \tilde{M}^{(\psi-\gamma)/(1-\psi)}_{t+dt} \tilde{R}_{j,t+dt} \right] = 1, 
\]

where

\[
\tilde{M}_{t+dt} = \frac{\tilde{P}_{t+dt}^C + C_t dt}{P_t^C} 
\]
Agent: Beliefs about future price growth

- investors believe that the expected growth rate of the stock market price is $(1 - \theta)g_D + \theta\tilde{\mu}_{S,t}$, where $\tilde{\mu}_{S,t}$ is a latent variable governed by

\[
\begin{align*}
\tilde{\mu}_{S,t} &= \mu_H \\
\tilde{\mu}_{S,t} &= \mu_L
\end{align*}
\]

\[
\begin{pmatrix}
\tilde{\mu}_{S,t} \\
\tilde{\mu}_{S,t}
\end{pmatrix} + dt = 
\begin{pmatrix}
\mu_H & 1 - \chi dt \\
\mu_L & \chi dt
\end{pmatrix}
\begin{pmatrix}
1 - \chi dt \\
\lambda dt
\end{pmatrix} dt
\]

- the regime-switching learning model implies that investors perceive

\[
dP_t^D / P_t^D = \mu_P^{D,e}(S_t)dt + \sigma_P^D(S_t)d\omega_t^e,
\]

where $S_t \equiv \mathbb{E}^e[\tilde{\mu}_{S,t}|\mathcal{F}_t^P]$ and

\[
\mu_P^{D,e}(S_t) = (1 - \theta)g_D + \theta S_t
\]
Setup, ctd.

**Agent: Beliefs about future price growth**

- optimal filtering theory implies

\[ dS_t = [\lambda \mu_H + \chi \mu_L - (\lambda + \chi)S_t]dt + (\sigma_{P,t}^D)^{-1}\theta(\mu_H - S_t)(S_t - \mu_L)d\omega_t^e \]

where

\[ d\omega_t^e \equiv [dP_t^D/P_t^D - (1 - \theta)g_d dt - \theta S_t dt]/\sigma_{P,t}^D \]

The evolution of \( S_t \) captures return extrapolation

- high past realizations of returns \( dP_t^D/P_t^D \) push up perceived shocks \( d\omega_t^e \)
- this leads investors to raise their expectation \( S_t \)

**Note:** optimal filtering does not imply rational expectations
Agent: Beliefs about future dividend growth

- the perceived dividend process is

\[ \frac{dD_t}{D_t} = g_D^e(S_t)dt + \sigma_D d\omega_t^e, \]

where

\[ g_D^e(S_t) = \underbrace{(1 - \theta)g_D + \theta S_t}_{\text{expectation of price growth}} - \underbrace{(f'/f)\mu^e_S(S_t)}_{\text{expectation of sentiment evolution}} \]

\[ + \sigma_D^2 - \sigma_P^D(S_t)\sigma_D - \frac{1}{2}(f''/f)(\sigma_S(S_t))^2 \]

Ito correction terms

- when the agent expects high price growth, she also expects high dividend growth
  - at a pace that exceeds her expectations about future price growth
Setup, ctd.

Agent: Beliefs about future dividend growth

Why?

• iterating forward the subjective Euler equation gives

\[
\frac{P_t^D}{D_t} = \mathbb{E}_t \left[ \int_t^\infty e^{-\delta(1-\gamma)(s-t)/(1-\psi)} \left( \frac{\tilde{C}_s}{C_t} \right)^{-\psi(1-\gamma)/(1-\psi)} \tilde{M}_{t\rightarrow s}^{(\psi-\gamma)/(1-\psi)} \left( \frac{\tilde{D}_s}{D_t} \right) ds \right]
\]

• the agent’s beliefs about future dividend growth are linked to her beliefs about future price growth

• the agent perceives the price-dividend ratio to be mean-reverting
Agent: Beliefs about consumption growth

- the *perceived* consumption process is

\[
dC_t/C_t = g^e_C(S_t)dt + \sigma_C \left( \rho \cdot d\omega^e_t + \sqrt{1 - \rho^2} \cdot d\omega^\perp_t \right),
\]

where

\[
g^e_C(S_t) - g = \rho \sigma_C \sigma_D^{-1} (g^e_D(S_t) - g_D)
\]

- the bias in the agent’s beliefs about consumption growth derives only from the bias in her beliefs about dividend growth
  - and it is small

- this is consistent with the lack of empirical evidence that investors have extrapolative beliefs about consumption growth
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asset parameters:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected consumption growth</td>
<td>$g_C$</td>
<td>1.91%</td>
</tr>
<tr>
<td>Standard deviation of consumption growth</td>
<td>$\sigma_C$</td>
<td>3.80%</td>
</tr>
<tr>
<td>Expected dividend growth</td>
<td>$g_D$</td>
<td>2.45%</td>
</tr>
<tr>
<td>Standard deviation of dividend growth</td>
<td>$\sigma_D$</td>
<td>11%</td>
</tr>
<tr>
<td>Correlation between $dD$ and $dC$</td>
<td>$\rho$</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Utility parameters:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative risk aversion</td>
<td>$\gamma$</td>
<td>10</td>
</tr>
<tr>
<td>Reciprocal of EIS</td>
<td>$\psi$</td>
<td>0.9</td>
</tr>
<tr>
<td>Subjective discount rate</td>
<td>$\delta$</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Belief parameters:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper bound of sentiment $H$</td>
<td>$\mu_H$</td>
<td>0.15</td>
</tr>
<tr>
<td>Lower bound of sentiment $L$</td>
<td>$\mu_L$</td>
<td>−0.15</td>
</tr>
<tr>
<td>Degree of extrapolation</td>
<td>$\theta$</td>
<td>0.5</td>
</tr>
<tr>
<td>Perceived transition intensity from $H$ to $L$</td>
<td>$\chi$</td>
<td>0.18</td>
</tr>
<tr>
<td>Perceived transition intensity from $L$ to $H$</td>
<td>$\lambda$</td>
<td>0.18</td>
</tr>
</tbody>
</table>
Parameterization, ctd.

- we set $\theta$, $\chi$, and $\lambda$ such that

  - for a regression of the agent’s expectations about future returns on past twelve-month returns, the model produces a regression coefficient and a $t$-statistic that match the empirical estimates

  - the agent’s beliefs match the survey evidence on the relative weight investors put on recent versus distant past returns when forming beliefs about future returns
### Parameterization, ctd.

**Investor expectations**

<table>
<thead>
<tr>
<th></th>
<th>( \mathbb{E}_t^c [dP_t^D / P_t^D dt] )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R_{t-12 \rightarrow t}^D )</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(8.4)</td>
</tr>
<tr>
<td>( \ell \ln(P/D) )</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>(36.8)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(12.1)</td>
</tr>
<tr>
<td>Sample size</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(48.9)</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>15 yr.</td>
</tr>
<tr>
<td></td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>50 yr.</td>
</tr>
<tr>
<td></td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>50 yr.</td>
</tr>
</tbody>
</table>

- empirical value:
  - for a 5-year long sample of data from the Michigan survey, the regression coefficient is 3.9% with a \( t \)-statistic of 1.68
  - for a 15-year long sample of data from the Gallup survey, the regression coefficient is 8% with a \( t \)-statistic of 8.81
Parameterization, ctd.

Determinants of investor expectations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi$</td>
<td>0.43</td>
<td>0.42</td>
</tr>
<tr>
<td>$a$</td>
<td>0.004</td>
<td>0.004</td>
</tr>
<tr>
<td>$b$</td>
<td>2.04</td>
<td>2.07</td>
</tr>
<tr>
<td>Sample size</td>
<td>15 yr.</td>
<td>50 yr.</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.99</td>
<td>0.98</td>
</tr>
</tbody>
</table>

$$\text{Expectation}_t = a + b \sum_{j=1}^{n} w_j R^D_{(t-j\Delta t) \rightarrow (t-(j-1)\Delta t)} + \varepsilon_t$$

where $w_j \equiv e^{-\phi(j-1)\Delta t} / \sum_{l=1}^{n} e^{-\phi(l-1)\Delta t}$

- empirical value:

  - Barberis et al. (2015) run the same regression using survey data studied in Greenwood and Shleifer (2014) and obtain an empirical estimate of 0.44 for $\phi$
Parameterization, ctd.

Remark:

- the literature has not reached consensus on the value of $\phi$
  - Greenwood and Shleifer (2014) and Kuchler and Zafar (2016) find that investor expectations depend only on recent returns
  - Malmendier and Nagel (2011, 2013) suggest that distant past events may also play an important role when investors form beliefs

- two possible explanations:
  - investors may simultaneously adopt two mechanisms when forming beliefs: one that focuses on recent past events, the other that focuses on infrequent but salient events
  - the horizon over which investors form expectations may affect how far they look back into the past
Model implications

• basic moments

• return predictability

• correlation between stock market returns and consumption growth

• cash flow expectations

• autocorrelations of returns and price-dividend ratios
Model implications, ctd.

*Basic moments*

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Theoretical value</th>
<th>Empirical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity premium</td>
<td>4.88%</td>
<td>3.90%</td>
</tr>
<tr>
<td>Return volatility</td>
<td>27.4%</td>
<td>18.0%</td>
</tr>
<tr>
<td>Sharpe ratio</td>
<td>0.20</td>
<td>0.22</td>
</tr>
<tr>
<td>Interest rate</td>
<td>2.16%</td>
<td>2.92%</td>
</tr>
<tr>
<td>Interest rate volatility</td>
<td>0.33%</td>
<td>2.89%</td>
</tr>
<tr>
<td>Price-dividend ratio</td>
<td>19.4</td>
<td>21.1</td>
</tr>
</tbody>
</table>
Model implications, ctd.

Basic moments: excess volatility

- the interaction between beliefs and preferences is quantitatively important:
  - without return extrapolation, Epstein-Zin preferences alone with i.i.d. dividend growth and consumption growth do not lead to any excess volatility
  - without Epstein-Zin preferences, return extrapolation alone leads to average return volatility of 13.8%

Basic moments: the equity premium

- the true equity premium is higher than the perceived one
  - when measured in log excess returns, the true equity premium is 4.9%; the perceived one is 1.6%
  - when measured in excess returns, the true equity premium is 8.6%; the perceived one is 5.1%
Model implications, ctd.

*Return predictability*

<table>
<thead>
<tr>
<th>Horizon (years)</th>
<th>10× coefficient</th>
<th>Adjusted $R^2$-squared</th>
<th>Empirical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-7.2</td>
<td>0.13</td>
<td>-1.3</td>
</tr>
<tr>
<td>2</td>
<td>-9.5</td>
<td>0.16</td>
<td>-2.8</td>
</tr>
<tr>
<td>3</td>
<td>-10.1</td>
<td>0.15</td>
<td>-3.5</td>
</tr>
<tr>
<td>5</td>
<td>-10.6</td>
<td>0.13</td>
<td>-6.0</td>
</tr>
<tr>
<td>7</td>
<td>-11.0</td>
<td>0.12</td>
<td>-7.5</td>
</tr>
</tbody>
</table>

\[
r_{t \to t+j}^{D,e} = \alpha_j + \beta_j \ln(P_t / D_t) + \varepsilon_{j,t+j}
\]

- regressions are based on simulated data from the model with a total length of 10,000 years and with a monthly frequency
Model implications, ctd.

*Model intuition for return predictability*

- if past returns have been high, return extrapolation causes the current price to increase
  - the same mechanism that generates excess volatility also gives rise to return predictability

- a strong degree of mean reversion in the agent’s expectations about stock returns is also an important factor
  - by assumption, the agent believes that her expectations about stock market returns will mean-revert
  - more important, the agent’s beliefs are *incorrect*: her return expectations mean-revert faster than what she perceives
Model implications, ctd.

Correlation between stock market returns and consumption growth

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Model (monthly)</th>
<th>Model (quarterly)</th>
<th>Model (annual)</th>
<th>Empirical value (annual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Corr}<em>\xi(r</em>{t\to t+1}^{D,e}, \ln(C_{t-1}/C_{t-2}))$</td>
<td>-0.01</td>
<td>-0.02</td>
<td>-0.02</td>
<td>-0.05</td>
</tr>
<tr>
<td>$\text{Corr}<em>\xi(r</em>{t\to t+1}^{D,e}, \ln(C_t/C_{t-1}))$</td>
<td>-0.01</td>
<td>-0.03</td>
<td>-0.06</td>
<td>-0.08</td>
</tr>
<tr>
<td>$\text{Corr}<em>\xi(r</em>{t\to t+1}^{D,e}, \ln(C_{t+1}/C_t))$</td>
<td>0.20</td>
<td>0.20</td>
<td>0.19</td>
<td>0.09</td>
</tr>
<tr>
<td>$\text{Corr}<em>\xi(r</em>{t\to t+1}^{D,e}, \ln(C_{t+2}/C_{t+1}))$</td>
<td>0.00</td>
<td>-0.00</td>
<td>0.01</td>
<td>0.49</td>
</tr>
<tr>
<td>$\text{Corr}<em>\xi(r</em>{t\to t+1}^{D,e}, \ln(C_{t+3}/C_{t+2}))$</td>
<td>-0.00</td>
<td>-0.00</td>
<td>0.01</td>
<td>0.05</td>
</tr>
</tbody>
</table>

- correlations in Campbell and Cochrane (1999) are 0.79 and 0.40 at a monthly and annual frequency, respectively

- the observed correlation between consumption growth and dividend growth is low, and the bias in the agent’s beliefs about consumption growth is small

  - so the agent’s beliefs about stock returns are not significantly affected by fluctuations in consumption growth


Model implications, ctd.

Cash flow expectations

- the agent’s expectation about price growth is less responsive to changes in sentiment than her expectation about dividend growth
Model implications, ctd.

Cash flow expectations

- the Campbell-Shiller decomposition of the log price-dividend ratio is

\[
\ell\ln\left(\frac{P_t^D}{D_t}\right) \approx \sum_{j=0}^{\infty} \xi^j \left(\Delta d_{(t+j\Delta t)} \to (t+(j+1)\Delta t) - \Delta r^D_{(t+j\Delta t)} \to (t+(j+1)\Delta t)\right) + \text{constant}
\]

- two approaches to empirically compute the relative importance of the “cash flow news” and “discount rate news” components

\[
1 \approx \frac{\text{Cov} \left(\sum_{j=0}^{\infty} \xi^j \Delta d_{(t+j\Delta t)} \to (t+(j+1)\Delta t), \ell\ln\left(\frac{P_t^D}{D_t}\right)\right)}{\text{Var} \left(\ell\ln\left(\frac{P_t^D}{D_t}\right)\right)} \quad \text{CF}_{\text{objective}}
\]

\[
+ \frac{\text{Cov} \left(-\sum_{j=0}^{\infty} \xi^j r^D_{(t+j\Delta t)} \to (t+(j+1)\Delta t), \ell\ln\left(\frac{P_t^D}{D_t}\right)\right)}{\text{Var} \left(\ell\ln\left(\frac{P_t^D}{D_t}\right)\right)} \quad \text{DR}_{\text{objective}}
\]
Model implications, ctd.

Cash flow expectations

$$1 \approx \frac{\text{Cov} \left( \mathbb{E}_t^e \left[ \sum_{j=0}^{\infty} \xi^j \Delta d_{(t+j\Delta t)\rightarrow(t+(j+1)\Delta t)} \right], \ln(P_t^D / D_t) \right)}{\text{Var} \left( \ln(P_t^D / D_t) \right)} + \frac{\text{Cov} \left( -\mathbb{E}_t^e \left[ \sum_{j=0}^{\infty} \xi^j r^D_{(t+j\Delta t)\rightarrow(t+(j+1)\Delta t)} \right], \ln(P_t^D / D_t) \right)}{\text{Var} \left( \ln(P_t^D / D_t) \right)}$$

- using realized dividend growth and returns or the subjective expectations of these quantities, Campbell-Shiller decomposition delivers very different results

$$-DR_{objective} = 0.98, CF_{objective} = 0.02, DR_{subjective} = -0.08, \text{ and } CF_{subjective} = 1.08$$
### Autocorrelations of price-dividend ratios and returns

<table>
<thead>
<tr>
<th>Lag (years)</th>
<th>Model</th>
<th></th>
<th>Empirical value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \ln(P/D) )</td>
<td>( r^{D,e} )</td>
<td>( \ln(P/D) )</td>
<td>( r^{D,e} )</td>
</tr>
<tr>
<td>1</td>
<td>0.33</td>
<td>-0.28</td>
<td>0.78</td>
<td>0.05</td>
</tr>
<tr>
<td>2</td>
<td>0.11</td>
<td>-0.09</td>
<td>0.57</td>
<td>-0.21</td>
</tr>
<tr>
<td>3</td>
<td>0.05</td>
<td>-0.02</td>
<td>0.50</td>
<td>-0.08</td>
</tr>
<tr>
<td>5</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.32</td>
<td>-0.14</td>
</tr>
<tr>
<td>7</td>
<td>-0.02</td>
<td>-0.01</td>
<td>0.29</td>
<td>0.11</td>
</tr>
</tbody>
</table>

- when calibrated to available survey expectations, the model predicts a persistence for \( P/D \) that is lower than its empirical value
Model comparison

- we compare our model to models with rational expectations
  - our model does a better job in matching survey expectations data
  - these models generate different implications for asset prices

Comparison with long-run risks models

- our model produces an equity premium that does not vary significantly with \( EIS \)
  - this differs from the long-run risks models

Reasons:

- sentiment is our model is less persistent than the stochastic growth component in the long-run risks models
- the perceived dividend growth in our model depends more strongly on the agent’s beliefs about price growth
  - dividend growth in Bansal and Yaron (2004) depends less on the stochastic growth component
- the true equity premium in our model is above the perceived one
Conclusion and future research

Conclusion

• we build a new return extrapolation model that allows for a quantitative comparison with the data on asset prices

• with the agent’s beliefs calibrated to fit the survey expectations, the model matches important facts about the aggregate stock market

• we compare our model with rational expectations models and document their different implications

Future research

• better understand the formation of investor expectations

• interaction between behavioral agents and rational agents