Long-run Bulls and Bears

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Asset pricing challenge

- The covariance and correlation between stock returns and measurable fundamentals is at best weak.
- This fact underlies almost all modern asset-pricing puzzles
  - The equity premium puzzle, Hansen-Singleton-style rejection of asset pricing models, Shiller's excess volatility of stock prices, etc.
- One response is to introduce unobserved risk premia shocks.
- Another response is to abandon Lucas-Breeden-style asset pricing and focus on statistical models of expected returns and back out risk premia as residuals.

Long-run bull and bears

- This paper re-examines the link between fundamentals and stock returns.
- Stock markets exhibit long run swings, which we call long run bull and bear episodes.
- We identify these episodes with a simple mechanical algorithm using only stock price data.
- We implement this algorithm using data for 17 OECD countries and 7 non-OECD countries, covering the period 1871-2006.

Empirical results

- We find that there is strong, positive correlation across episodes between consumption and output growth with stock returns.
- In contrast, correlations at a one year horizon are virtually zero. Even at a 15 year horizon correlations are less than half of what they are across bull and bear episodes.
- Key question: how can we reconcile the weak correlation in calendar time with the strong correlation across episodes?

Empirical results, U.S.

- U.S. long-run bulls and bears are associated with political, military, or technological events.
- Measures of fundamentals available for the U.S.
  - Consumption, output, dividends, and earnings.
- The correlation between these fundamentals and stock returns across episodes is particularly strong for the U.S.

Model

- The economy undergoes regime shifts in which there are persistent changes in the growth rate.
- Agents receive noisy signals about the nature of these regime shifts.
    - E.g. will railroads transform the economy?
- An otherwise standard asset pricing model can account for the key findings if the event is sufficiently rare.
- Episodes are a useful statistical filter that isolates regime shifts.

Model

- Problem: model-based 10 and 15-year correlations are too high.
- Conjecture: this difficulty reflects our current assumption that episodes are all alike, in the sense that they are drawn from a stationary, ergodic distribution.
- Ongoing work models episodes as draws from a non-ergodic distribution.

Identifying turning points

- The Bry and Boschan (1973) algorithm was designed to identify business cycle turning points.
- We use a modified version of their algorithm to identify long run bulls and bears.
- We do not smooth the data with moving averages and the Spencer curve. Instead we use a bandpass filter.
- We do not require that each episode last for a minimum of years.

Modified Bry-Boschan algorithm

- Step 1: take logs and use a bandpass filter to eliminate the business cycle frequencies (those lower than 8 years).
  - Bry and Boschan first eliminate outliers and then compute 12-month moving averages.
- Step 2: Identify peaks and troughs by finding dates at which the current value is higher or lower than in any other period within one year.
- Step 3: Checks if there no two subsequent peaks or troughs.
  - If two subsequent peaks (troughs) are found, only the most extreme peak (trough) is retained. If the values are equal, the last peak (trough) is selected.
- Step 4: Refine peaks and troughs by looking one year around the current peaks and troughs to find new peaks or troughs.

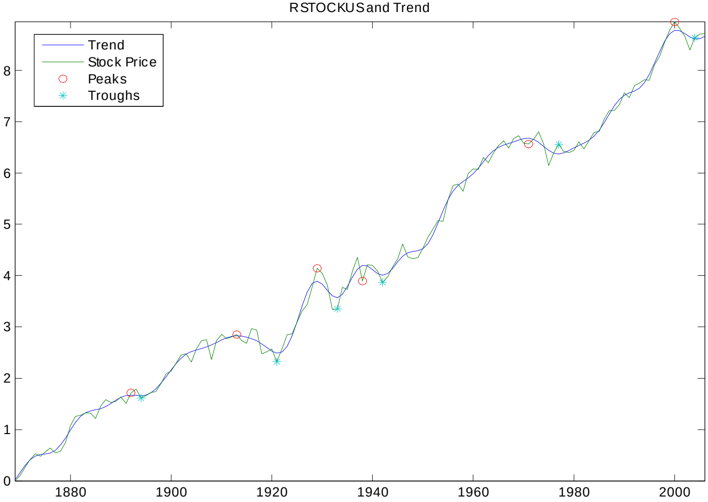
Booms and busts

- We date booms and busts using *only the stock price index*.
- How do fundamentals covary with stock returns across episodes?
  - We also consider output and dividends in addition to consumption.

Historical data

- Sample: 1871-2006.
- Nakamura, Steinsson, Barro, and Ursúa (2011) for stock returns.
- Barro and Ursúa (2008) for consumption expenditures and real per capita GDP.
- Shiller for real S&P500 earnings and dividends.

U.S. bulls and bears



U.S. bulls and bears

Average	Bulls	Bears	Full sample
Length in years	16.8	4.20	
Fraction of time	0.80	0.20	
Equity returns	9.13	-3.88	6.55
Bond returns	1.98	0.01	1.65
Equity premium	7.15	-3.89	4.90
Consumption growth	2.73	-0.97	1.78
Output growth	2.98	0.64	2.08
Dividends growth	3.47	-3.14	0.99
Earnings growth	5.88	-9.67	1.63

U.S. bulls and bears

Boom/bust episode	Historical events
1835-39	Texas war of independence, bank panic of 1837
1839-53	U.S. wins U.S.-Mexican war (manifest destiny), California gold rush, compromise of 1850
1853-58	Panic of 1857 (failure of Ohio Life Insurance and Trust Company)
1858-74	Bessemer converter, steel, phamaceuticals
1874-75	Bank panic associated Germany abandoning the silver standard;
1875-92	Second industrial revolution (the greatest era of invention), railway, power station, electrical light, phonograph,electrical transformer, electric railway, vaccine, telephone, steam turbine generator, internal combustion engine,reinforced concrete, movie camera
1892-94	Depression of 1893 (financial panic associated with railroads) shocks to agriculture
1894-1913	Victory on Spanish American war, technical progress (telegraph, escalator, movies, Yukon goldrush, car production starts)
1913-1921	World War I and its aftermath
1921-29	Period of fast technological progress, automobiles, road building, telephone electricity spreads, urbanization
1929-33	The Great Depression
	Innovations in chemical engineering, infrastructure, diffusion of electricity, machinery and
1933-38	the automotive
1938-42	Uncertainty associated with World War II
1942-71	Pax Americana, commercial aviation, interstate highway system
1971-77	Oil shocks
1977-2000	Computers for businesses, personal computers, robotics, the internet

Concordance

- Harding-Pagan concordance index measures synchronization of episodes across countries.

$$S_t^j = \begin{cases} 1 & \text{if country } j \text{ is in long-run bull} \\ 0 & \text{if country } j \text{ is in long-run bear} \end{cases}$$

- The concordance index between the U.S. and country j:

$$I_j = \frac{1}{T} \left\{ \sum_{t=1}^{T} S_t^{US} S_t^j + \sum_{t=1}^{T} \left(1 - S_t^{US}\right) \left(1 - S_t^j\right) \right\}.$$

- Measures fraction of time two countries spend in the same stock-market phase.
- Results:
  - Concordance between U.S. and developed countries is very high, (peak value of 0.93 for Canada and the Netherlands.)
  - In all but two cases (Korea and Colombia) the concordance exceeds 0.50.

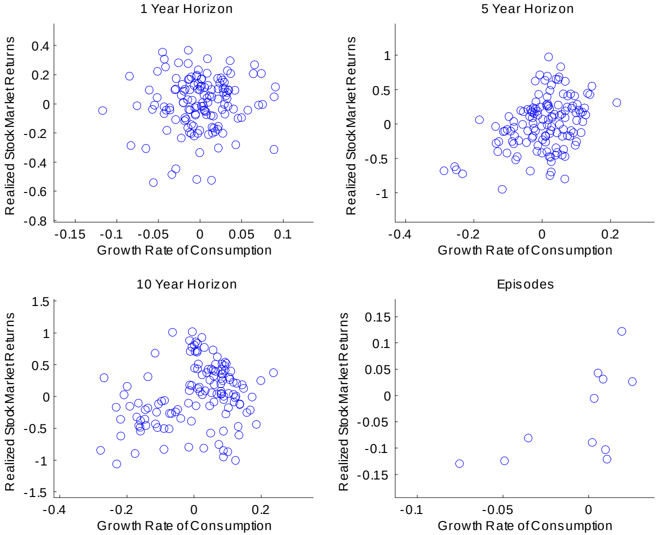
U.S. stock returns and fundamentals

Correlation between real stock market returns and the growth rate of fundamentals
United States, 1871-2006

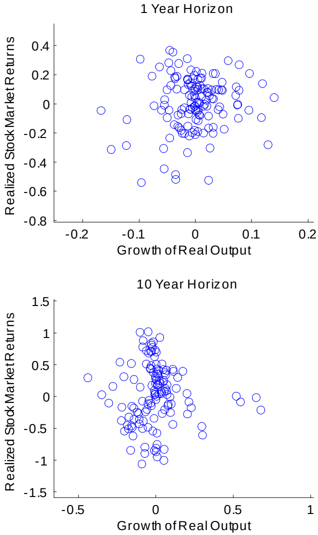
	Consumption	Output	Dividends	Earnings
1 year	0.090 (0.089)	0.136 (0.101)	-0.039 (0.0956)	0.126 (0.1038)
5 years	0.397 (0.177)	0.249 (0.137)	0.382 (0.148)	0.436 (0.179)
10 years	0.248 (0.184)	-0.001 (0.113)	0.642 (0.173)	0.406 (0.125)
15 years	0.241 (0.199)	-0.036 (0.148)	0.602 (0.158)	0.425 (0.111)
Episodes	0.615 (0.271)	0.308 (0.303)	0.713 (0.305)	0.708 (0.292)
Weighted Episodes	0.631 (0.147)	0.268 (0.168)	0.787 (0.131)	0.692 (0.149)

Standard errors are indicated in parenthesis.

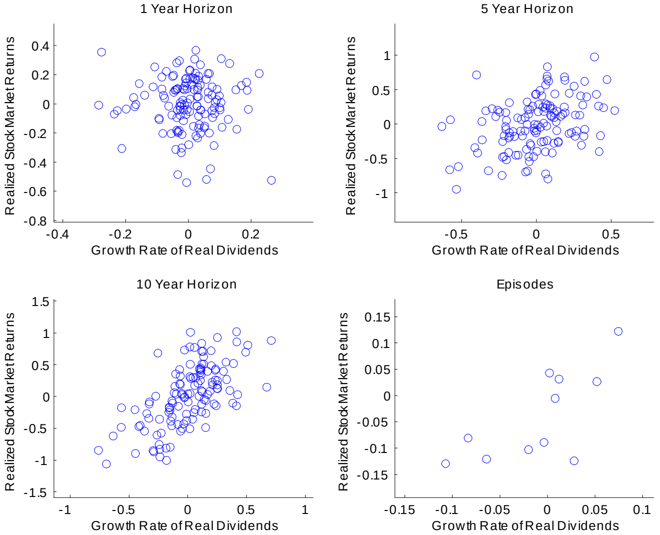
U.S. stock returns and consumption growth



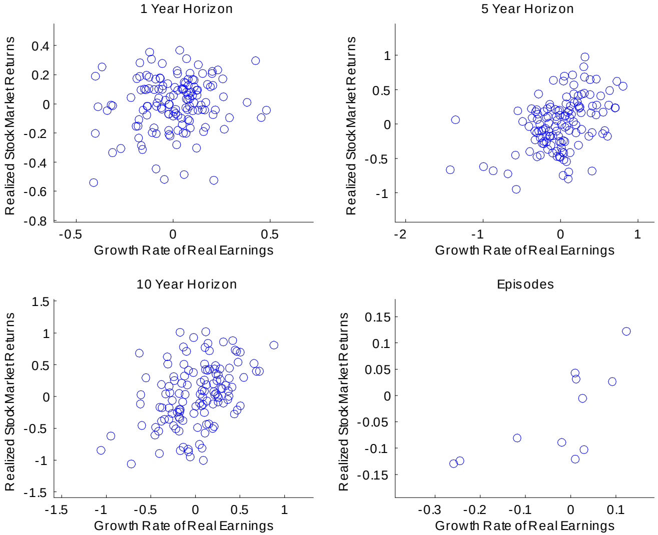
U.S. stock returns and output growth



U.S. stock returns and dividend growth



U.S. stock returns and earnings growth



G7 and non G7 stock returns and fundamentals

Correlation between real stock market returns and growth rate of fundamentals
G7 and non G7 countries

	G7 countries		Non G7 countries	
	Consumption	Output	Consumption	Output
1 year	0.008	0.182	0.050	0.089
	(0.062)	(0.081)	(0.027)	(0.031)
5 years	0.189	0.355	0.087	0.157
	(0.105)	(0.092)	(0.069)	(0.074)
10 years	0.277	0.394	0.027	0.098
	(0.132)	(0.119)	(0.122)	(0.130)
15 years	0.308	0.374	0.023	0.084
	(0.176)	(0.171)	(0.166)	(0.176)
Episodes	0.651	0.702	0.376	0.474
	(0.100)	(0.073)	(0.107)	(0.109)
Weighted Episodes	0.741	0.770	0.342	0.445
	(0.036)	(0.040)	(0.028)	(0.029)

Standard errors are indicated in parenthesis.

Model features

- Lucas tree model
  - Growth in the endowment of the economy can take on two values, high and low.
  - With constant probability ϕ the economy switches from the current growth rate to a new value.
- Epstein-Zin preferences
  - With time separable preferences and risk aversion greater than one, good news about future growth rates drives down stock prices.
  - Epstein-Zin preferences allow us to resolve this issue by separating risk aversion from intertemporal substitution.

Model

$$U^*(x_t, g_t, Y_t) = \max_{C_t, x_{t+1}} \left\{ (1-\beta) C_t^{1-\rho} + \beta \left[Z^*(x_{t+1}, g_t, Y_{t+1}) \right]^{1-\rho} \right\}^{1/(1-\rho)}$$

- $Z^*(.)$ is certainty equivalent of future utility:

$$Z^*(x_{t+1}, g_t, Y_{t+1}) = \left\{ E_t \left[U^*(x_{t+1}, g_{t+1}, Y_{t+1}) \right]^{1-\sigma} \right\}^{1/(1-\sigma)}.$$

- Budget constraint:

$$C_t = x_t \left[P^*(g_t, Y_t) + Y_t \right] - x_{t+1} P^*(g_t, Y_t),$$

- Y_t = endowment
- g_t = growth rate of endowment.
- $P^*(g_t, n_t, Y_t)$ = price of a share in the tree.
- x_t = shares in the tree owned by the agent.

Results

- Model produces high correlations between consumption growth and returns at *all* horizons, including one year, as well as across episodes.

Model with signals

- Agents receive signals about the new value of g that will be realized once the regime switch occurs.
- Signal takes on one of two values, s^H or s^L. Precision of signal, z:

$$z = \Pr(s = s^i | g = g^i) \geq 0.5, \ i = L, H.$$

- Agent's posterior probability that $g = g^H$ is given by the function $p(n_t, p_t)$:

$$p(n_t, p_t) = \begin{cases} \frac{z^{n_t} p_t}{z^{n_t} p_t + (1-z)^{n_t}(1-p_t)}, & n_t \geq 0, \\ \frac{(1-z)^{-n} p_0}{z^{-n_t}(1-p_t) + (1-z)^{-n_t} p_t}, & n_t < 0. \end{cases}$$

- n_t = number of times that $s = s^H$ minus the number of times that $s = s^L$.

Model implications

Correlation between real stock market returns and consumption growth

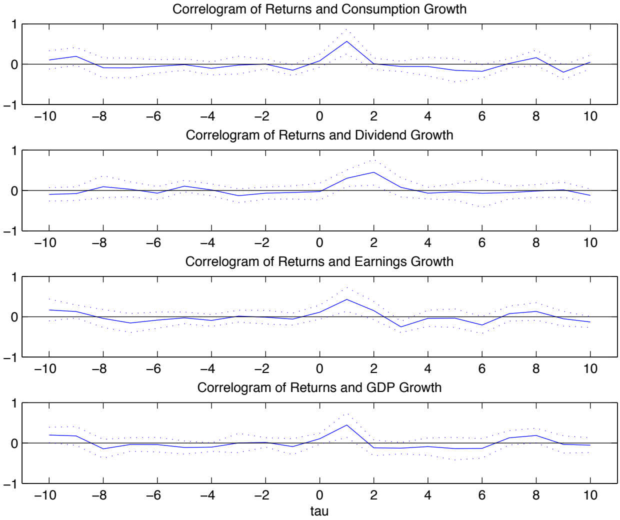
	U.S. data	Benchmark parameter values	Disaster parameter values
		Correlations	Correlations
1 year	0.090	0.14	0.048
	(0.089)	(0.013)	(0.048)
5 years	0.397	0.662	0.623
	(0.177)	(0.009)	(0.033)
10 years	0.248	0.852	0.83
	(0.184)	(0.006)	(0.021)
15 years	0.241	0.908	0.892
	(0.199)	(0.005)	(0.015)
Episodes	0.615	0.58	0.834
	(0.271)	(0.044)	(0.070)

Sensitivity analysis

Correlation between real stock market returns and consumption growth

	Benchmark parameter values	High risk aversion (σ=5)	Low intertemporal substitution (ρ=.5)	Less frequent epsiodes (ϕ=.40)	Less frequent busts (p=.70)	Less informative signals (z=.70)	Disaster parameter values
	Correlations	Correlations	Correlations	Correlations	Correlations	Correlations	Correlations
1 year	0.126	0.176	0.454	0.116	0.113	0.123	-0.023
	(0.084)	(0.081)	(0.072)	(0.085)	(0.090)	(0.087)	(0.241)
5 years	0.644	0.682	0.839	0.601	0.626	0.668	0.521
	(0.063)	(0.058)	(0.034)	(0.071)	(0.074)	(0.059)	(0.184)
10 years	0.832	0.852	0.930	0.803	0.820	0.846	0.739
	(0.047)	(0.042)	(0.021)	(0.054)	(0.055)	(0.042)	(0.152)
15 years	0.886	0.899	0.953	0.865	0.876	0.895	0.809
	(0.043)	(0.038)	(0.019)	(0.049)	(0.050)	(0.039)	(0.135)
Episodes	0.635	0.708	0.88	0.573	0.636	0.65	0.812
	(0.235)	(0.228)	(0.120)	(0.245)	(0.262)	(0.222)	(0.315)

Stock returns lead consumption



Stock returns lead consumption, model implications

Correlogram between consumption growth and stock returns

years of lead-lag

-4	-3	-2	-1	0	1	2	3	4
Baseline calibration								
0.01	0.0197	0.039	0.073	0.139	0.676	0.424	0.259	0.157
(0.014)	(0.015)	(0.015)	(0.014)	(0.013)	(0.005)	(0.011)	(0.013)	(0.014)
Disaster calibration								
0.003	0.006	0.011	0.023	0.048	0.73	0.391	0.209	0.109
(0.019)	(0.023)	(0.027)	(0.034)	(0.048)	(0.018)	(0.039)	(0.037)	(0.032)

Model with signals

- It produces low correlations between stock returns and fundamentals at yearly frequency and high correlation across episodes.
- Key failing: the model cannot account for the low correlations at 10 and 15-year horizons.
- There is something special about episodes that is not captured by models driven by stationary, ergodic fundamentals.
- Ongoing work: extend model to allow episodes to be fundamentally different from each other.
  - The invention and diffusion of railroads is very different from World War II.

Khronos and Kairos

- There were two words for time in ancient Greece
  - Khronos was the word for calendar time.
  - Kairos referred to a moment of indeterminate time in which something special happens.
- This paper argues that asset prices are correlated with fundamentals in Kairos time.
- We need a model that distinguishes between Khronos and Kairos.