One-Factor Asset Pricing

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Presentation Outline

- Motivation and Related Literature
- Generalized Disappointment Aversion SDF
- Asset Pricing Tests
- Disappointment Events
- Robustness Checks
- Conclusions

Motivation

- Long tradition in asset pricing linking premia to consumption risk
- C-CAPM: aggregate consumption growth should be a sufficient statistic for expected returns (Breeden, 1979)
- Main implication: *Risk Premium* $\propto \gamma Cov\left(r_{i,t+1}, \Delta c_{t+1}\right)$
- However, aggregate consumption growth has proved too smooth to
  - generate the empirical equity premium (Mehra and Prescott, 1985)
  - explain the cross-section of stock/ portfolio premia

  $\rightarrow$implied Risk Aversion coefficient implausibly high (Rabin, 2000)
- Recent attempts to engineer a more volatile SDF via alternative definitions of consumption risk (Parker and Julliard, 2005, Yogo, 2006, Jagannathan and Wang, 2007, Savov, 2011) have had limited success

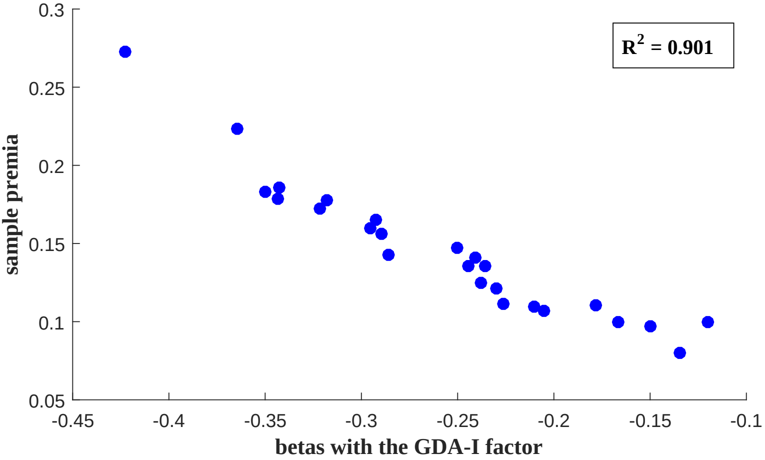
Motivation

- Empirical asset pricing literature dominated by multi-factor models since Fama and French (1993)
- Fishing license: Merton's ICAPM and Ross's APT
- Factors are typically return-generated and *a-theoretical*
- Unsettled debate whether factors proxy macro risks or capture anomalies, e.g.:
    - Why SMB does not yield a premium in recent sample periods?
    - What type of risk does WML capture?
- Proliferation of factors and factor models (3-factor FF, 4-factor FFC, 4-factor HXZ, 5-factor FF...)
- Serious data mining concerns (Harvey et al., 2016)

This Paper

- Propose a *single-factor*, *consumption-based* asset pricing model to explain the cross-section of equity returns
- Sole factor is an indicator of consumption growth being less than its certainty equivalent, derived from GDA preferences
- Intuitive interpretation of "bad times" and consumption risk
- Very good and robust empirical fit for various portfolio sorts and frequencies, comparable to Fama-French multi-factor models
- Plausible Disappointment Aversion coefficients

25 Size/BM Portfolio Premia



Disappointment Aversion

- Model is based on Disappointment Aversion preferences (Gul, 1991)
- Axiomatic framework, but relaxing the independence axiom of EU
- *Asymmetric* treatment of losses vs gains à la Kahneman and Tversky (1979) & Benartzi and Thaler (1995) $\longrightarrow$ kink in the utility function
- *But* reference point is endogenously defined (certainty equivalent of lottery) rather than imposed ad hoc
- Can resolve Allais paradox and explain Samuelson's famous gamble
- Investor exhibits *first-order risk aversion* (Segal and Spivak, 1990) unlike the traditional second-order risk aversion framework

Generalized Disappointment Aversion

- Functional form for GDA preferences (Routledge and Zin, 2010):

$$u(\mu(p)) = \sum_{x_i \in X} p(x_i)\, u(x_i) - \theta \sum_{x_i \leq \delta\mu(p)} p(x_i)\left(u(\delta\mu(p)) - u(x_i)\right)$$

  where $\mu(p)$ is the certainty equivalent for lottery p, θ is the DA coefficient, and δ is the multiplier of $\mu(p)$

- Interpretation: Investor imposes a penalty proportional to θ on lottery outcomes below the disappointment threshold

- Can be combined with separable or non-separable utility functions

Related Studies with (G)DA Preferences

- Portfolio Choice:
  - Ang, Bekaert and Liu (2005)
  - Khanapure (2012)
  - Dahlquist, Faragó and Tédongap (2016)
- Equity premium:
  - Epstein and Zin (2001)
  - Routledge and Zin (2010)
  - Bonomo, Garcia, Meddahi and Tédongap (2011)
  - Dolmas (2014)
- Cross-sectional asset pricing:
  - Ostrovnaya, Routledge and Zin (2006)
  - Faragó and Tédongap (2015)
  - Delikouras (2016)

Routledge and Zin (2010) SDF

- Starting point: GDA intertemporal SDF of Routledge and Zin (2010)

$$M_{t+1}^{GDA} = \overbrace{\underbrace{\beta \left(\frac{C_{t+1}}{C_t} \right)^{\rho - 1}}_{\text{C-CAPM}} \left[\frac{V_{t+1}}{\mu_t \left(V_{t+1} \right)} \right]^{\alpha - \rho}}^{\text{Epstein-Zin terms}} \underbrace{\left[\frac{1 + \theta \mathbf{1}\{ V_{t+1} \leq \delta \mu_t \}}{1 + \theta \delta^{\alpha} \mathbb{E}_t [\mathbf{1}\{ V_{t+1} \leq \delta \mu_t \}]} \right]}_{\text{Disappointment Aversion correction}}$$

- $\mu_t(V_{t+1})$: Certainty Equivalent of Lifetime Utility (non-separability)
- θ : Disappointment Aversion coefficient (overweigh losses)
- $\mathbf{1}\{ V_{t+1} \leq \delta \mu_t \}$: Indicator of disappointment events
- Nested preferences:
  - $\theta = 0 \rightarrow$ Epstein-Zin preferences
  - $\theta = 0$ & $\alpha = \rho \rightarrow$ Power utility preferences

GDA-I SDF

1. Homoscedastic AR(1) consumption growth with normal shocks
2. Disappointment Aversion *only* ($\alpha = \rho = 1$)

- Derive GDA-I SDF for *excess returns*:

$$M_{t+1}^{GDA-I} \propto \theta \mathbf{1}\{\Delta c_{t+1} \leq \underbrace{\overbrace{\mu_c(1-\phi_c) + \phi_c \Delta c_t}^{\text{conditional mean}} + d_2 \overbrace{\sqrt{1-\phi_c^2}\sigma_c}^{\text{st dev}}}_{\text{certainty equivalent}}\}$$

- Threshold for disappointment event depends on deviation from expected consumption growth controlled by d_2
- Consumption growth covariance risk is not priced
- GDA-I is an indicator function of consumption growth being less than its certainty equivalent $\longrightarrow$ *bi-modal SDF*

Comparison with Popular SDFs

- C-CAPM SDF:

$$M_{t+1}^{C-CAPM} \propto -\gamma \Delta c_{t+1}$$

- CAPM SDF:

$$M_{t+1}^{CAPM} \propto -b_m R_{m,t+1}^x$$

- NBER SDF:

$$M_{t+1}^{NBER} \propto \lambda \mathbf{1}\{> 4 \text{ NBER recession months in a year}\}$$

- Fama-French 3-factor SDF:

$$M_{t+1}^{FF3} \propto -b_m R_{m,t+1}^x - b_{SMB} R_{SMB,t+1} - b_{HML} R_{HML,t+1}$$

- Fama-French 5-factor SDF:

$$M_{t+1}^{FF5} \propto -b_m R_{m,t+1}^x - b_{SMB} R_{SMB,t+1} - b_{HML} R_{HML,t+1} - b_{RMW} R_{RMW,t+1} - b_{CMA} R_{CMA,t+1}$$

Data

- Sample period: 1933-2012
- BEA consumption of services and non-durables
- Normalized by population and PCE price index
- NBER recession periods
- K. French's online data library
    - 6 & 25 & 100 Size/BM portfolios
    - 25 Size/OP & 25 Size/INV portfolios (post '64)
    - 10 LTR portfolios
    - 10 E/P portfolios (post '53)
    - Fama-French factors
- Corporate bond and equity index option portfolios

Estimation

- Need to specify consumption growth moments to identify disappointment events and test GDA-I model
- Fit the empirical consumption growth moments *jointly* with Euler equations for excess portfolio returns for each cross-section via GMM:

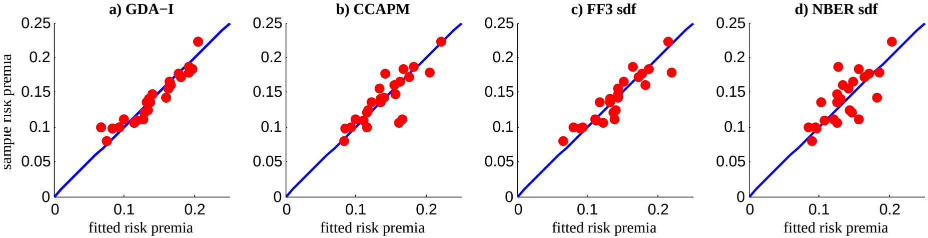
$$\begin{bmatrix} \mathbb{E}[\Delta c_t] - \mu_c \\ \mathbb{E}[\Delta c_t^2] - \mu_c^2 - \sigma_c^2 \\ \mathbb{E}[\Delta c_t \Delta c_{t-1}] - \mu_c^2 - \phi_c \sigma_c^2 \\ \mathbb{E}\left[(R_{i,t} - R_{1y,t}) \left(1 - \mathbb{E}\left[M_t^{GDA-I} \right] + M_t^{GDA-I} \right) \right] \end{bmatrix} = \mathbf{0}$$

- Weighting matrix ensures consumption growth moments matching
- Competing asset pricing models estimated via GMM using identity weighting matrix

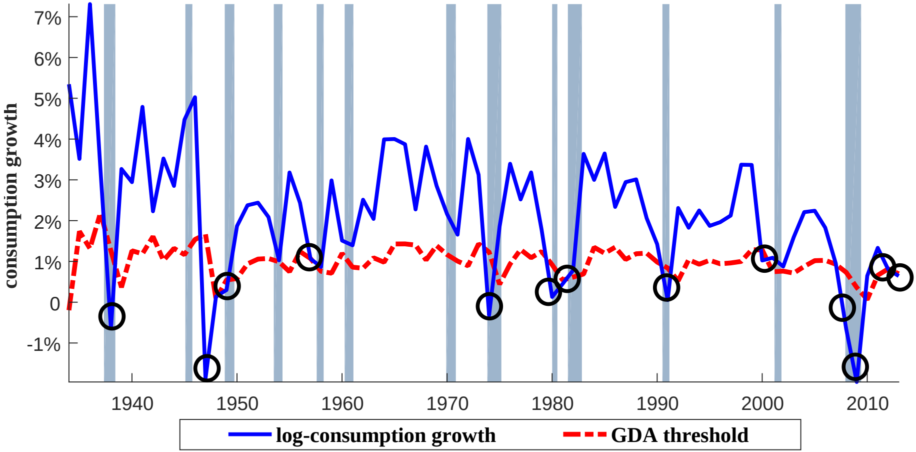
Annual 25 Size/BM Portfolios: Estimates

	GDA-I	CCAPM	CAPM	FF3	FF5	NBER
GDA ind	**4.126**					
	[4.207]					
d_2	**-0.77**					
	[-3.006]					
CONS		**57.331**				
		[3.499]				
MKT			**2.935**	**2.043**	**3.191**	
			[4.781]	[2.375]	[2.218]	
SMB				**0.335**	**1.912**	
				[0.309]	[1.242]	
HML				**3.026**	**-0.473**	
				[3.079]	[-0.153]	
RMW					**0.967**	
					[0.308]	
CMA					**9.321**	
					[2.080]	
NBER ind						**9.157**
						[1.053]
χ^2	**28.795**	**87.58**	**97.94**	**62.46**	**42.57**	**5.543**
dof	**23**	**24**	**24**	**22**	**20**	**24**
p	**0.187**	**0**	**0**	**0**	**0.002**	**1**
RMSE	**1.345**	**2.107**	**2.973**	**1.648**	**1.563**	**2.358**
R^2	**0.901**	**0.758**	**0.519**	**0.852**	**0.821**	**0.697**

Annual 25 Size/BM Portfolios: Fit



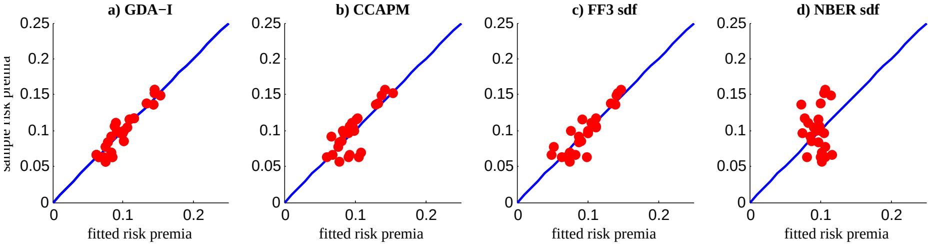
Disappointment Events



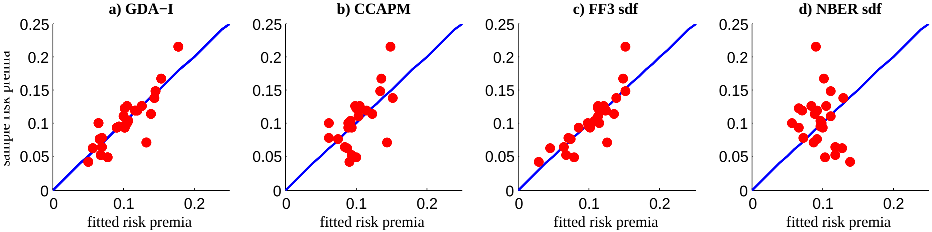
Disappointment Years Characteristics

	Full Sample	Disappointment	Non-Disappointment
Market Premium	**9.16%**	**-3.05%**	**11.52%**
SMB Premium	**2.12%**	**-5.68%**	**3.63%**
HML Premium	**9.02%**	**4.23%**	**9.95%**
S&P 500 Daily St. Dev.	**15.43%**	**19.22%**	**14.70%**
Term spread	**1.62%**	**0.99%**	**1.74%**
Real Consumption growth	**2.21%**	**-0.07%**	**2.65%**
Earnings growth	**11.23%**	**3.20%**	**12.78%**
Net Equity Expansion	**1.52%**	**0.77%**	**1.66%**
cay	**0.00%**	**-0.16%**	**0.03%**
Change in unemployment, t+1	**0.06%**	**0.97%**	**-0.10%**
Δ% in Consumer Confidence	**0.16%**	**-7.49%**	**1.80%**

Annual 25 Size/OP Portfolios: Fit



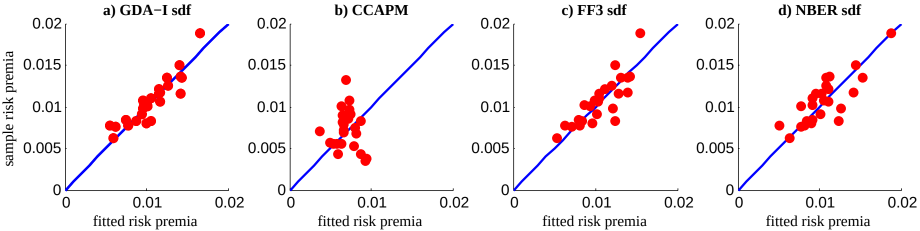
Annual 25 Size/INV Portfolios: Fit



Monthly 25 Size/BM Portfolios: Estimates

	GDA-I	CCAPM	CAPM	FF3	FF5	NBER
GDA ind	**3.673**					
	[3.293]					
CONS		**248.151**				
		[2.464]				
MKT			**3.579**	**2.342**	**3.625**	
			[4.974]	[2.847]	[2.245]	
SMB				**0.517**	**6.724**	
				[0.434]	[3.638]	
HML				**4.905**	**2.138**	
				[4.521]	[0.367]	
RMW					**9.49**	
					[1.837]	
CMA					**10.265**	
					[0.891]	
NBER ind						**7.786**
						[1.374]
χ^2	**41.296**	**70.582**	**121.875**	**94.856**	**94.631**	**9.662**
dof	**24**	**24**	**24**	**22**	**20**	**24**
p	**0.015**	**0**	**0**	**0**	**0**	**0.995**
RMSE	**0.119**	**0.283**	**0.249**	**0.156**	**0.142**	**0.174**
R^2	**0.818**	**-0.496**	**0.178**	**0.677**	**0.673**	**0.601**

Monthly 25 Size/BM Portfolios: Fit



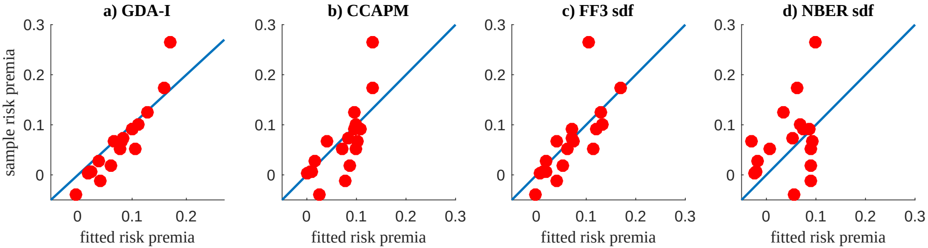
Robustness Checks

GDA-I SDF performs very well with:

1. Other equity portfolio cross-sections (LTR, E/P, 100 Size/BM, Joint)
2. Great Depression, pre-crisis & post-WWII periods
3. Recursive estimation of disappointment events
4. Value-weighted portfolios
5. Quarterly data
6. Two-stage GMM estimation
7. Other asset classes (corporate bond & equity index option portfolios)

Other Asset Classes

5 Corporate Bond & 6 Index Option & 6 Size/BM Portfolios: Annual Fit



Why does GDA-I SDF work?

- GDA-I SDF implies that an asset's premium should be a linear function of its losses during disappointment events

- The standard asset pricing equation

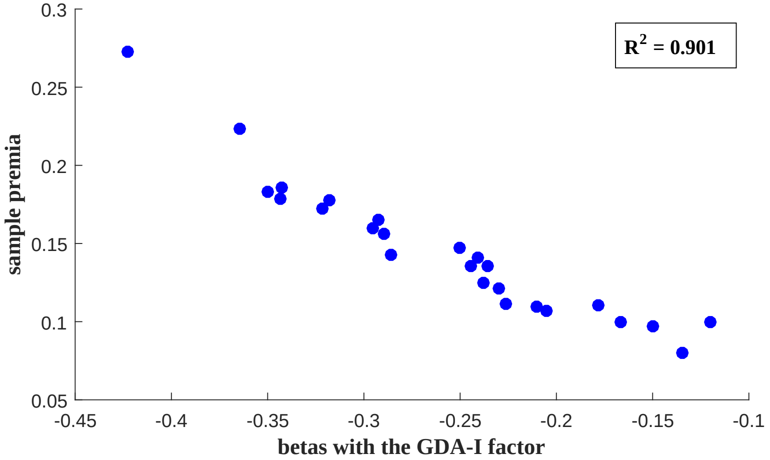
$$\mathbb{E}[R_{i,t} - R_{f,t}] = -Cov\left(R_{i,t} - R_{f,t}, M_t\right)$$

yields for GDA-I SDF:

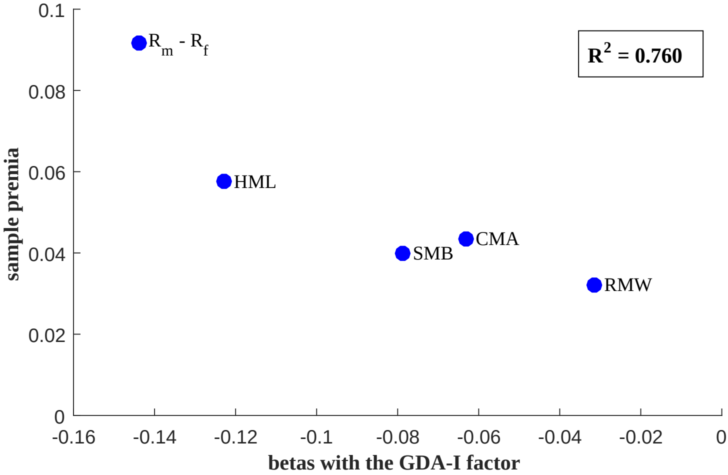
$$\mathbb{E}[R_{i,t} - R_{f,t}] = -\frac{\theta \mathbb{E}[\mathbf{1}_t]}{1 - \theta \mathbb{E}[\mathbf{1}_t]} \mathbb{E}[(R_{i,t} - R_{f,t}) | \mathbf{1}_t = 1]$$

- GDA-I SDF successfully aligns portfolio & factor premia with their *disappointment betas*

Premia & Disappointment Betas: 25 Size/BM Portfolios



Premia & Disappointment Betas: 5 Fama-French Factors

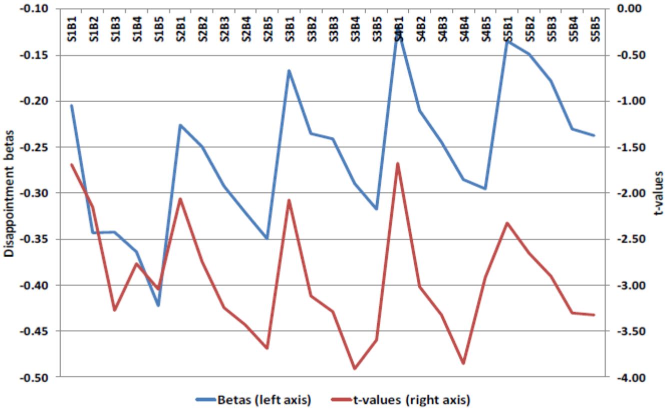


Disappointment Betas: Identification and Dispersion

- Reject the following H_0 regarding 25 Size/BM portfolio betas:

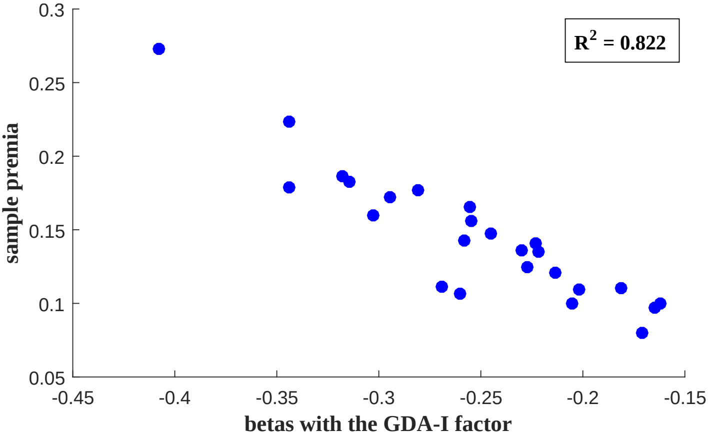
i) $\widehat{\beta}_i = 0 \ \forall$ portfolios, ii) $\widehat{\beta}_i = \overline{\widehat{\beta}} \ \forall$ portfolios

iii) $\widehat{\beta}_i = \widehat{\beta}_m \ \forall$ portfolios, iv) $\widehat{\beta}_{S1B5} = \widehat{\beta}_{S5B1}$



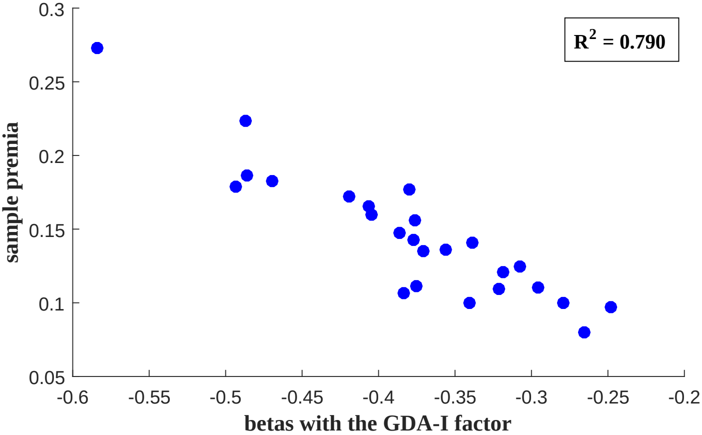
Sensitivity to Disappointment Threshold

- Use $\widetilde{d_2} = \widehat{d_2} \pm std\ error(\widehat{d_2})$ to determine new disappointment threshold & events and re-estimate 25 Size/BM portfolio betas
- $\widetilde{d_2} = \widehat{d_2} + std\ error(\widehat{d_2}) \Rightarrow$ 21 disappointment years



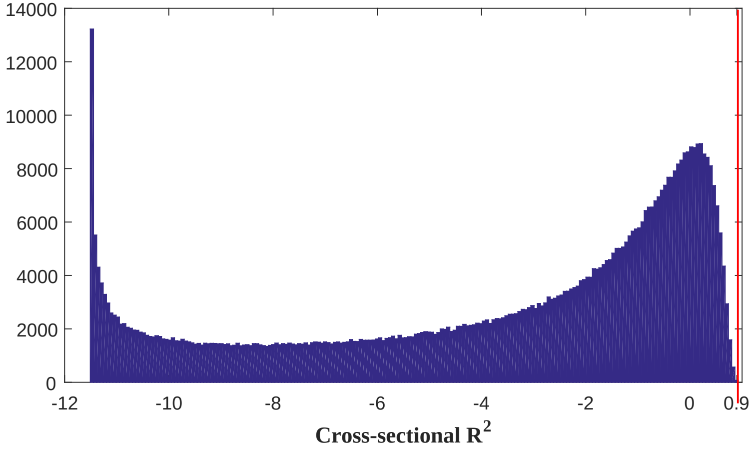
Sensitivity to Disappointment Threshold

- $\widetilde{d}_2 = \widehat{d}_2 - std\ error(\widehat{d}_2) \Rightarrow$ 7 disappointment years



Spurious Explanatory Power? Placebo Indicators

- Generate 1m series consisted of 13 ones & 67 zeros ($n = 80$)
- Estimate 25 Size/BM portfolio betas wrt placebo indicators
- Compute R^2 of portfolio premia on placebo betas (no intercept)



Conclusions

- Propose a simple SDF to explain the cross-section of equity returns
- GDA-I SDF consists of an indicator function of consumption growth being less than its certainty equivalent
- Founded on (G)DA preferences of Gul & Routledge and Zin
- Yields very good empirical fit and plausible DA coefficients for various cross-sections
- Question the ability of second-order risk aversion (smooth utility functions) to explain the cross-section of equity returns
- Support consumption-based asset pricing but highlight the importance of downside consumption risk