Natural Expectations, Macroeconomic Dynamics, and Asset Pricing

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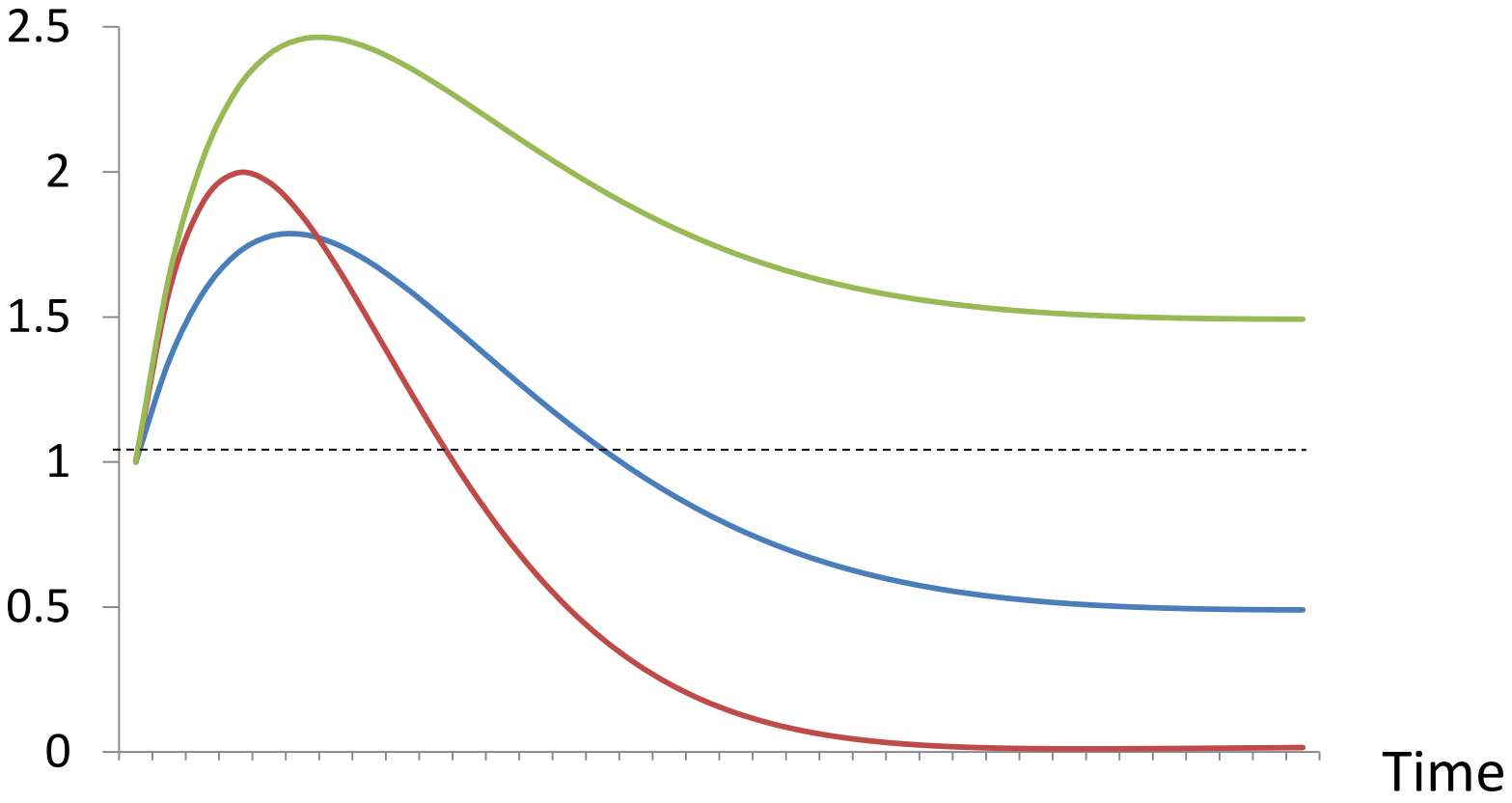
Two starting assumptions

(cf. Fuster, Mendel, and Laibson 2010)

1. Assume that fundamentals are hump-shaped.
   - Momentum in the short-run.
   - Partial mean reversion in the long run.



Second assumption

2. Agents do not know that fundamentals are hump-shaped and base their beliefs on parsimonious high-frequency models that they fit to the data.

Assume that this preference for parsimonious high-frequency models is at least partially a psychological bias.

Economic reasons for parsimonious models

- Tradeoff between model flexibility (more parameters) and overfitting
- To avoid overfitting limit number of parameters, k
- Formalizations:
  - Akaike Information Criterion (AIC)
  - Bayesian (Schwarz) Information Criterion (BIC)

Psychological reasons for parsimonious models:

- Myopia: short-term predictions → low k
- Recency bias: small samples → low k
- Complexity aversion → low k
- Preference for tractibility → low k
- Anchoring and Representativeness, also lead agents to underestimate mean reversion, which is similar to low k

Consequences of parsimonious models:

1. Agents recognize the short-term momentum but miss some of the long-run mean reversion
   - Endogenous extrapolation bias and pro-cyclical excess optimism
2. Asset returns are excessively volatile and exhibit overreaction
   - Returns negatively predicted by lagged returns, P/E, and $\Delta \ln C$
3. Real economic activity has amplified cycles
   - $\Delta \ln C$ negatively auto-correlated in medium run
4. Equity premium is large, although long-run equity returns covary weakly with long-run consumption growth
   - If agents had RE, equity premium nearly vanishes
5. Agents with rational expectations hold large equity shares
   - Follow counter-cyclical asset allocation policy

Related Literature

Adam and Marcet (2011): learning and asset pricing

Barberis, Shleifer, and Vishny (1998): extrapolative dividend forecasts

Barsky and De Long (1993): extrapolation and excess volatility

Benartzi (2001): extrapolation and company stock

Black (1986): noise traders

Campbell and Mankiw (1987): shocks are persistent in low-order ARIMA

Campbell and Shiller (1988a,b): P/E ratio and return predictability

Choi (2006): extrapolation and asset pricing

Choi, Laibson, and Madrian (2009): positive feedback in investment

Cutler, Poterba, and Summers (1991): return autocorrelations

De Long, et al (1990): noise traders and positive feedback

De Bondt (1993): extrapolation bias in surveys and experiments

De Bondt and Thaler (1985, 1989, 1993): over-shooting in asset prices

Gabaix (2010): sparse representations

Hommes (2005, 2008): bubbles in the lab

Hong and Stein (1999): forecasting biases

Some Related Literature

Kahneman and Tversky (1973): representativeness

Keynes (1936): animal spirits

Lansing (2010): extrapolation and asset pricing in a macro model

LaPorta (1996): Growth expectations have insufficient mean reversion

LeBaron, Arthur, and Palmer (1999): agent-based modeling

LeBaron and Tesfatsion (2008): agent-based modeling

Leroy and Porter (1981): excess volatility in stock prices

Lettau and Ludvigson (1991): W/C correlates negatively with future returns

Lo and MacKinlay (1988): variance ratio tests

Loewenstein, O'Donoghue, and Rabin (2003): projection bias

Malmendier and Nagel (2011): Recency bias and role of personal experience

Parker (2001): Cov of returns and $\Delta \ln C$ rises from short- to medium-run

Piazessi and Schneider (2009): extrapolative beliefs in the housing market

Previtero (2010): extrapolative beliefs and annuity investment

Shiller (1981): excess volatility in stock prices

Summers (1986): power problems in financial econometrics

Tortorice (2010): extrapolative beliefs in unemployment forecasts

Model

- Equity tree: earnings growth is an AR(40)
- CARA habit preferences (Alessie and Lusardi)

$$\sum_{t=0}^{\infty} \delta^t \left\{ -\frac{1}{\alpha} \exp\left(-\alpha \left[c_t - \gamma c_{t-1} \right] \right) \right\}$$

α controls curvature of the utility function

γ represents strength of habit

- Dynamic budget constraint for wealth, w_t

$$w_t = \left(w_{t-1} - c_{t-1} - \theta_{t-1} P_{t-1} \right) R + \theta_{t-1} (d_t + P_t)$$

θ_t represents claims on the Lucas tree at date t

d_t represents Lucas tree dividend at date t

P_t represents price of Lucas tree at date t

- Elastic supply of foreign capital with gross return R
- Assume foreign agents don't hold domestic capital
  - Home bias
  - Moral hazard

Natural expectations

$\Delta d_t = AR(40)$ Data generating process

$\Delta d_t = AR(p) \quad p \leq 40$ Natural expectations

We will study cases $1 \leq p \leq 40$.

Model matches the data for $p \leq 20$.

Consumption is a weighted average of $c_{t\text{-}1}$ and Y_t

$$c_t = \frac{\gamma}{R} c_{t-1} + \left(1 - \frac{\gamma}{R}\right) Y_t - Q$$

Permanent income

$$Y_t = \frac{R-1}{R}\left[-RB_t + \sum_{s=0}^{\infty} \frac{E_t d_{t+s}}{R^s}\right]$$

Shift term

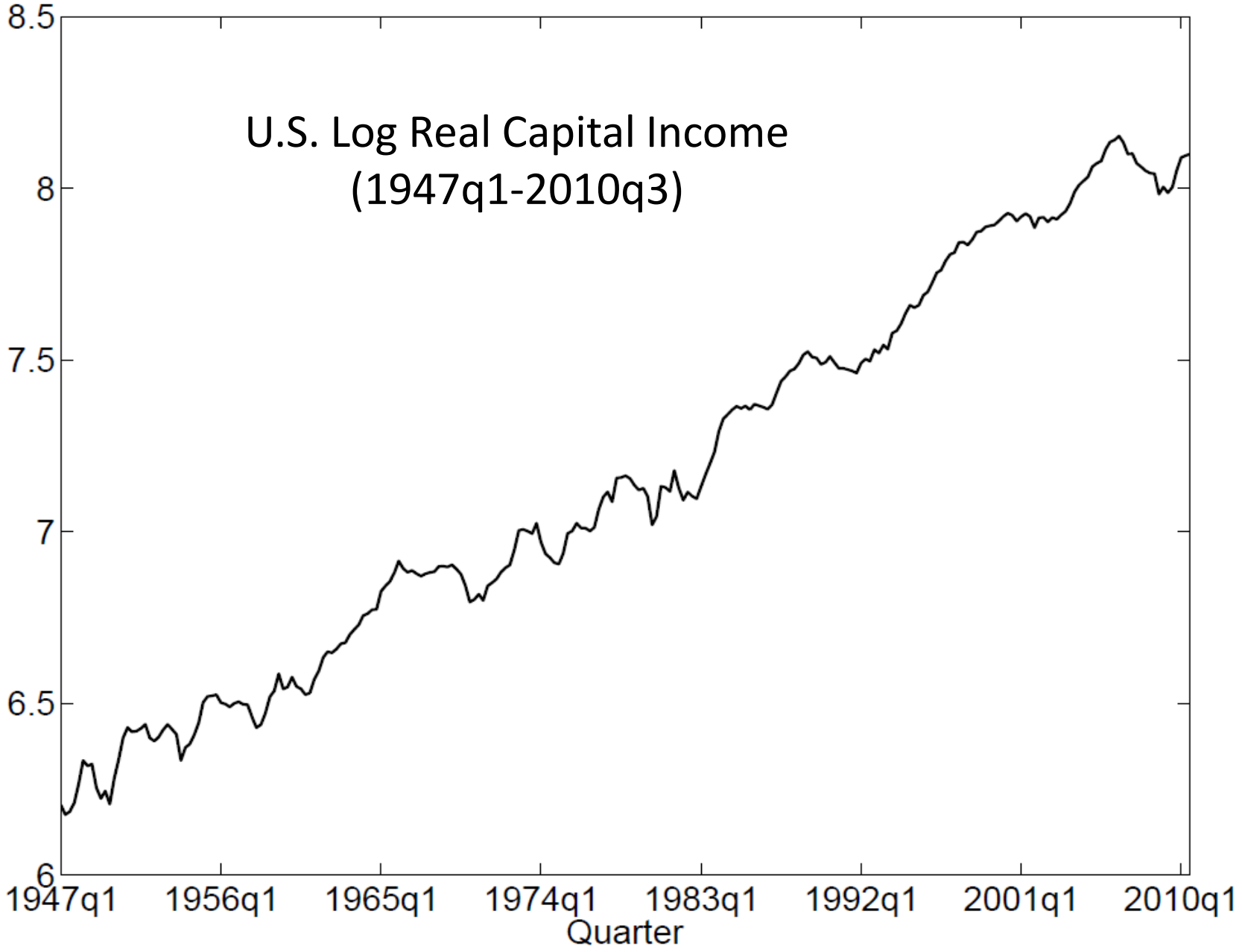
$$Q = \frac{1}{R-1}\left[\frac{1}{\alpha}\ln\left(R\delta\right) + \frac{\alpha}{2} Var_t\left(c_{t+1}\right)\right]$$

Value function:

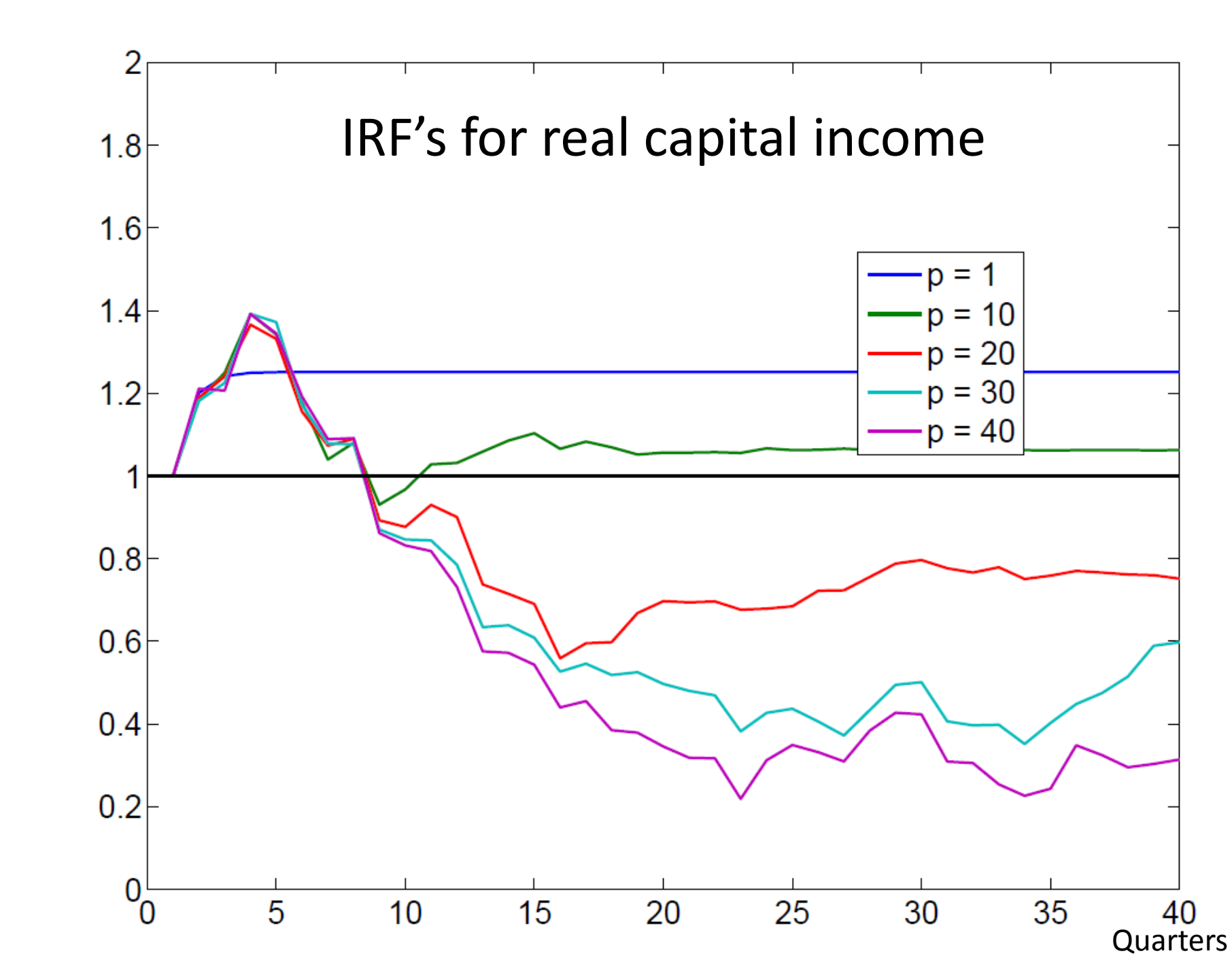
$$V(c_{t-1}, B_t, d_t, d_{t-1}, \ldots) = \frac{-1}{\alpha(1-\delta)} \exp\left(-\alpha\left[c_t - \gamma c_{t-1}\right]\right)$$

Price of the equity tree:

$$P_t = \sum_{s=1}^{\infty} \frac{E_t d_{t+s}}{R^s} - \frac{\alpha \times Var_t\left(c_{t+1}\right)}{\left(1-\frac{\gamma}{R}\right)(R-1)^2}$$

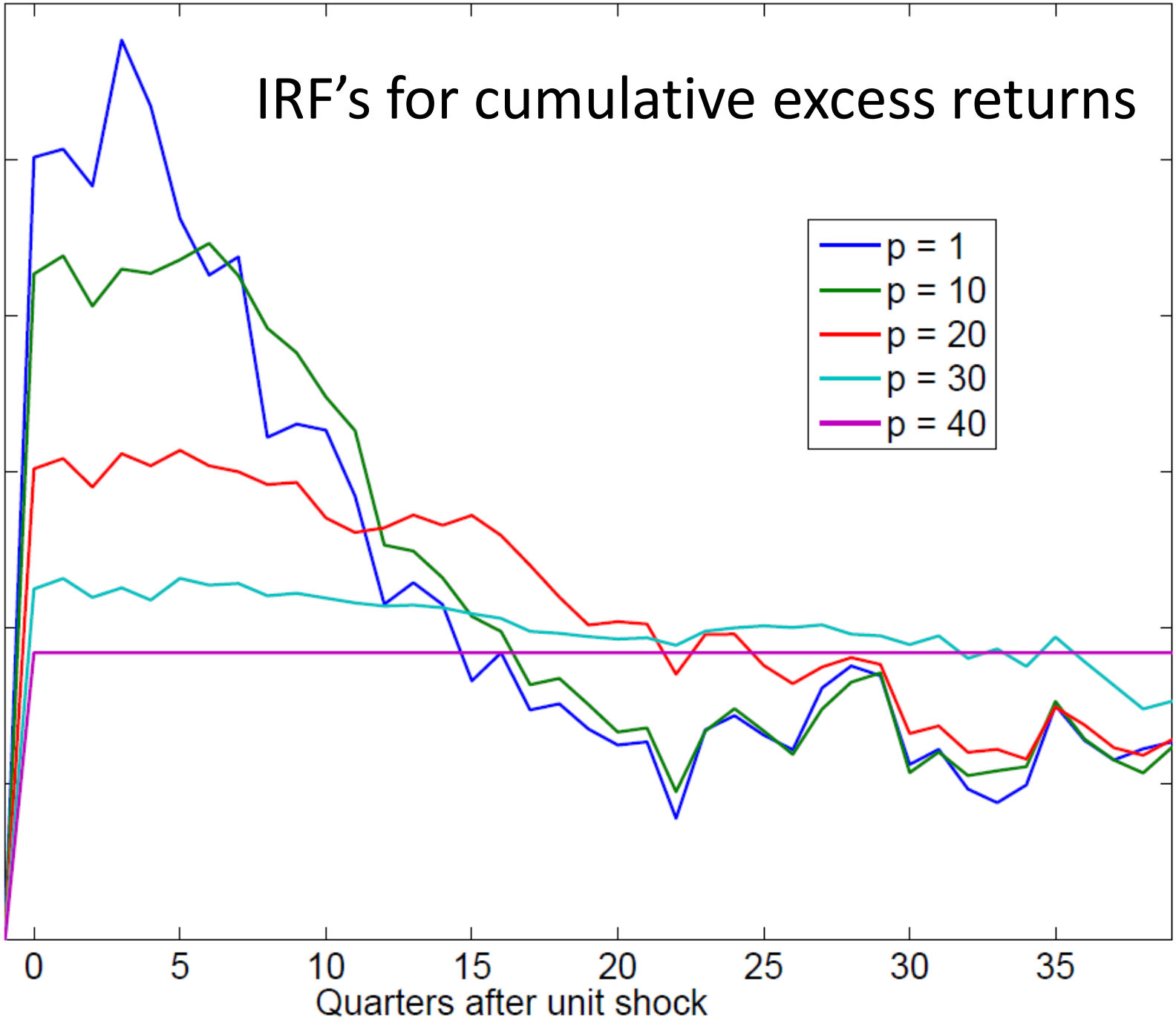


U.S. NIPA (BEA): net operating surplus of private enterprises.

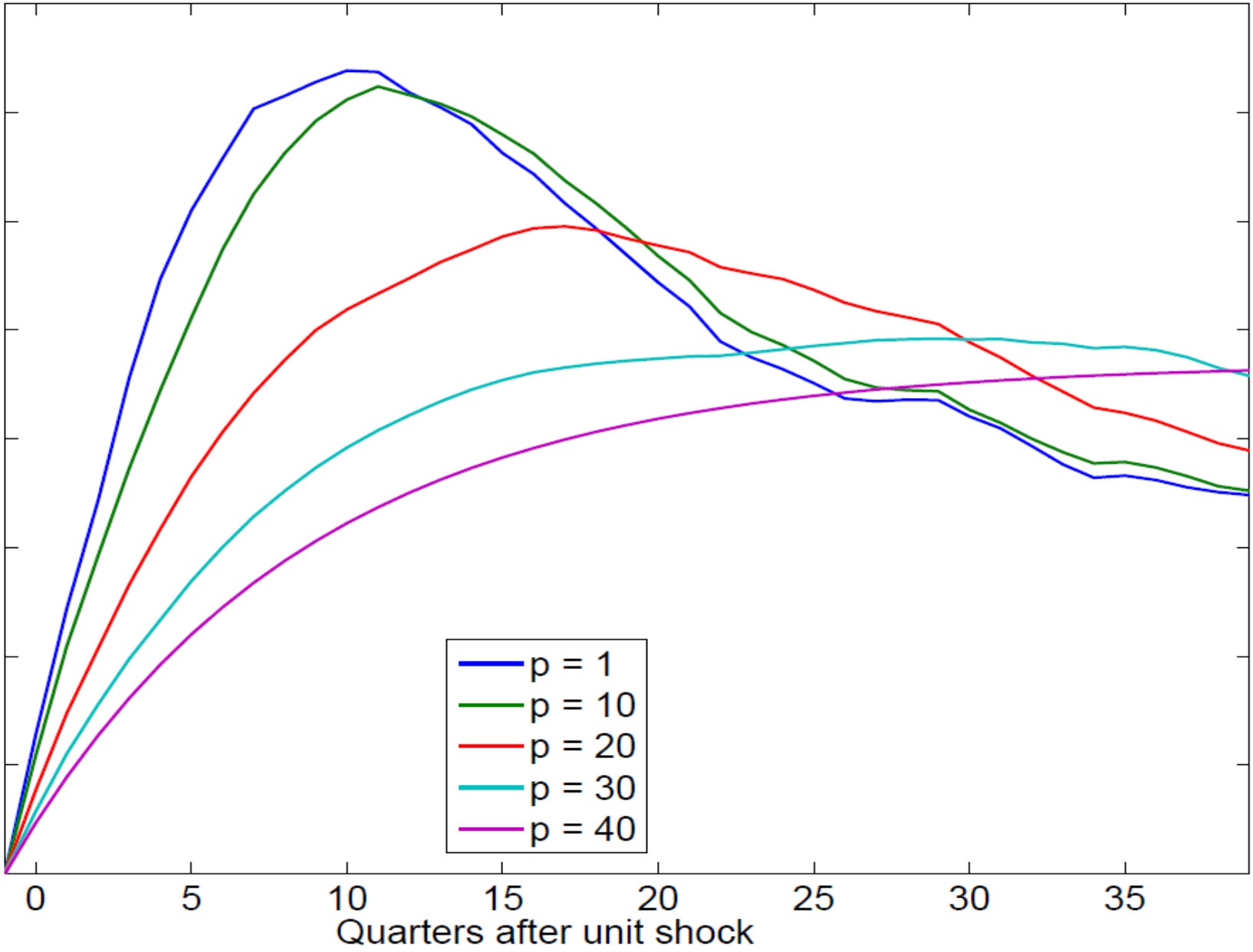

IRF’s for real capital income
p = 1
p = 10
p = 20
p = 30
p = 40
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
35
40
Quarters

Calibration

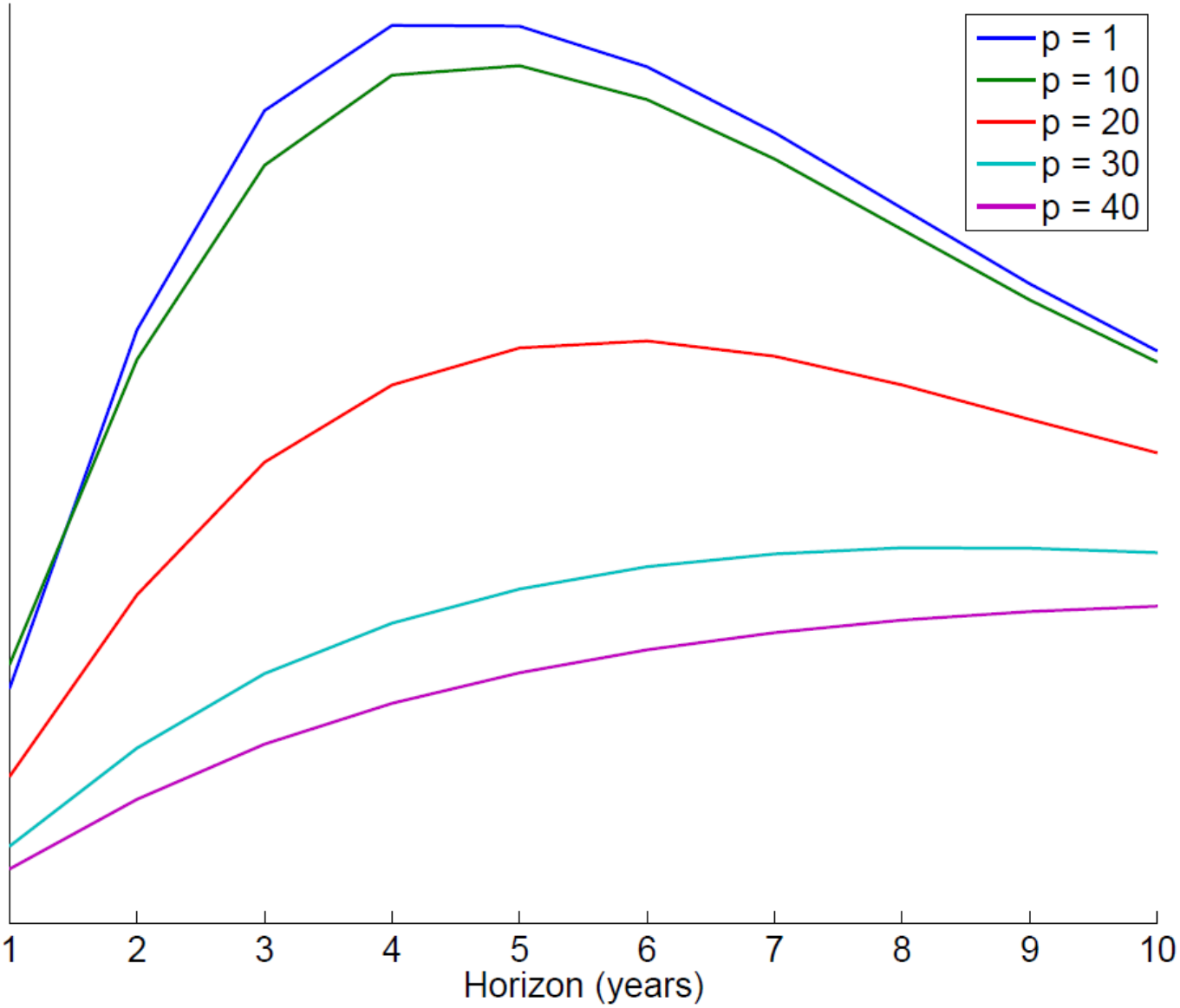
True DGP	$\Delta \ln d$ ~ AR(40) estimated from NIPA
Perceived DGP	$\Delta \ln d$ ~ AR(p) estimated from NIPA
$R = 1.0025$	gross risk-free rate (quarterly)
$\delta R = 1$	discount factor
$\gamma = 0.9$	habit weight
$\alpha = \frac{4}{c\left(1 - \frac{\gamma}{R}\right)}$	local relative risk aversion of 4


IRF’s for cumulative excess returns
p = 1
p = 10
p = 20
p = 30
p = 40
0
5
10
15
20
25
30
35
Quarters after unit shock

IRF's for consumption



Covariance of consumption growth and cumulative return at different horizons

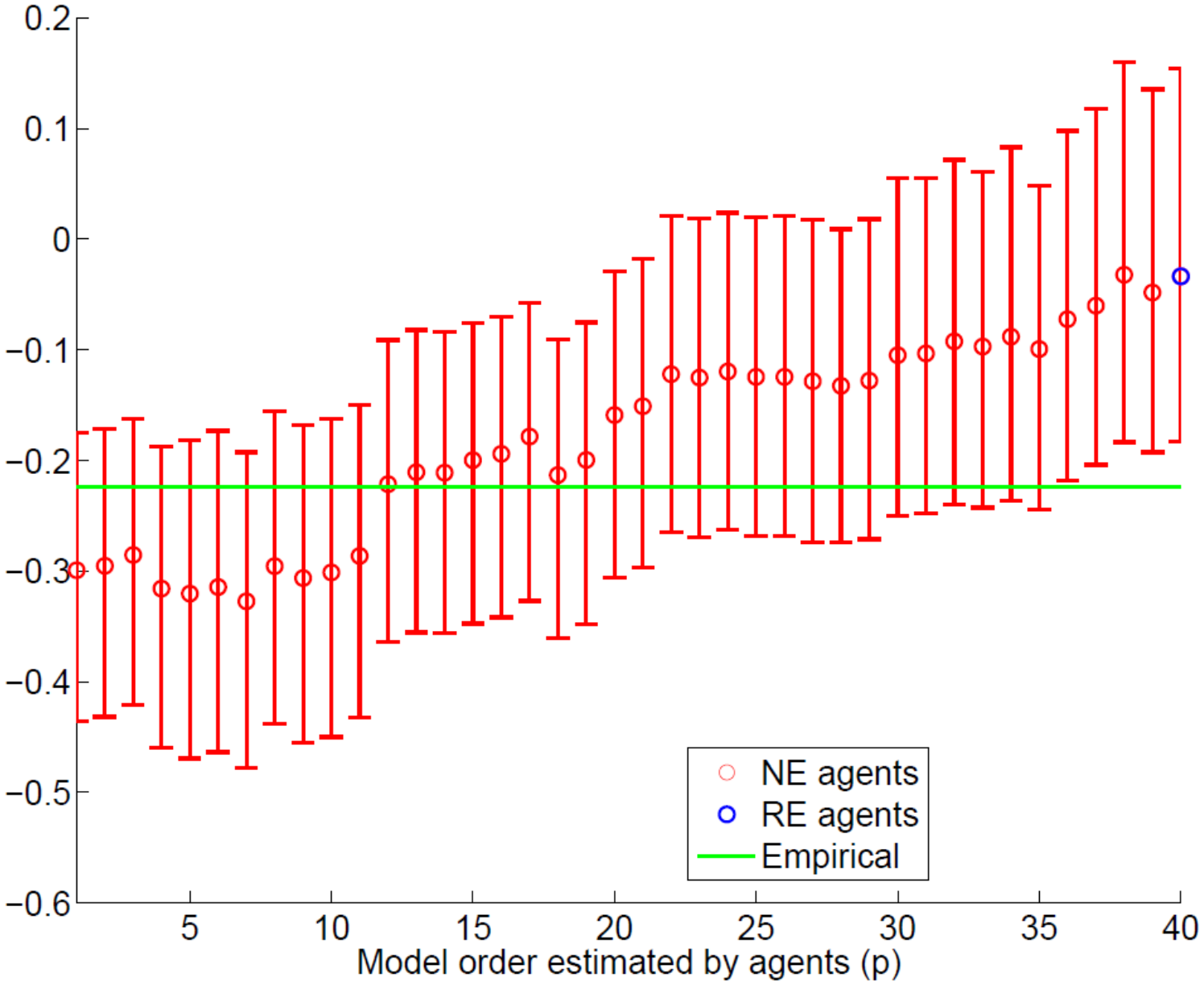


Empirical evaluation

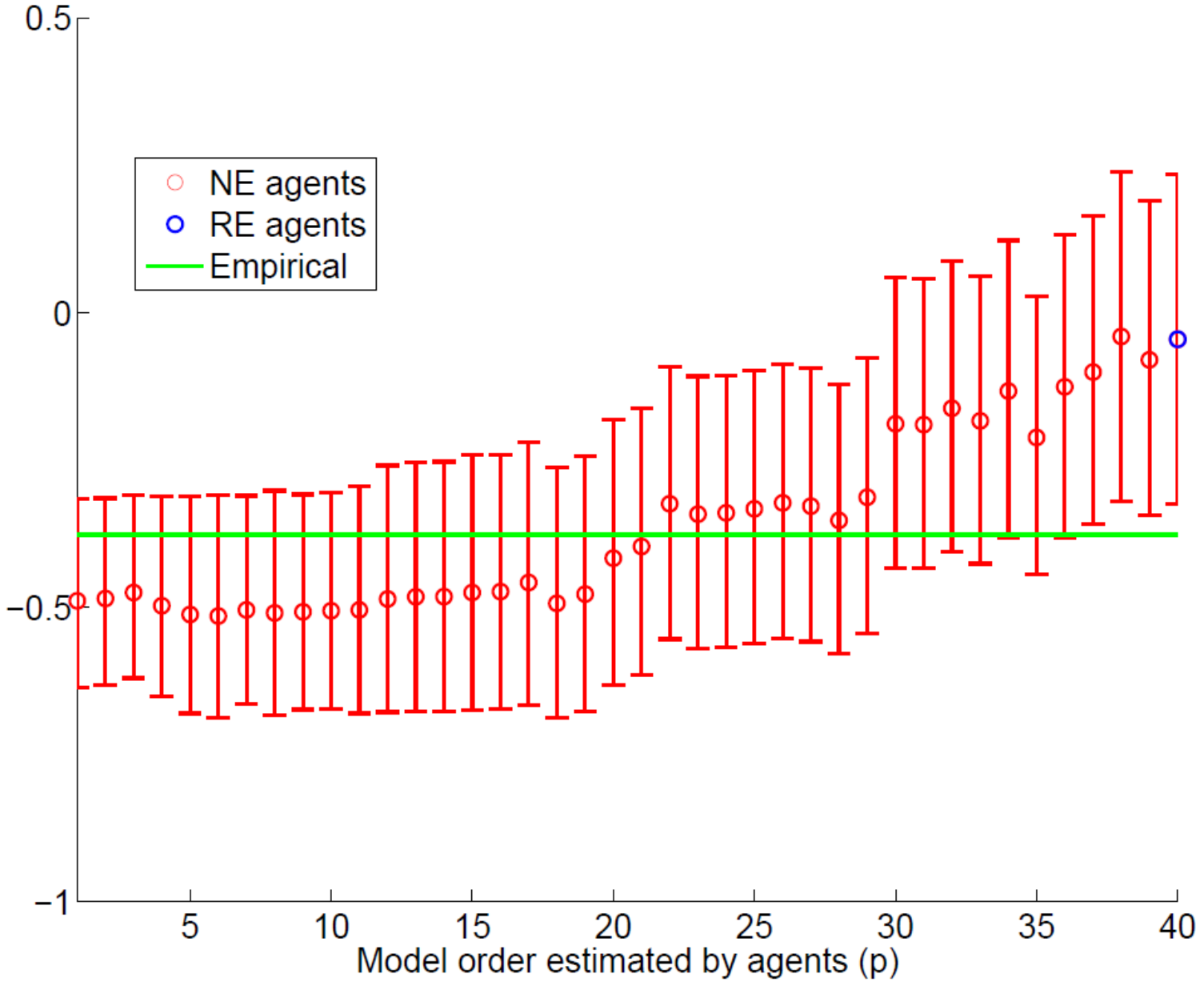
- Annual data (1929-2010)
- Real per-capita consumption: US NIPA
- Excess returns
- P/E ratios

- Simulations annualized for comparisons
- Simulations generated for 82 years of data
- Monte Carlo to generate confidence intervals

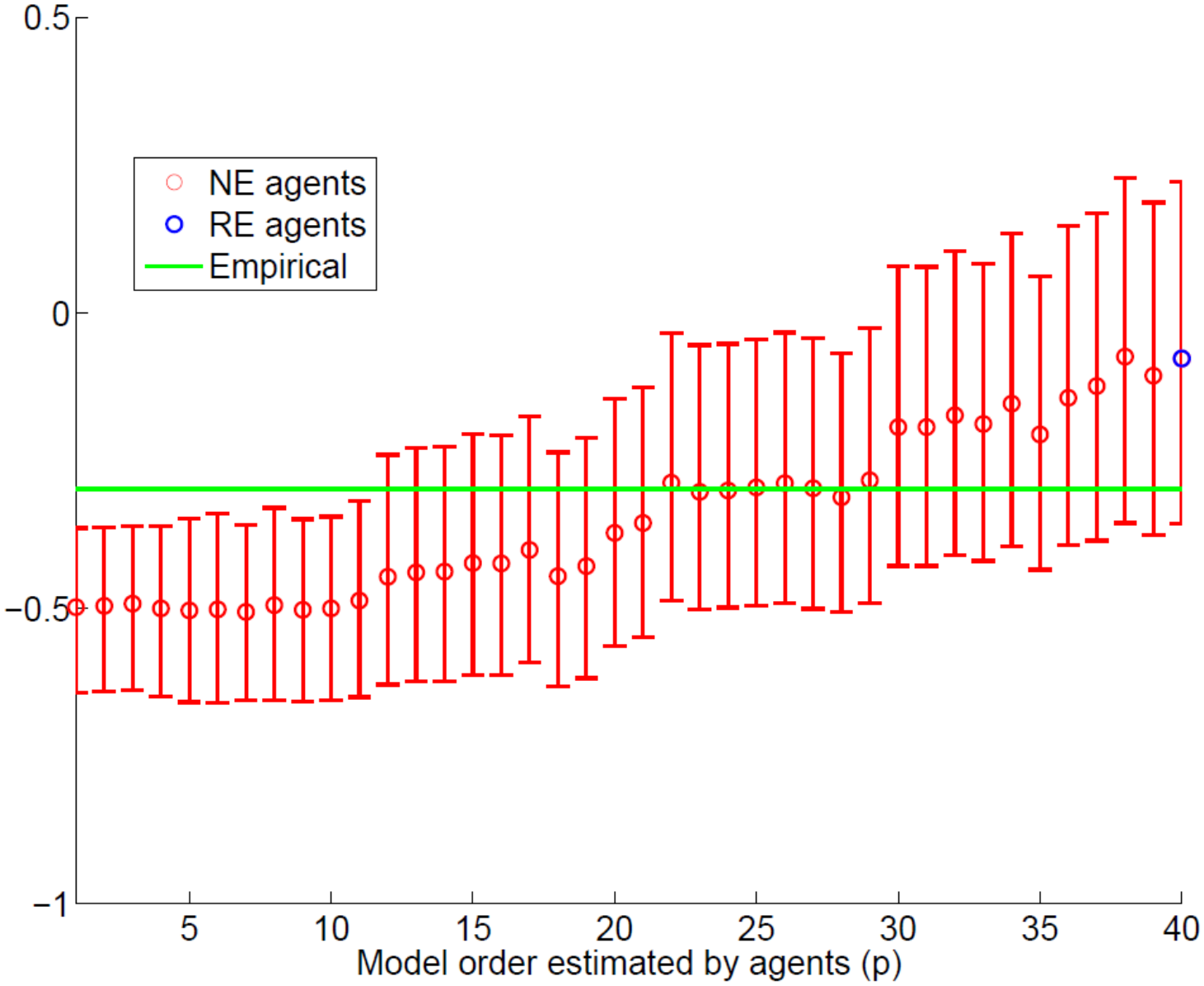
Correlation of Excess Returns in Year τ with Cumulative Excess Returns for Years $\tau + 2$ to $\tau + 5$, for Different AR(p) Models of Earnings



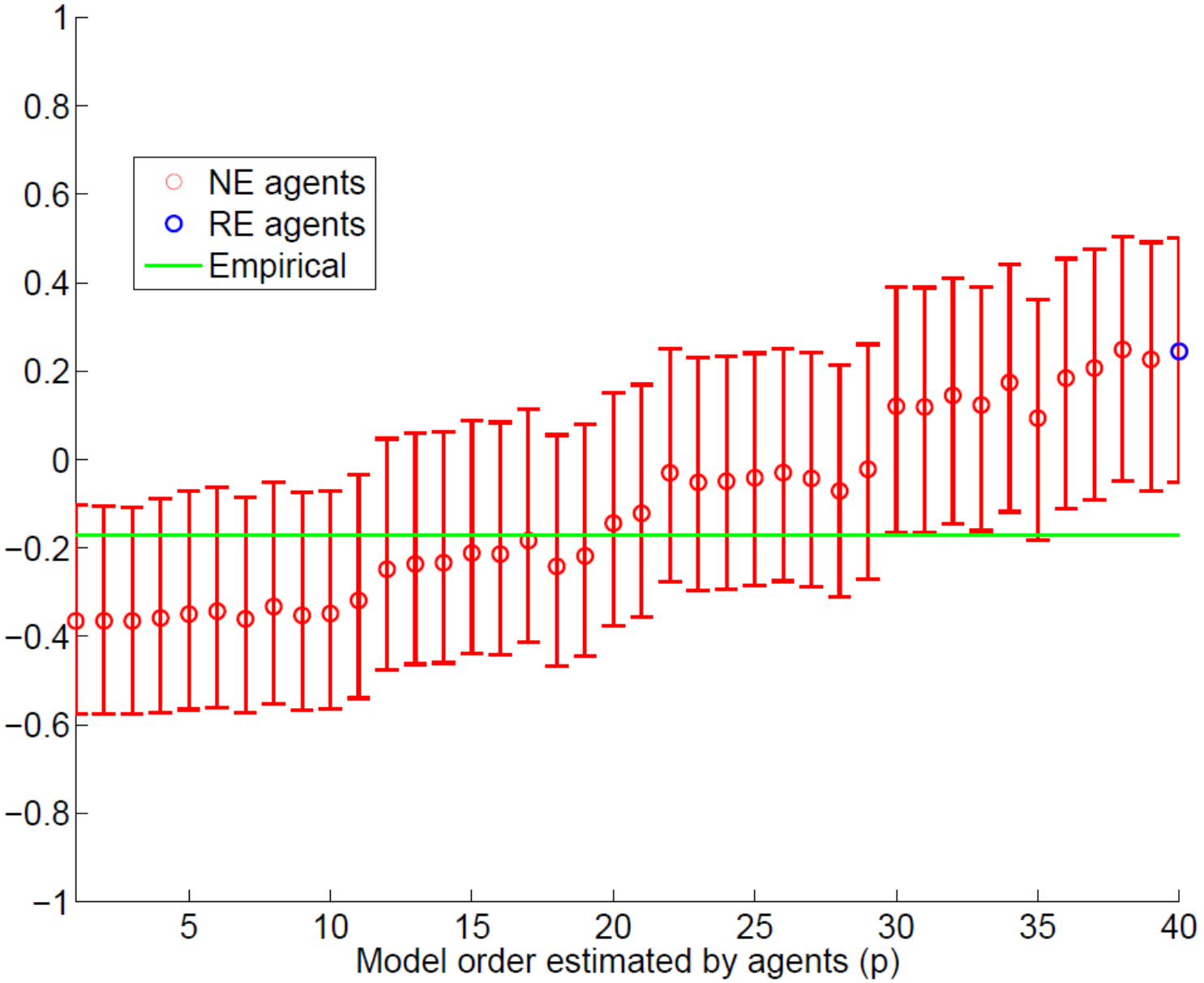
Correlation of $\mathrm{P/E}_{40}$ in Year τ with Cumulative Excess Returns for Years $\tau + 2$ to $\tau + 5$, for Different AR(p) Models of Earnings



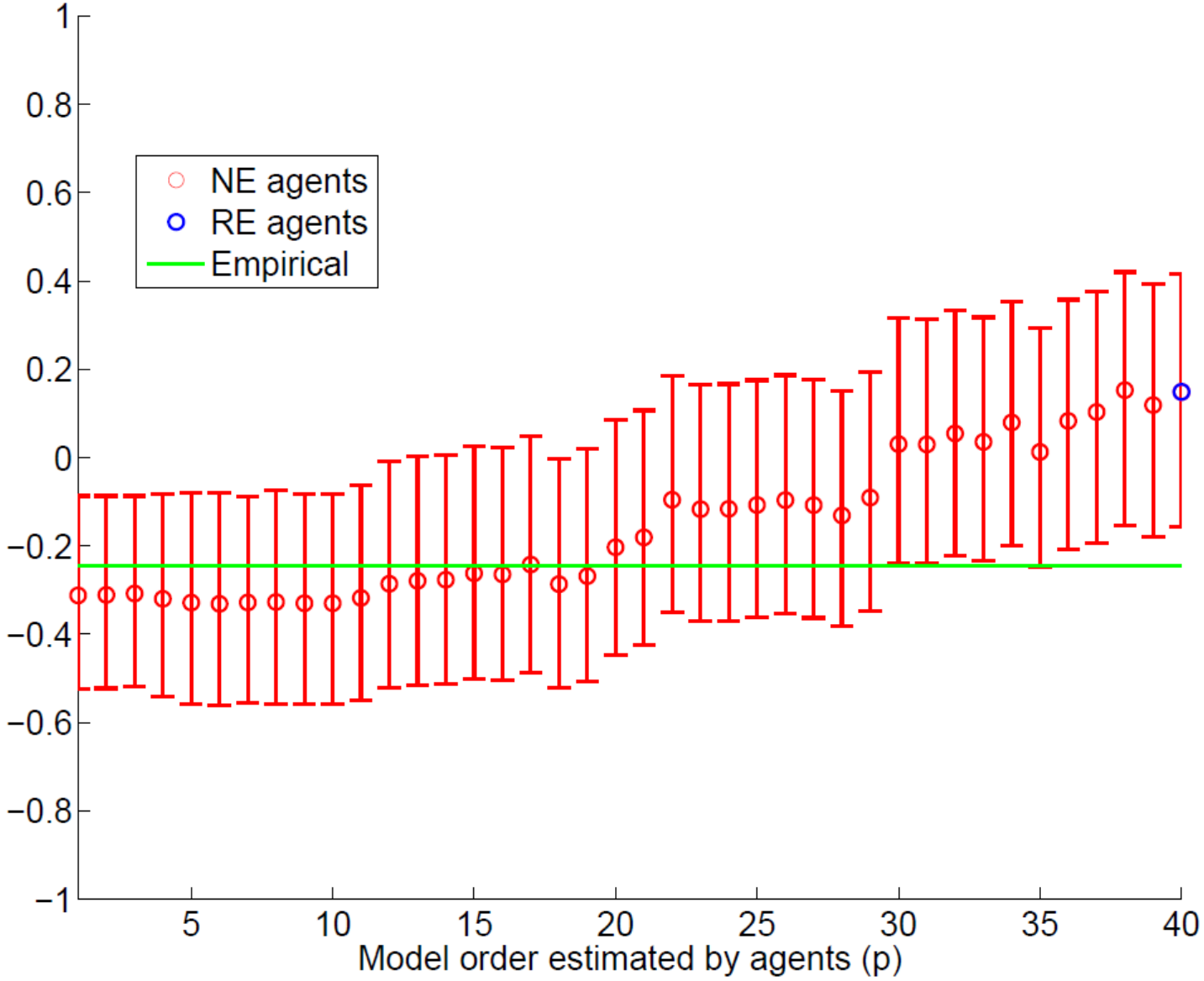
Correlation $\Delta \ln C_\tau$ with Cumulative Excess Returns for Years τ+2 to τ+5, for Different AR(p) Models of Earnings



Correlation of P/E_{40} in Year τ with ($\ln C_{\tau+6}$ - $\ln C_{\tau+2}$), for Different AR(p) Models of Earnings



Correlation of $\Delta \ln C_\tau$ with ($\ln C_{\tau+6}$ - $\ln C_{\tau+2}$), for Different AR(p) Models of Earnings



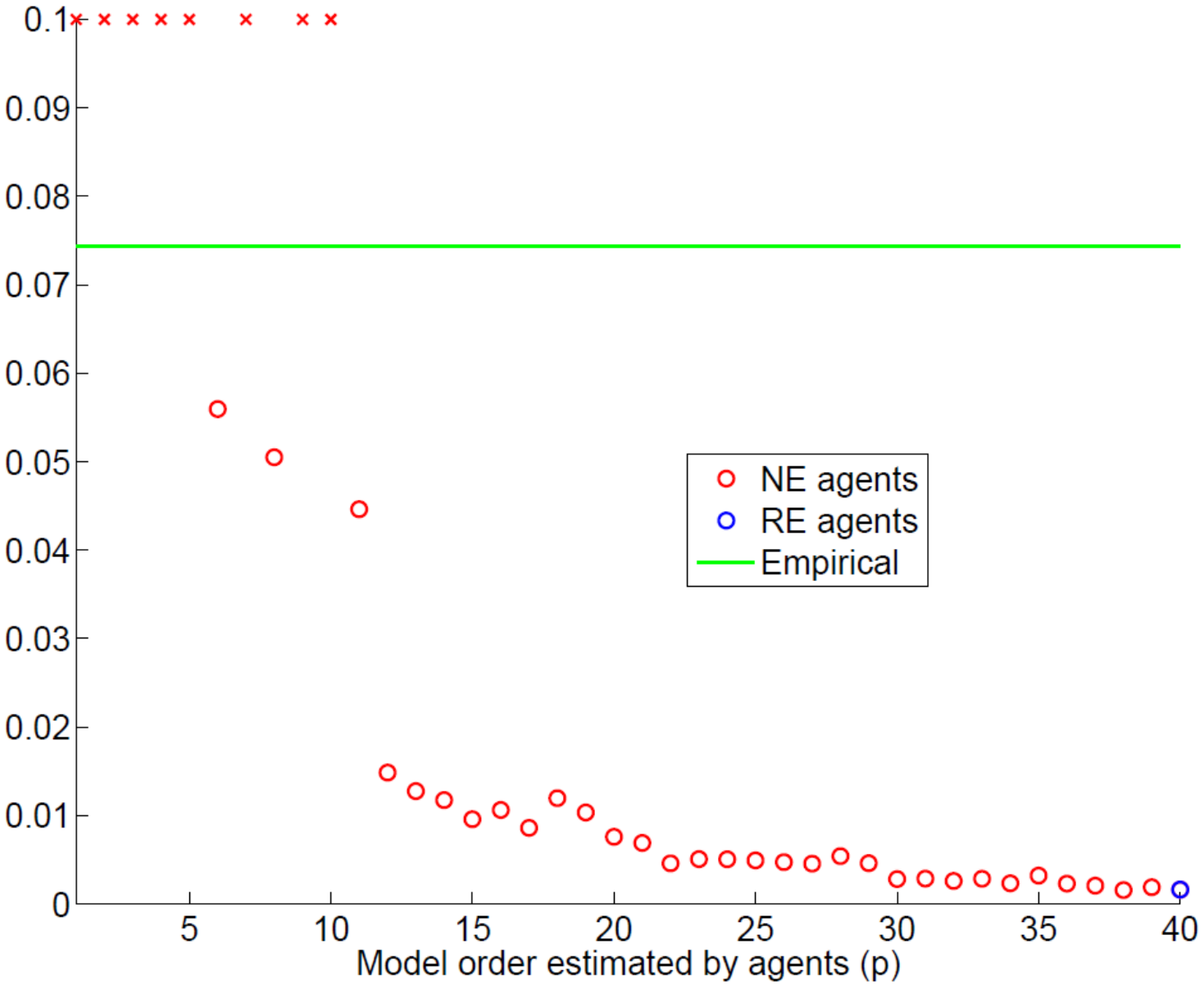
Application to equity premium puzzle

- Agents perceive equities to be very risky, since they don't recognize the mean reversion

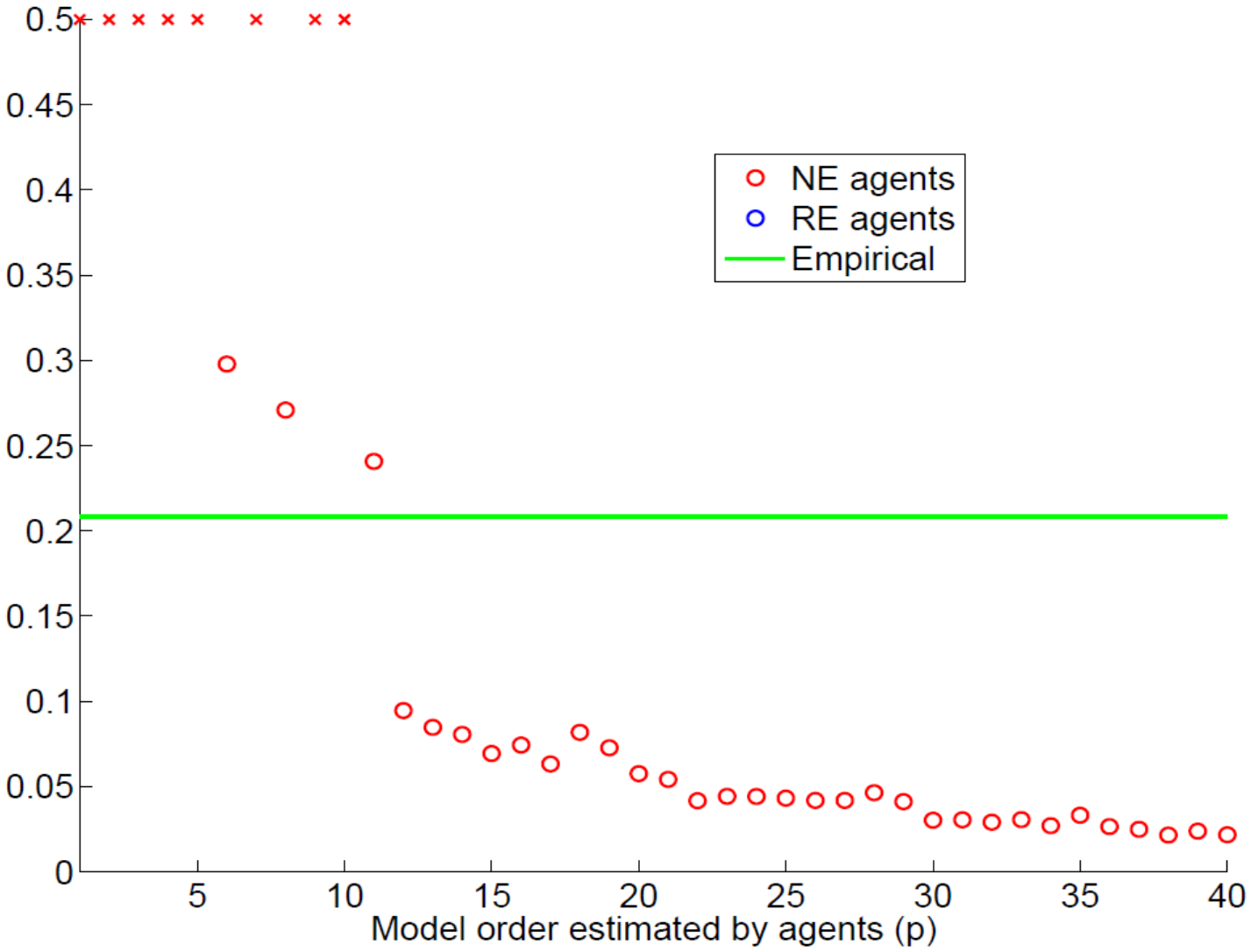
$$COV\left(\Delta_h c_{t+h}, R_{t,t+h}\right) = \frac{1}{3} \times \frac{1}{3} \times \widehat{COV}\left(\Delta_h c_{t+h}, R_{t,t+h}\right)$$

- In other words, equities are about 9 times less risky than they are perceived to be.

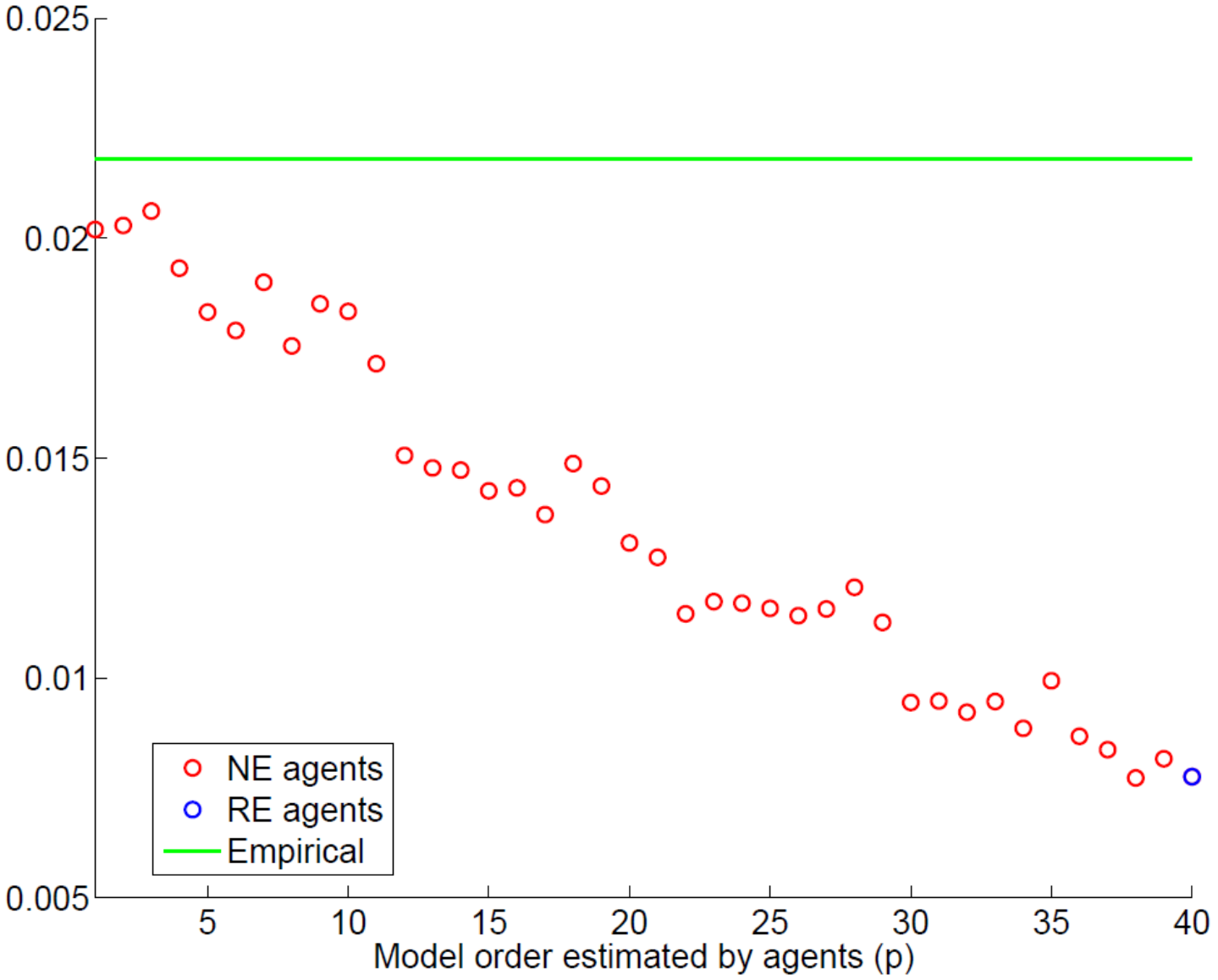
Equity Premium for Different AR(p) Models of Earnings



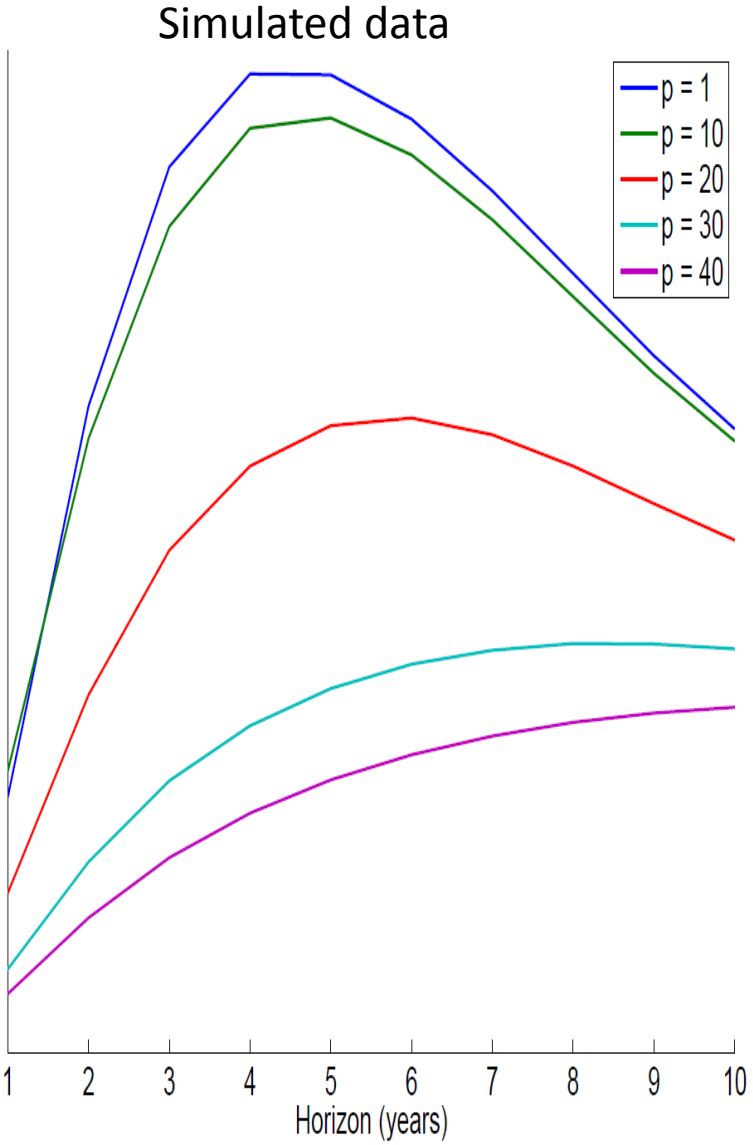
Standard deviation of equity returns for Different AR(p) Models of Earnings

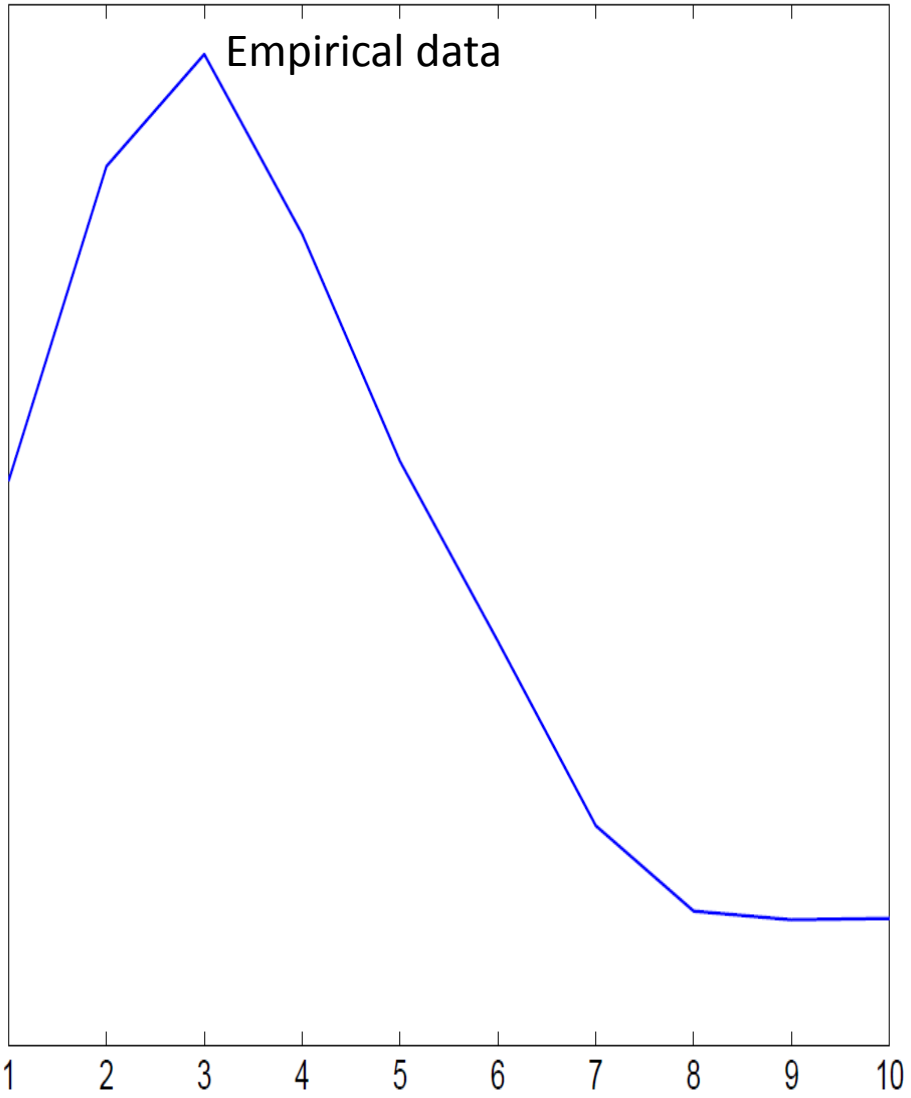


Standard Deviation of Consumption Growth for Different AR(p) Models of Earnings



Covariance of consumption growth and cumulative return at different horizons

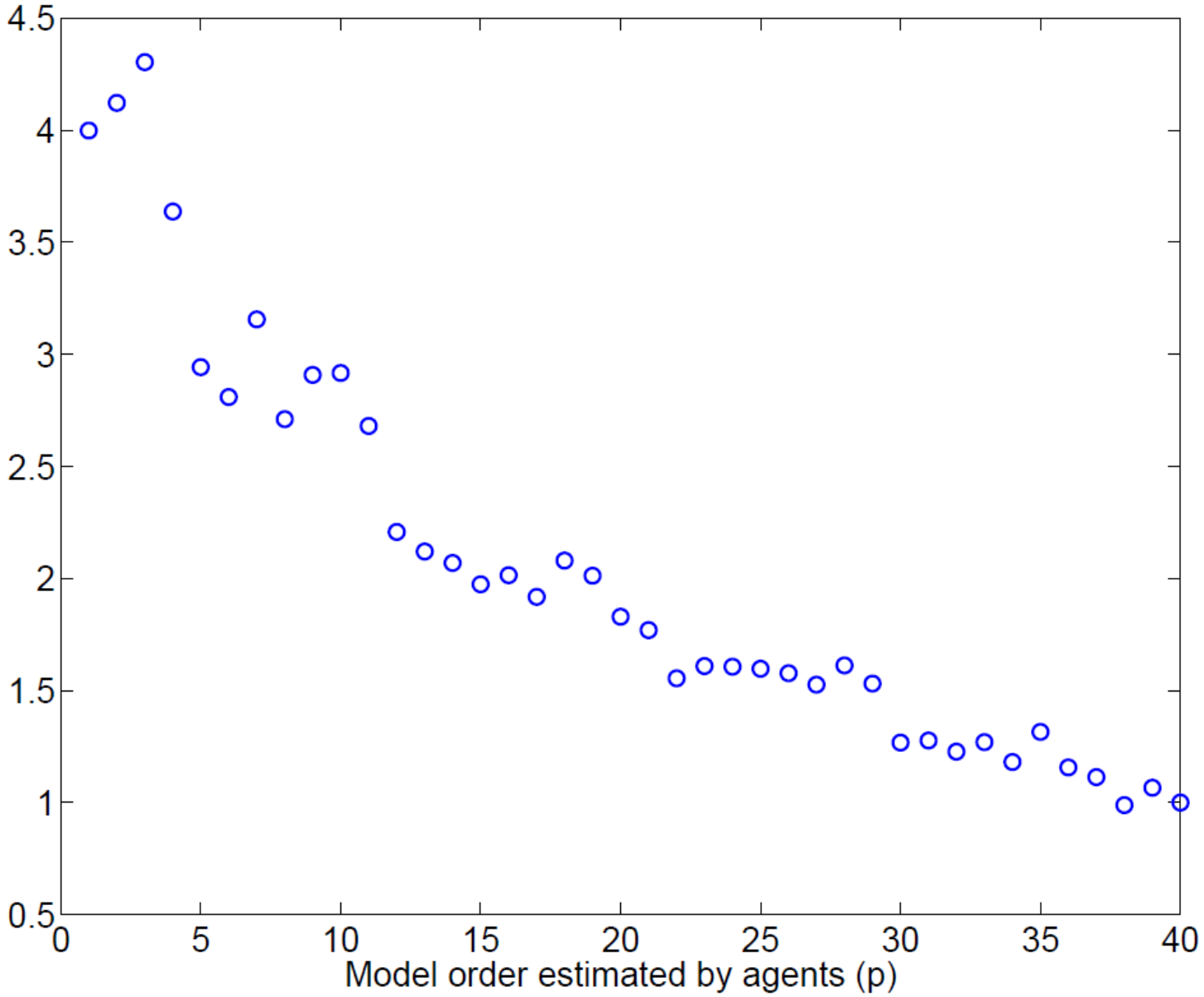




How would RE agents behave in this economy?

- Closed form solution for consumption function and asset allocation
- RE agents are relatively highly leveraged
- RE agents adjust their equity allocation counter-cyclically

Leverage of RE agents for Different AR(p) Models of Earnings



Summary

1. Fundamentals follow hump-shaped dynamics:
    - Short-run momentum
    - Long-run (partial) mean reversion
2. Agents estimate simple models
    - Parsimonious, tractable
    - Typical models chosen in economics literature

Summary

1. Low order forecasting equations miss some of the mean reversion in fundamentals, so resulting asset prices exhibit excess volatility and long-run mean reversion
2. Cycles in consumption (and investment)
3. The covariance of returns and consumption growth rises and then falls with h
4. New explanation for the ability of cay to predict returns.
5. Equity is perceived as many times riskier than it actually is
6. Rational Expectations investors hold far more equity than Natural Expectations investors