The Habit Habit

John H. Cochrane

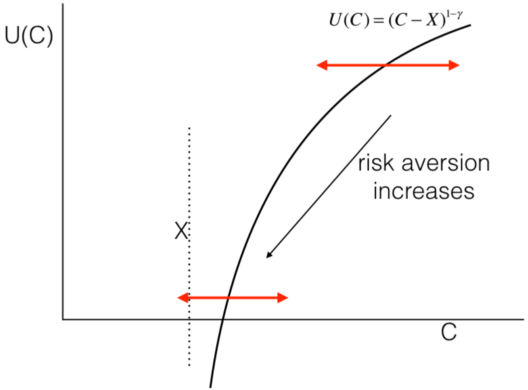
Hoover Institution, Stanford University and NBER

March 2016

Habits

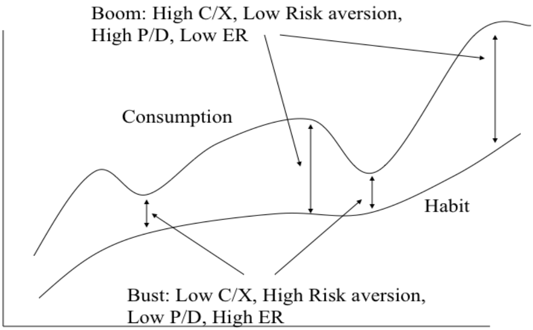
$$u(C) = (C - X)^{1-\gamma} \rightarrow -\frac{u''(C)}{Cu'(C)} = \gamma\left(\frac{C}{C-X}\right) = \frac{\gamma}{S}$$

As C (or S) declines, risk aversion rises.



Habits

Slow-moving habit. Roughly, $X_t \approx \sum \phi^j C_{t-j}$; $X_t \approx \phi X_{t-1} + C_t$



→ Time-varying, recession-driven, risk premium drives return predictability from p/d; "excess" volatility, much else (correlation, CAPM vs CCAPM, volatility, etc.). "Bubble" story.

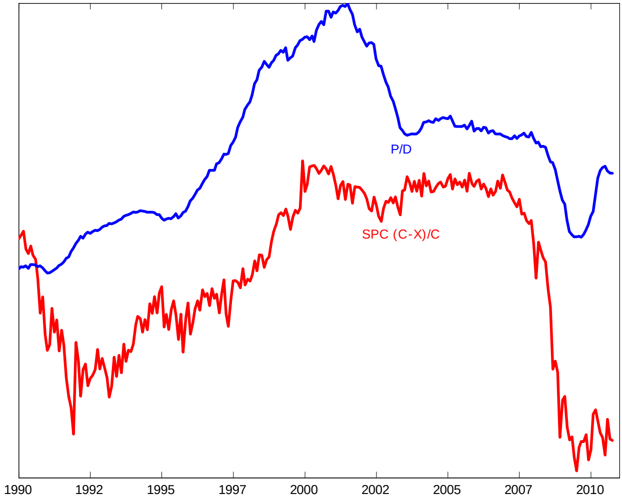
Habits

- $$u'(C) = (C - X)^{-\gamma}$$
- Precautionary savings offset intertemporal substitution.
- Expected returns and fear/hunger. Habits add S = fear that stocks fall in recession

$$1 = E_t\left(M_{t+1}R_{t+1}\right);\ E(R^e_{t+1}) = -cov(R^e_{t+1}, M_{t+1})$$

$$M_{t+1} = \beta\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\left(\frac{S_{t+1}}{S_t}\right)^{-\gamma}$$

Habits – latest data



Here, $X_t = k \sum_{j=0}^{\infty} \phi^j C_{t-j}$

Habits – successes and ... directions for improvement

- Yes: Equity premium, low $\sigma(\Delta c)$, unpredictable Δc, low and constant (or slow varying) risk free rate.
- No: ... and low risk aversion.
- Yes: return predictability, p/d volatility, $\sigma(R)$ volatility, long run equity premium.

$$M_{t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \left(\frac{S_{t+1}}{S_t} \right)^{-\gamma}$$

- Needed: ....

The Standard VAR

$$r_{t+1} \approx 0.1 \times dp_t + \varepsilon^r_{t+1}$$
$$\Delta d_{t+1} \approx 0 \times dp_t + \varepsilon^d_{t+1}$$
$$dp_{t+1} \approx 0.94 \times dp_t + \varepsilon^{dp}_{t+1}$$

$cov(\varepsilon\varepsilon') =$

	r	Δd	dp
r	$\sigma = 20\%$	+big	-big
Δd		$\sigma = 14\%$	**0 not -1**
dp			$\sigma = 15\%$

- Needed: Two shocks! Data $\varepsilon^d, \varepsilon^{dp}$ uncorrelated. Δc is both a cashflow and a discount rate shock.
- Δd shock in model has less correlation. Match VAR? d, c need to be cointegrated.

(Identities)

- Note: Δd, dp carry all information

$$
\begin{aligned}
r_{t+1} &\approx dp_t - \rho dp_{t+1} + \Delta d_{t+1} \\
b_r &= 1 - b_{dp} + b_d \\
\varepsilon^r_{t+1} &= -\varepsilon^{dp}_{t+1} + \varepsilon^d_{t+1}
\end{aligned}
$$

Habits – successes and ... directions for improvement

- Needed: More state variables (?)
  1. Empirical

     $$R^i_{t+1} = a_i + b_i x_t + c_i y_t + ..\varepsilon^i_{t+1};\ E_t(R^i_{t+1}) = a_i + b_i x_t + c_i y_t$$

     How many state variables – independent linear combinations of x, y, z are there? Factor analysis of $cov(E_t(R^i_{t+1}))$? Across stocks, bonds, fx, etc? (For example, one factor for all bonds.) For mean and variance (separate?)
  2. Theoretical: If more than 1, need more state variables (S) in the model!
- Test; Other assets, $1 = E(mR^{ei})$? Cross section (treating time aggregation right)?
- But, warning, all explicit models fail $R^2 = 1$ tests.
- Still low hanging fruit for *all* similar models.

Other directions

- A sampling
  1. Recursive utility (Epstein-Zin)
  2. Long run risks (e.g. Bansal Yaron)
  3. Idiosyncratic risk (e.g. Constantinides and Duffie)
  4. Rare Disasters (e.g. Reitz; Barro)
  5. Nonseparable across goods (e.g. Piazzesi Schneider, housing)
  6. Leverage; balance-sheet; "institutional" (e.g. Brunnermerier, ..)
  7. Ambiguity aversion, min-max, (Hansen and Scheinkman)
  8. Behavioral finance; probability mistakes. (e.g. Shiller, Thaler)
  9. Many others
- Great unity of theoretical ideas.

$$M_{t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \left(\frac{Y_{t+1}}{Y_t} \right)^{\theta}$$

$$P_t U'(C) = \beta \sum_s \pi_s (Y?) U'(C_s) X_s$$

  Y varies with business cycle. "Fear of Y" drives asset prices. (Probability = marginal utility)
- Habits can still capture most of these ideas. Convenience?

Recursive utility / Long run risk

- Function

$$U_t = \left((1-\beta) c_t^{1-\rho} + \beta \left[E_t \left(U_{t+1}^{1-\gamma} \right) \right]^{\frac{1-\rho}{1-\gamma}} \right)^{\frac{1}{1-\rho}}.$$

$\gamma =$ risk aversion $\rho = 1/\text{eis}$. Power utility for $\rho = \gamma$.

- Fear = utility index

$$M_{t+1} = \beta \left(\frac{c_{t+1}}{c_t} \right)^{-\rho} \left(\frac{U_{t+1}}{\left[E_t \left(U_{t+1}^{1-\gamma} \right) \right]^{\frac{1}{1-\gamma}}} \right)^{\rho-\gamma}$$

$$= \beta \left(\frac{c_{t+1}}{c_t} \right)^{-\rho} \left(Y_{t+1} \right)^{\rho-\gamma}.$$

Recursive utility / Long run risk

- Fear: news of future long-horizon consumption. ($\rho \approx 1$).

$$\Delta E_{t+1}\left(\ln m_{t+1}\right) \approx -\gamma \Delta E_{t+1}\left(\Delta c_{t+1}\right) + (1-\gamma)\left[\sum_{j=1}^{\infty} \beta^j \Delta E_{t+1}\left(\Delta c_{t+1+j}\right)\right]$$

- Features/thoughts
  1. iid Δc, reduces to power utility. Needs predictable Δc.
  2. Current conditions Δc_t are essentially irrelevant to fear. Only from coincidence / assumption that current Δc_t is correlated with long run $E_t \Delta c_{t+j}$. (Not strong in data)
  3. Is there really a lot of news about long run future Δc? Is that really the fear in 2008? Or "Dark Matter?" (Chen, Dou, Kogan)
  4. Time-varying risk premium, return predictability volatility, etc. must come from exogenously changing $\sigma_t(\Delta c_{t+1})$
  5. $\rightarrow$Interesting phenomena all from hard-to-see features of exogenous consumption process. Habits: endogenous rise in RA.
  6. "Separates IES / RA." "Solves risk free rate puzzle (high risk aversion, steady low R^f)." (Still needs high RA). But so do habits!
  7. "Preference for early resolution of uncertainty." "Separate time vs. state separability" Feature or bug?

(Note: Bansal Yaron Kiku consumption process)

$$
\begin{aligned}
\Delta c_{t+1} &= \mu_c + x_t + \sigma_t \eta_{t+1} \\
x_{t+1} &= \rho x_t + \phi_e \sigma_t e_{t+1} \\
\sigma_{t+1}^2 &= \bar{\sigma}^2 + v(\sigma_t^2 - \bar{\sigma}^2) + \sigma_w w_{t+1} \\
\Delta d_{t+1} &= \mu_d + \phi x_t + \pi \sigma_t \eta_{t+1} + \phi \sigma_t u_{d,t+1}
\end{aligned}
$$

Constantinides and Duffie – idiosyncratic risk

- Bottom line:

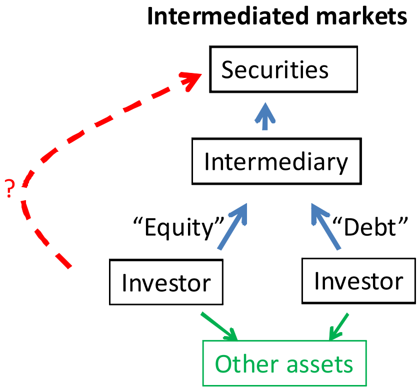
$$M_{t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \left(e^{\frac{\gamma(\gamma+1)}{2} y_{t+1}^2} \right)$$

y_{t+1} =*cross-sectional variance* of consumption growth.

$$\Delta c_{t+1}^i = \Delta c_{t+1} + \eta_{i,t+1} y_{t+1} - \frac{1}{2} y_{t+1}^2; \ \sigma^2 \left(\eta_{i,t+1} \right) = 1$$

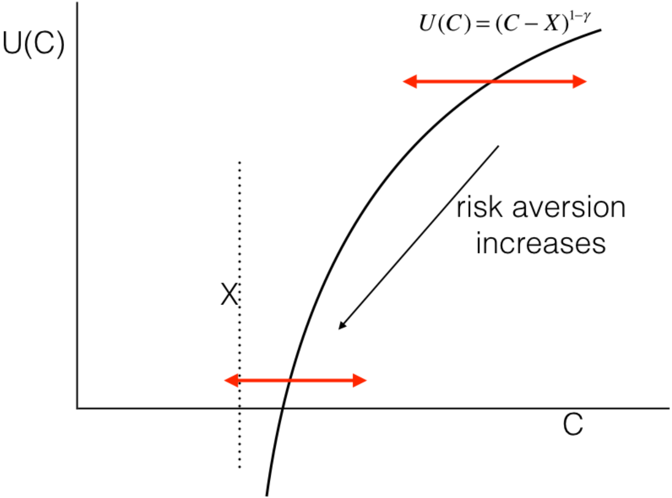
- Needs $y = \sigma$(cross-sectional variance) large, varies with business cycles, conditional distribution varies over time. Exogenous, or needs new theory
- New work in data (Schmidt). Maybe individual rare "disasters" in recessions drives $\sigma(\Delta c)$?

Balance sheets – debt – institutional / intermediated finance



- As people / intermediaries lose money, closer to default, they get more risk averse

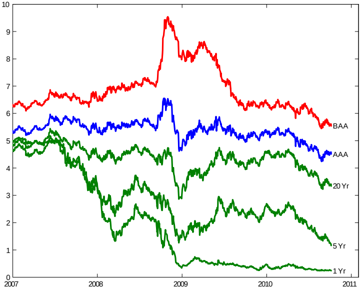
Debt can look just like habit



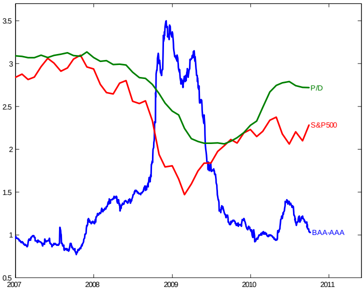
Debt/intermediated objections

- Why do agents get *more* risk averse as they approach bankruptcy, not *less*?
- OK for obscure CDS. But why not buy S&P500 directly?
- Why get in so much debt in the first place? Why use agents?
- Where are unconstrained, debt-free rich people, Warren Buffet, endowments, sovereign wealth funds etc.? (Answer: selling in a panic just like everyone else.)
- Why the strong correlation to macroeconomics? (Will the true state variable please stand up?)
- Why are individual mean returns strongly associated with comovement (factors)?
- Data (2008): Widespread coordinated rise in all risk premiums, including easy-to-trade, held in your and my 401(k) and Vanguard's website.

A common risk premium



Bond yields



Bonds and stocks

Rare disasters

$$E_t(R_{t+1}) - R_t^f = cov_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}, R_{t+1}\right]$$

- A small chance of a very low C_{t+1}/C_t can drive the whole covariance, raise $E_t R_{t+1}$ despite reasonable γ, and despite samples with small $\sigma(\Delta c_{t+1})$.
- Objections:
  1. Shouldn't we see them more often? (Data controversy)
  2. Beyond equity premium? To get return predictability, p/d volatility, varying volatility, we need time-varying probabilities of rare disasters. External measurement or dark matter?
  3. We seem to need different time-varying probabilities for different assets (Gabaix).
  4. Correlation with business cycles? Probability of rare disasters exogenously correlated with business cycles? Or causality from stocks to recessions?

Probability assessments

$$P_t U'(C) = \beta \sum_s \pi_s U'(C_s) X_s$$

- π, U' always enter together. There is no way to tell them apart without a priori restriction – $U'(C)$ or $\pi(Y)$
- Do surveys "what do you expect" reveal $E = \sum \pi$ or $E^* = \sum \pi U'$?
- Some model restricting π to other data, $\pi(Y)$, or dark matter?
- Why the business cycle correlation?
- Min - max; robust control

$$P_t U'(C) = \beta \min_{\{\pi \in \Theta\}} \sum_s \pi_s(Y_s) U'(C_s) X_s$$

But what's θ? Why time-varying and business cycle related?

Summary:

- Many ideas give about the same result. An extra, recession-related state variable,

$$M_{t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} Y_{t+1}$$

- No model yet decisively improves on habit in describing time-varying, business-cycle related risk premia; return predictability; "excess" volatility; "bubbles" associated with business cycles, long-run equity premium.
- No other model does so without relying on exogenous variation in the consumption process, just-so correlations (Δc_t with long run news) "dark matter" (time varying rare probabilities, business cycle correlated "sentiment," long run news), rather than endogenous variation in risk premiums
- Habit, despite neglect, is at least still a convenient formalism for capturing the common ideas.

Risk averse recessions

- Time to unite with production, general equilibrium! Integrate finance and macro (alternative to frictions)
- Keynesian: Recessions are driven by static flows: $C = a + mpcY; I = \bar{I} - br$; etc.
- New-Keynesian: Recessions are intertemporal substitution

$$c_t = E_t c_{t+1} - \sigma r_t = E_t c_{t+1} - \sigma \left(i_t - E_t \pi_{t+1} \right)$$

- Habit vision: Recessions are driven by endogenous time-varying *risk aversion*, not intertemporal substitution.
- Vision: Small shock. Risk aversion rises. Precautionary savings rise.

$$r = \delta + \gamma \left(\frac{c}{c-x} \right) E \left(\frac{dc}{c} \right) - \frac{1}{2} \gamma(\gamma+1) \left(\frac{c}{c-x} \right)^2 \sigma^2$$

  (Looks like "discount rate shock" of NK models.) Consumption declines. (Edc/c rise.) Risk aversion rises some more. .. Asset prices decline. Investment declines. C+I.. Output declines. Almost mulitiplier-accelerator.
- Does it work?

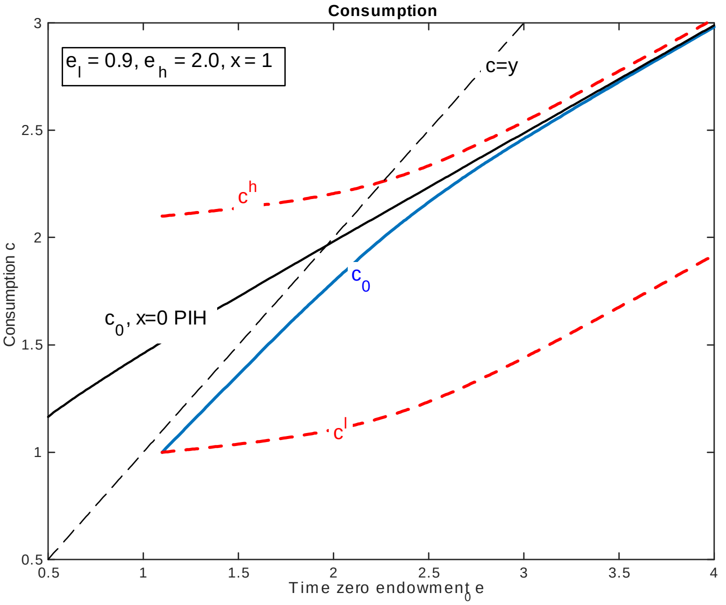
Simple GE model 1: PIH with habit

$$\max \frac{(c_0 - x)^{1-\gamma}}{1-\gamma} + E\left[\frac{(c_1 - x)^{1-\gamma}}{1-\gamma}\right]$$
$$c_1 = (e_0 - c_0) + e_1$$
$$e_1 = \{e_h, e_l\} \;\; pr(e_l) = \pi_l.$$

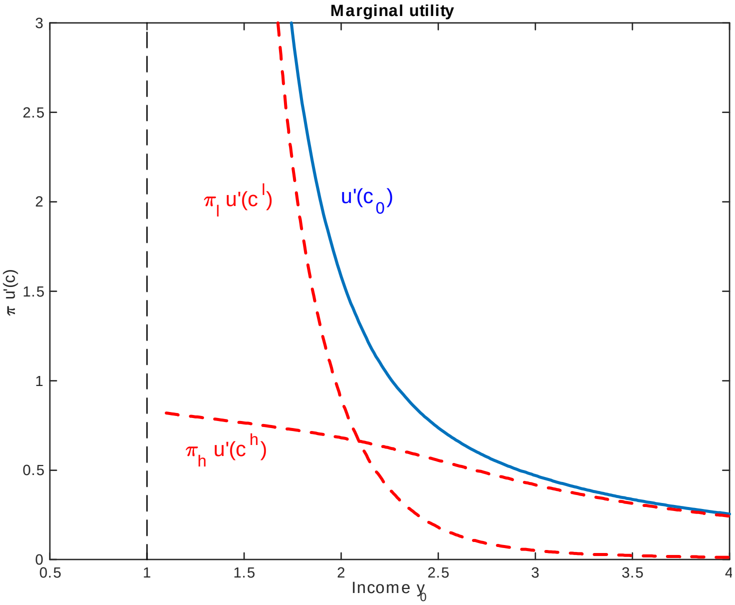
$$(c_0 - x)^{-\gamma} = E(c_1 - x)^{-\gamma}$$
$$(c_0 - x)^{-\gamma} = \pi_l(c_l - x)^{-\gamma} + \pi_h(c_h - x)^{-\gamma}$$

- $x = 1,\ \gamma = 2,\ e_h = 2,\ e_l = 0.9\ (< x!), \pi = 0.01$ (endpoint)
- c_0 falls drastically in bad times, to make sure $c_l > x$
- c_0 acts like buffer stock, leverage, debt models: high *mpc* for low c.
- $u'(c_0) = \pi_h u'(c_h)$ for high e_0, but $u'(c_0) = \pi_l u'(c_l)$ for low e_0. Like min-max, ambiguity aversion, rare disaster, salience models.
- Stock prices fall, expected returns rise. Investment to fall?

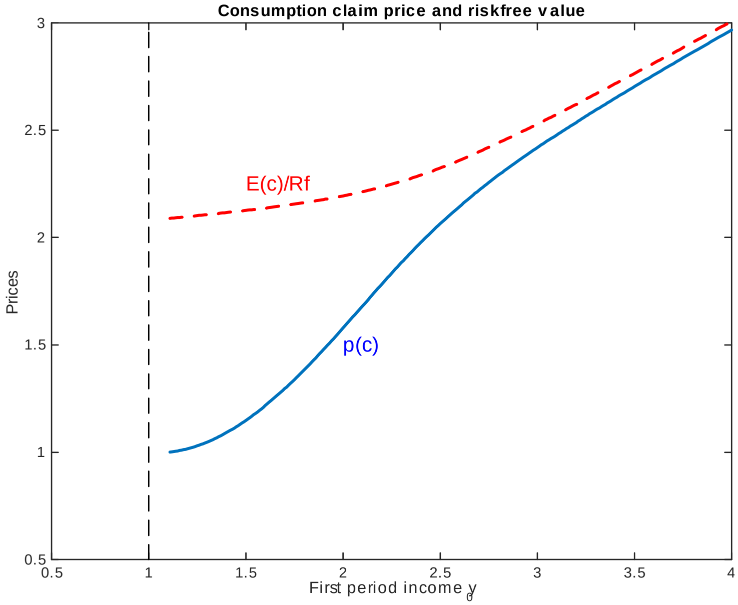
Rising mpc in bad times



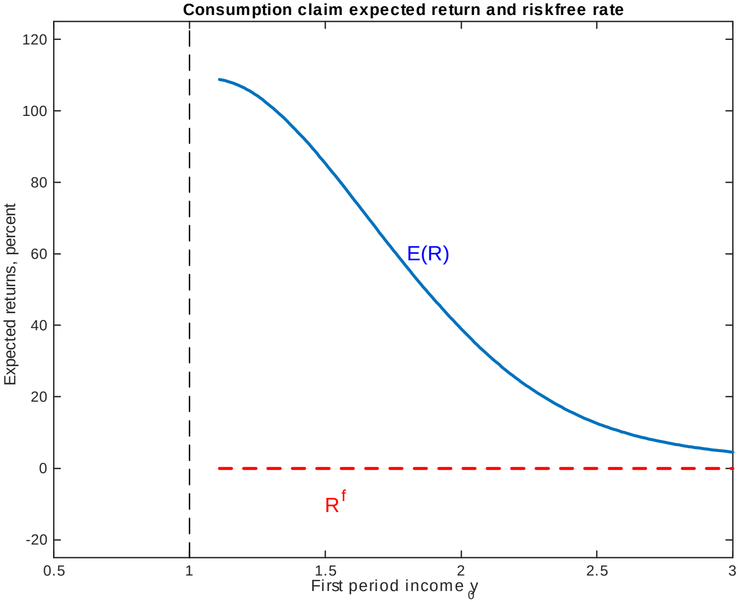
Minimax, rare disaster behavior



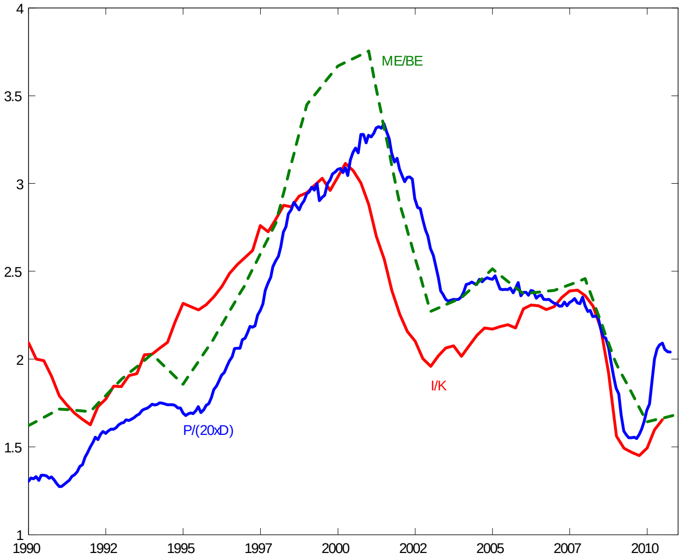
Stock prices fall



Risk Premia Rise



Investment and Q



$$1 + \alpha \frac{i_t}{k_t} = \frac{\text{market}_t}{\text{book}_t} = Q_t$$

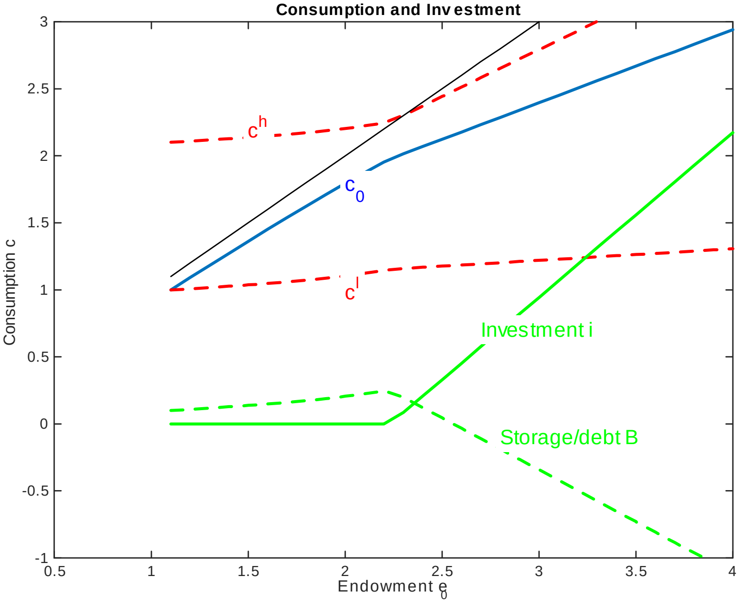
A risky investment opportunity

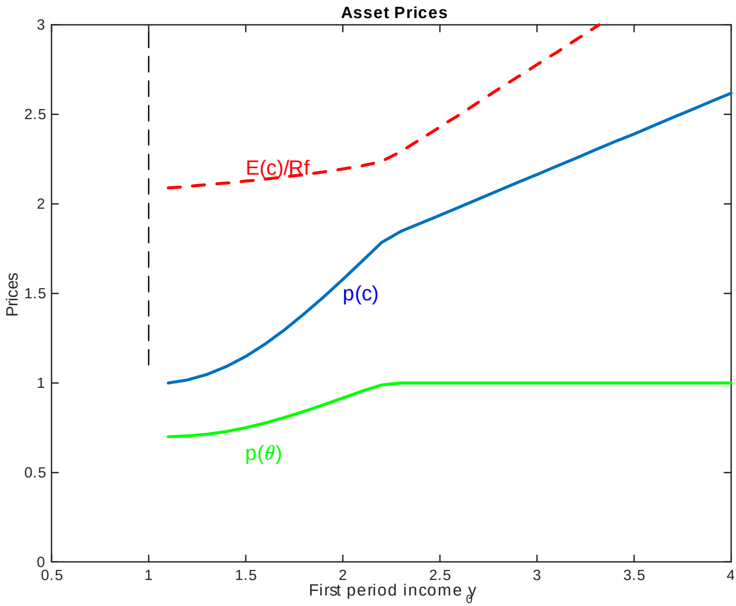
$$\max \frac{(c_0 - x)^{1-\gamma}}{1-\gamma} + E\left[\frac{(c_1 - x)^{1-\gamma}}{1-\gamma}\right]$$

$$c_1 = e_1 + \theta_1 i_0 + B_0$$
$$c_0 = e_0 - i_0 - B_0 / R^f$$
$$i_0 \geq 0$$

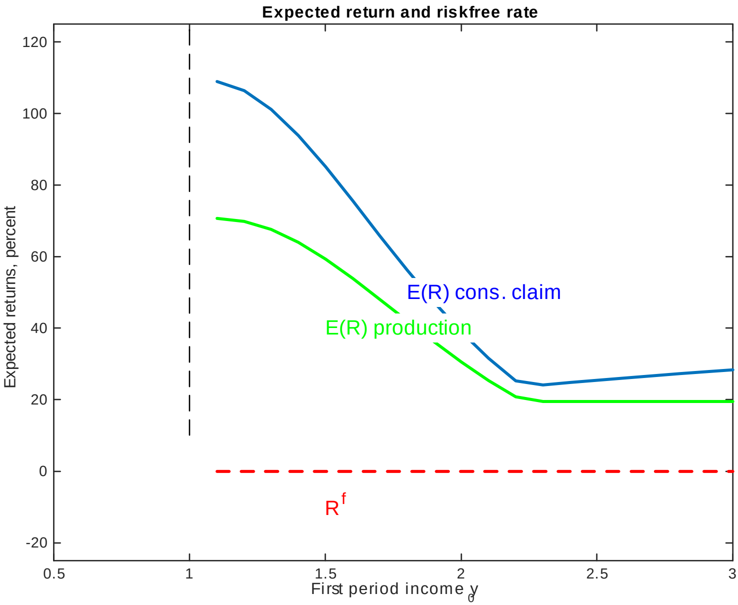
$$(c_0 - x)^{-\gamma} = E(c_1 - x)^{-\gamma}$$
$$(c_0 - x)^{-\gamma} = E\left[(c_1 - x)^{-\gamma}\theta_1\right] \text{ if } i_0 > 0.$$

- $x = 1$, $\gamma = 2$, $e_h = 2$, $e_l = 0.9$ $(< x!)$, $\pi = 0.01$,
- $\rightarrow \theta_l = 0.9$, $\theta_h = 1.2 \leftarrow$
- Risky investment collapses


Consumption and Investment
Consumption c
Endowment e0
c^h
c0
c^l
Investment i
Storage/debt B
3
2.5
2
1.5
1
0.5
0
-0.5
-1
0.5
1
1.5
2
2.5
3
3.5
4



Asset Prices
E(c)/Rf
p(c)
p(θ)
Prices
First period income y0
3
2.5
2
1.5
1
0.5
0
0.5
1
1.5
2
2.5
3
3.5
4


Expected return and riskfree rate
Expected returns, percent
120
100
80
60
40
20
0
-20
0.5
1
1.5
2
2.5
3
First period income y_0
E(R) cons. claim
E(R) production
R^f

On to recessions

- The main issue of all macro:
  1. "Demand" falls, but $Y = F(K, L)$. Why does output fall?
  2. If u' rises, hungry, why not work more?

$$\max\,(c-x)^{1-\gamma} + (h-n)^{1-\gamma} \ \ \text{s.t.} c = wn$$

$$(c-x) = w(h-n)$$

  3. Desire to save rises. Why does investment fall?
- Answers:
  1. Traditional: sticky prices, wages.
  2. Shift of investment from risky private opportunity to storage/ government debt. ("R^f") Only i counts as y.
  3. h habit?
  4. Private work contributes to risky project which is being scaled back.

$$c_1 = e_1 + \theta_1 \min\,(i_0, n_0) + B_0$$
$$c_0 = e_0 - i_0 - B_0$$
$$i_0 \geq 0;\, h > n > 0$$

$$\rightarrow i_0 = n_0 \text{ collapses}$$

- Summary: Private economy is a risky project. Everyone wants to put in less money and less labor effort.
- Real dynamic model...

Summary

- Empirical: Asset prices are driven by a large, time-varying, business-cycle correlated risk premium.
- Theory: Habit captures it, endogenously.
- Lots of other models capture many of the same ideas. (Elegant? Exogenous? Dark Matter?)
- Habits capture many of the same ideas of those models. (Convenient?)
- Business cycle correlation; merge asset pricing and finance!
- Recessions are phenomena of risk aversion. Precautionary saving; scale back risky production / investment projects; all try to hold government debt.
- See you in 20 years?