Do Disaster Expectations Explain Household Portfolios?

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Motivation

- In the context of the standard neoclassical representative agent paradigm, the empirical equity premium (return earned from a well diversified portfolio in excess of a risk-free government bond yield) is too high to be rationalized as a premium for bearing systematic risk: Mehra-Prescott (1985).
- *Average annual inflation-adjusted return on the US stock market over the last 116 years has been about 7.67%. Over the same period, return on T-Bills was 1.31%; equity premium of 6.36%*
- Since the publication of Mehra-Prescott a large body of research has accumulated which proposes solutions to the "equity premium puzzle."

Proposed Solutions

- Non-risk based explanations
  - borrowing constraints (Constantinides et al. 2002)
  - transaction costs
- Risk based explanations
  - re-specifying preferences
    - Epstein-Zin (1991),
    - internal habit formation, Constantinides (1990), Campbell and Cochrane (1999)
    - external habit formation, Abel (1990)
  - Idiosyncratic and uninsurable income risk (Constantinides and Duffie (1996))
  - A disaster state Reitz (1988), Barro (2006) and Barro and Ursua (2008), Gabaix (2008)
- Others like model uncertainty (Weitzman 2007).

A disaster state

Rietz (1988) hypothesis: the possibility of rare disasters (depressions, wars etc) is the major determinant of high equity risk premium.

Recently, the hypothesis has been revived by several authors:

- Barro (2006) shows using 20th century cross-country data that actual disasters are large and frequent enough to account for the high risk premium on equities.
  - Using 35 countries, a calibrated disaster probability of $1.5 - 2$ percent a year, with an associated decline in per capita GDP of $15 - 64$ percent from peak to trough.
  - Using 21 countries, Barro and Ursua (2008) calibrate the disaster probability to 3.6 percent a year with an associated 22 percent decline in consumption from peak to trough.
- Gabaix (2008) extends the Reitz-Barro framework (constant intensity of disasters) to "variable rare disasters" and shows that not only the high risk premium but many other asset puzzles can be resolved (the risk-free rate puzzle, excess volatility, predictive power of price/dividend ratios etc)

The equity premium puzzle has a spectacular manifestation in household micro data:

- Most recent empirical evidence suggests that at least fifty percent of households in any developed country do not hold equities directly or indirectly (the stock market participation puzzle).
- In contrast to the predictions of the standard model, we observe a great deal of heterogeneity in the share of risky assets (stocks) in household portfolios even after conditioning on stock market participation and controlling for income and wealth
- In its standard form, life cycle portfolio theory with labor income risk and return uncertainty predicts that households who are early in their life cycle should take advantage of the high equity premium and hold large positions in stocks. In fact, the model often predicts a 100 percent share of stocks in the financial portfolios of young investors (portfolio specialization or the small saver puzzle).

Proposed Solutions

- Different preference specifications, Gomes and Michaelides (2005)
- Transaction costs (stock market participation costs) and borrowing constraints, Haliassos and Michaelides (2003), Cocco et al (2005), Gomes and Michaelides (2005), Alan (2006).
- Uninsurable labor income risk (all above)

None of these provides a satisfactory explanation for household portfolio choice, consumption and financial wealth accumulation decisions jointly.

- Standard intertemporal models cannot be reconciled with observed household portfolios even when we allow for liquidity constraints, transaction costs, preference heterogeneity, labour income uncertainty.

Why do we fail?

- In all attempts expected stock returns are assumed to be the historical average returns. (For example for the US, post war average of excess returns of 6% and 16% standard deviation is usually the convention).
- Intertemporal decisions: consumption, saving and portfolio allocation. These three are tightly linked in any dynamic intertemporal choice model and it has been hard to rationalize consumption, saving and portfolio allocation decisions together.

One reason: data availability: no data set that has, consumption, income, wealth and portfolio choice all together

- Bigger reason: the model does not work!

It does not work!

- Parameters of the standard model that match consumption profile (Gourinchas and Parker 2002) have no hope of matching the same households' wealth and portfolio allocation). They imply too much stock holding.
- Parameters that match wealth profile imply implausible portfolios (Cagetti 2003)
- Parameters that match stock market participation with parameters acceptable to match consumption (Alan 2006) imply 100% equity investment.

The Idea

If rare economic disasters can solve the pricing puzzles they should also explain the observed quantities (household portfolio holdings).

- We should be able to jointly rationalize consumption, saving and portfolio allocation decisions with sensible preference parameter values.

Reversing the argument,

- Household data on consumption, financial wealth and portfolio allocation should imply sensible disaster probabilities and sensible expectations of disaster size.

Application

Two ways of doing this:

1. Take historically calibrated values of disasters (from, for example, Barro (2006)) and apply them to a life cycle model with assumed preference parameter values to show how close one can get to the observed life cycle profiles.
2. Jointly estimate disaster expectations and preference parameters from observed portfolios and then judge whether the estimates are plausible as compared to the historically calibrated values.

I choose (2): I estimate a structural model of consumption and portfolio choice by allowing a small probability of a disaster in the stock market, under labor income uncertainty, boorowing constraints and transaction costs, AND discount rate hetrogeneity.

Model Ingredients

- Standard dynamic portfolio allocation model under income and return uncertainty.
- CRRA framework.
- Following Reitz (1988) and Barro (2006), disasters strike in an i.i.d fashion.
- In the event of a disaster, households face significant labor market stress (in particular, a chance of zero labor income for a year).
- Discount rate heterogeneity.
- Per-period participation costs.
- Borrowing and shortsale constraints.

Model

$$\max E_t \left[\sum_{j=0}^{T-t} \frac{(C_{h,t+j})^{1-\gamma}}{1-\gamma} \frac{1}{(1+\delta_h)^j} \right]$$

where C is non-durable consumption, γ is the coefficient of relative risk aversion (homogenous within a group), δ_h is household specific rate of time preference which is assumed to be distributed lognormally such that $ln\delta_h \sim N(\mu_\delta, \sigma_\delta)$

$$X_{t+1} = (1 + r^e_{t+1})S_t + (1+r)B_t + Y_{t+1}$$

Y_{t+1} is stochastic labour income which follows the following exogenous stochastic process:

$$\begin{aligned} Y_{t+1} &= P_{t+1} U_{t+1} \\ P_{t+1} &= G_{t+1} P_t N_{t+1} \end{aligned}$$

- $G = f(t, Z_t)$, t represents age and Z_t are observable variables relevant predicting earnings growth.
- U_t are distributed independently and identically, take the value of zero with some small but positive probability and otherwise lognormal such that $\ln(U_t) \sim N(-0.5\sigma_u^2\ ,\sigma_u^2)$.
- Similarly, permanent shocks N_t are i.i.d and $\ln(N_t) \sim N(-0.5\sigma_n^2\ ,\sigma_n^2)$.
- $$r^e_{t+1} - r = \mu + \varepsilon_{t+1}$$

  where $\varepsilon_{t+1} \backsim N(0, \sigma_\varepsilon^2)$
- If a disaster strikes, a large portion of the household's stock market wealth evaporates (return of $-\phi$ percent where $\phi > 0$).
- The probability ofa zero income realization increases (from a small calibrated value to π percent)

Estimation Overview

The simulation procedure takes a vector of structural parameters $\Psi = \{\gamma, \mu_\delta, \sigma^2_\delta, p, \phi, \pi, \kappa\}$ where

(γ) coefficient of relative risk aversion

(μ_δ) mean discount rate

(σ^2_δ) variance of the discount rate

(p) probability of the event

(ϕ) size of the expected loss in case of the event

(π) probability of zero income in the case of the event

(κ) per-period participation cost to stock market

and solves the dynamic program. The resulting age and discount rate dependent policy functions are used to simulate consumption, portfolio share and participation paths for H households for $t = 1, \dots T$.

Choice of Auxiliary Parameters (aps)

- $\lambda_{01} = mean\,(finw)$
- $share = \lambda_{02} + \lambda_{03} Age + \lambda_{04} Age^2 + \varepsilon$
- $part = \lambda_{05} + \lambda_{06} Age + \lambda_{07} Age^2 + \nu$
- $\lambda_{08} = mean(share|part = 1)$
- $\lambda_{09} = std(share|part = 1)$
- $\Delta \log C = \zeta_0 + \zeta_1 \Delta size + \epsilon$
  - $\lambda_{10} = \zeta_0$
  - $\lambda_{11} = std(\epsilon)$

Data

- American Consumer Expenditure Survey (CEX) for consumption aps.
  - The data covers the period between 1983 and 2004 (quarterly).
  - Only non-durable expenditure
  - Made annual
  - Select white, married households that report all 4 quarters of non-durable consumption.
- American Survey of Consumer Finances (SCF) for wealth aps.
  - Same restrictions (1983-2004)
  - Triennial survey.
- PSID for income process parameters.
- **3 Cohorts and 2 Education levels: Total 6 groups:**
- Cohort 1 (youngest) 25-27 years of age in 1983, Cohort 2, 28-32, Cohort 3, 33-35.
- More educated, Less Educated

Initial Conditions and Other Parameters

- risk-free rate= 2%
- mean equity premium= 6%
- probability of zero income (in normal times)= 0.3%
- Income variances are estimated seperately for 6 groups while income growth differs only across education levels
- a log-normal initial wealth-to-permanent income ratio is assumed (differs across six groups).
- replacement rate for retirement is 50%.

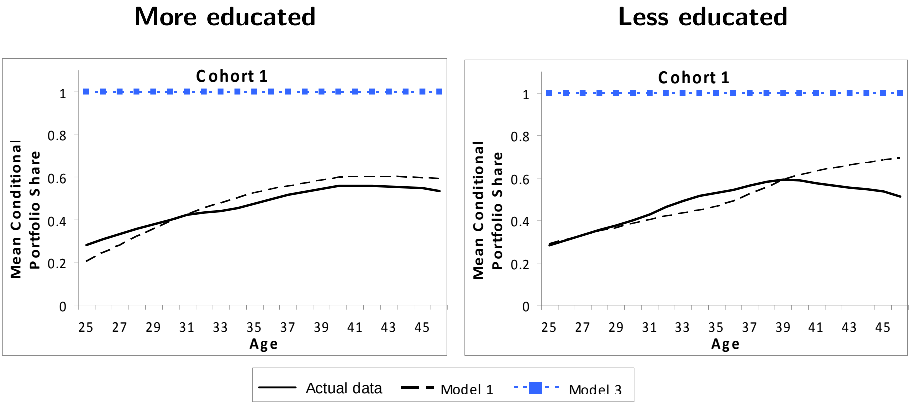
Parameter	More Educated			Less Educated		
	Cohort 1	Cohort 2	Cohort 3	Cohort 1	Cohort 2	Cohort 3
CRRA (γ)	2.19	2.16	1.84	1.26	1.35	0.93
Median discount rate (%)	10.3	11.4	11.1	12.1	11.8	10.4
Standard dev. of discount rate (%)	5.2	8.9	6.9	7	6.8	5.5
Probability of the event (%)	4.4	4.2	3.7	3.9	4	5.3
Probability of zero income in case of the event (%)	10.5	7.9	14.9	20.1	18.9	14.2
Per-period participation cost (%)	0	0	0	0	0	0
Size of the expected loss in case of the event (%)	53.7	55.8	59.8	65.1	66.2	51.8
χ^2	83.7	186.1	294.6	27	25.5	131.9

Note: critical value for χ^2_4 = 9.5 for (95% confidence)

Table: Structural Estimation Results

Model	Parameter restrictions	Degrees of freedom	More educated (χ^2) Coh.1	Coh.2	Coh.3	Less educated (χ^2) Coh.1	Coh.2	Coh.3
1	–	4	83.7	186.1	294.6	27.0	25.5	131.9
2	$\sigma_\delta^2 = \kappa = 0$	6	172.7	334.3	592.4	117.1	105.2	153.2
3	$p = \phi = 0, \quad \pi = 0.032$	7	7,436	9,620	5,655	2,379	2,244	5,080
4	$p = \phi = \sigma_\delta^2 = \kappa = 0, \ \pi = 0.032$	9	11,863	14,701	13,650	7,969	8,441	9,511

Notes: Number of *aps* =11


More educated
Less educated
Cohort 1
Mean Conditional Portfolio Share
Age
0
0.2
0.4
0.6
0.8
1
25 27 29 31 33 35 37 39 41 43 45
Actual data
Model 1
Model 3

A Disaster Scenario

	Percentage Fall in Consumption
More Educated	9.5%
Less Educated	11.1%
Aggregate	10.1%

2004 is the disaster year. 50% of the stock market wealth is lost and 15% of the population receive zero labor income for the entire year.

Important caveats

- Labor income risk is doing a lot of heavy lifting. If zero income possibility is eliminated:
  - conditional portfolio shares would still be hard to match.
  - disaster probabilities and sizes would be even less plausible
- Heterogeneity in preference parameters is essential (possible in income processes too).