The Zero Beta Rate

Sebastian Di Tella (Stanford and NBER)
Benjamin Hébert (Stanford and NBER)
Pablo Kurlat (USC and NBER)
Qitong Wang (USC)

May 18, 2023

The Consumption Euler Equation

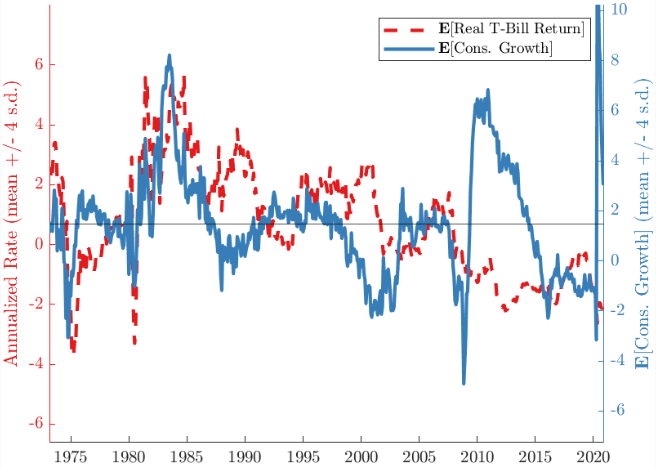
- The consumption Euler equation,

$$C_t^{-\sigma} = \mathbb{E}_t \left[\delta C_{t+1}^{-\sigma} \frac{R_{f,t}}{1 + \pi_{t+1}} \right]$$

is a foundation of modern macro models.

- Problem: it does not describe the data
  - with aggregate consumption C_t, CPI inflation π_t, and Treasury bill yield $R_{f,t}$
  - Hansen and Singleton [1983], Dunn and Singleton [1986], Yogo [2004]

The Consumption Euler Equation: Theory vs Data



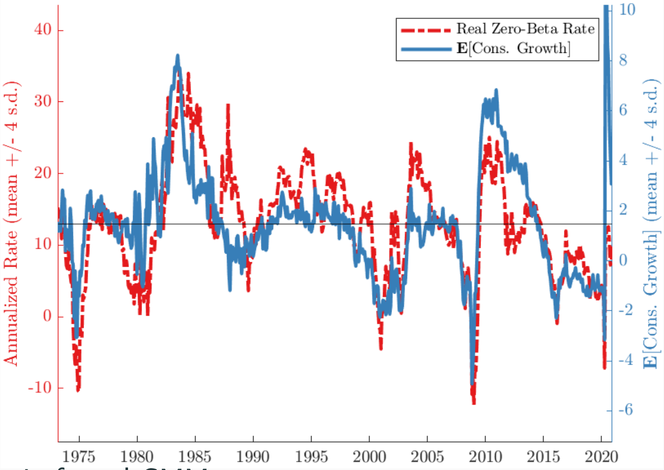
- Formal GMM tests reject: Dunn and Singleton [1986], Yogo [2004]

Responses

- Maybe habits or Epstein-Zin preferences? but see Canzoneri et al. [2007]
- Maybe wrong C_t, or time preference (δ_t) shocks?

- Our hypothesis: bonds are convenient, stocks are not
  - Cash and deposits have convenience. We don't expect the Euler equation to hold with their return. What if bonds are also convenient?
- Implication: all assets without convenience have same risk-adjusted return
  - call this the "zero-beta rate"
- We first estimate the zero-beta rate, then test the Euler equation

Main Result: A Consumption Euler Equation That Works



- cannot reject in formal GMM tests

Literature

- Key idea: time-varying estimate of zero-beta rate (Black [1972])
  - Black et al. [1972], Bali et al. [2017] : zero-beta rate 3-8% above Tsy yield
  - could have been problem with CAPM...
  - but Lopez-Lira and Roussanov [2020] and Kim et al. [2021] (among others) find high returns with no factor exposure
  - Some (weak) evidence on time-variation: Black et al. [1972], Shanken [1986]
- Macro models: large, volatile "Euler shock" needed in DSGE models (Smets and Wouters [2007]; Chari et al. [2009]; Fisher [2015])

What We Do

1. Construct a time-varying estimate of the zero beta rate
2. Show that it works in the consumption Euler
3. Implications for monetary policy

The Classic Euler Equation: Three Implications

1. Cross-sectional asset pricing: $0 = \mathbb{E}_t \left[\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}} \frac{R_{i,t+1} - R_{j,t+1}}{1+\pi_{t+1}} \right]$
2. Safe bonds: $R_{b,t}^{-1} = \mathbb{E}_t \left[\delta \frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}} \frac{1}{1+\pi_{t+1}} \right]$
3. The zero-beta (covariance w/ sdf) rate: $R_{0,t}^{-1} = \mathbb{E}_t \left[\delta \frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}} \frac{1}{1+\pi_{t+1}} \right]$

The Classic Euler Equation: Three Implications

1. Cross-sectional asset pricing: $0 = \mathbb{E}_t\left[\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}}\frac{R_{i,t+1}-R_{j,t+1}}{1+\pi_{t+1}}\right]$
2. Safe bonds: $R_{b,t}^{-1} = \mathbb{E}_t\left[\delta\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}}\frac{1}{1+\pi_{t+1}}\right]$
3. The zero-beta (covariance w/ sdf) rate: $R_{0,t}^{-1} = \mathbb{E}_t\left[\delta\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}}\frac{1}{1+\pi_{t+1}}\right]$

- (1) is false (cross-sectional AP e.g. Fama and French [1993])
- (2) is false (convenience, Hansen-Singleton)
- idea: test (3) without imposing (1) or (2)
- first: a modified Euler in which (3) but not (1) or (2) holds

Motivating Euler Equation

- Representative household maximizes

$$\mathbb{E}\left[\sum_{t=0}^{\infty}\delta^t\xi_t\left(\frac{C_t^{1-\sigma}}{1-\sigma}+\eta\left(\theta_t\right)\right)\right]$$

  - C_t: consumption, θ_t: asset holdings
  - $\eta(\theta_t)$: "convenience" from asset holdings. role: explain convenience yields (2)
  - ξ_t: exogenous shock to marginal utility, martingale independent of consumption
    - independence from consumption derived from primitive conditions in full model
    - role: explain why consumption doesn't price the cross-section (1)

- generalized Euler equation for nominal asset return $R_{i,t+1}$:

$$C_t^{-\sigma}=\frac{\partial\eta\left(\theta_t\right)}{\partial\theta_{i,t}}+\mathbb{E}_t\left[\delta\frac{\xi_{t+1}}{\xi_t}C_{t+1}^{-\sigma}\frac{R_{i,t+1}}{1+\pi_{t+1}}\right]$$

The Zero-Beta Rate

- Consider portfolio with (i) no convenience and (ii) uncorrelated with the SDF.
- R_{t+1} vector of N returns, $w \in \mathbb{R}^N$ weights of a zero-beta portfolio
- For zero-beta, zero-convenience portfolios only,
  1. classic consumption Euler holds,

$$C_t^{-\sigma} = \mathbb{E}_t\left[w' \cdot R_{t+1}\right] \mathbb{E}_t\left[\delta \frac{\xi_{t+1}}{\xi_t} \frac{C_{t+1}^{-\sigma}}{1+\pi_{t+1}}\right] = \underbrace{R_{0,t}}_{\text{zero-beta rate}} \mathbb{E}_t\left[\delta \frac{C_{t+1}^{-\sigma}}{1+\pi_{t+1}}\right]$$

  2. expected portfolio return is zero-beta rate:

$$\mathbb{E}_t[w' \cdot (R_{t+1} - R_{0,t})] = 0$$

- Plan: use second + extra structure to construct zero-beta rate, then test first

Factor Structure Implementation

- Implementation: (i) use stocks, and (ii) assume linear factor SDF,

$$\underbrace{\delta \frac{\xi_{t+1}}{\xi_t} \left(\frac{C_{t+1}}{C_t}\right)^{-\sigma} \frac{1}{1+\pi_{t+1}}}_{\text{SDF}} = (R_{0,t})^{-1} + \sum_{j=1}^{K} \omega_{j,t} \left(F_{j,t+1} - \mathbb{E}_t \left[F_{j,t+1}\right]\right) + \zeta_{t+1}$$

  - K factors, time-varying prices of risk $\omega_{j,t}$, ζ_{t+1} uncorrelated with returns
- Constant beta of excess returns to factors:

$$R_{i,t+1} - R_{0,t} = \alpha_i + \sum_{j=1}^{K} \beta_{ij} F_{j,t+1} + \epsilon_{i,t+1},\ \mathbb{E}_t \left[F_{j,t+1} \epsilon_{i,t+1}\right] = 0$$

  - note: $R_{0,t}$, not $R_{b,t}$, defines excess returns
- Zero-beta spread vs Tsy yield ("convenience spread") affine in L instruments Z_t:

$$R_{0,t} = R_{f,t} + \gamma' \cdot Z_t$$

  - $Z_{0,t} = 1$; extension: $\beta_{ij,t}$ linear in Z_t (ala "conditional CAPM")

Portfolio Interpretation

- Pretend we know excess returns $R_{t+1} - R_{0,t}$

1. Regress excess returns on factors to get betas
2. Form minimum variance zero-beta portfolio, $w^*(\gamma, \beta)$
   - minimum variance for efficiency, Ledoit and Wolf [2017] for robustness
3. Predict returns of portfolio using instruments Z_t,

$$w^*(\gamma, \beta)' \cdot R_{t+1} - R_{f,t} = \gamma' \cdot Z_t + \kappa_{t+1}$$

Portfolio Interpretation

1. Regress excess returns on factors to get betas
    - moments $\mathbb{E}\left[F_{j,t+1}\epsilon_{i,t+1}\right]$, $F_{0,t+1} = 1$
2. Form minimum variance zero-beta portfolio, $w^*(\gamma, \beta)$
    - minimum variance for efficiency, Ledoit and Wolf [2017] for robustness
3. Predict returns of portfolio using instruments Z_t,

$$w^*(\gamma, \beta)' \cdot R_{t+1} - R_{f,t} = \gamma' \cdot Z_t + \kappa_{t+1}$$

    - moments $\mathbb{E}\left[\kappa_{t+1} Z_t\right] = 0$

- Feasible: both moments at same time with GMM
    - inspired by Shanken [1986] MLE procedure
    - if all factors tradable: non-linear least squares w/ GLS

GMM Moments

- Let $\theta = (\alpha, \beta, \gamma)$ be the relevant parameters of the model.
- Define the orthogonal projection matrix, $H(\beta) = I - \beta\beta^{+}$.
  - If $w \in \mathbb{R}^N$ are portfolio weights, $\hat{w} = H(\beta) \cdot w$ are portfolio weights with zero beta.
- time-series moments (α, β) + instrumented asset pricing moments (γ):

$$g_{t+1}(\theta) = \begin{bmatrix} \epsilon_{t+1}(\theta) \otimes F_{t+1} \\ H(\beta) \cdot (R_{t+1} - R_{f,t} - \gamma' \cdot Z_t) \otimes Z_t \end{bmatrix}$$

- Weight second group by $w^*(\gamma, \beta) = H(\beta) w^*(\gamma, \beta)$ for exact identification,

$$W(\theta) = \begin{bmatrix} I & 0 \\ 0 & w^*(\gamma, \beta) w^*(\gamma, \beta)' \otimes I_L \end{bmatrix}$$

Data

- Stock portfolios: size by value by market beta sorted portfolios + industries
- Factors: five equity factors (Fama and French [2015]) + 2 bond factors (Fama and French [1993]). Also: consumption SDF (doesn't matter)
- Instruments: t-bill yield, 12m trailing inflation, unemployment, term spread, excess bond premium (EBP)
- Consumption: real Non-Durable + Services per capita

- Reasoning + Robustness in paper

Results (Jan 1973-Dec 2020)

Table 1: Predicting the Zero-Beta Rate

	(1) GMM	(2) OLS (inf.)
Lrf	1.186	1.187
	(0.914)	(0.789)
Lump	0.105	0.105
	(0.0986)	(0.0965)
Lebp	-0.603	-0.603
	(0.342)	(0.309)
Ltsp	0.310	0.310
	(0.118)	(0.119)
L2cpi_rolling	-2.582	-2.586
	(1.175)	(1.048)
Constant	0.718	0.716
	(0.137)	(0.134)
Wald/F	21.46	5.012
p-value	0.000663	0.000167
Observations	574	574

Standard errors in parentheses

Discussion

- Significant predictability (Wald/F); minimum-variance helps here
- High constant: 0.7%/mo excess return (not too surprising)
  - 3.2% std. dev., 0.8 annual Sharpe ratio vs. T-bills
- Spread increasing in rate level (Nagel [2016]), statistically weak)
- Spread decreasing in inflation (contra Cohen et al. [2005] story?)
- inverted TS, high EBP, low ump: bad expected returns when recession soon
  - macro variables help predict these stock returns

Perspectives

- Our perspective: $R_{0,t} - R_{f,t} = \mathbb{E}_t \left[R_{p,t+1} - R_{f,t}\right]$ represents convenience yield
- Alternative perspective: $R_{p,t+1} - R_{f,t}$ is an omitted factor
  - with a high Sharpe ratio, uncorrelated with all other factors
  - by no-arbitrage, there is an SDF the prices the stocks + Treasury bills
- The two perspectives can co-exist within the same model
  - Frazzini and Pedersen [2014]
  - and with other stories: Hong and Sraer [2016], Bali et al. [2017]
- Our perspective can explain why $R_{0,t}$ predicts consumption growth

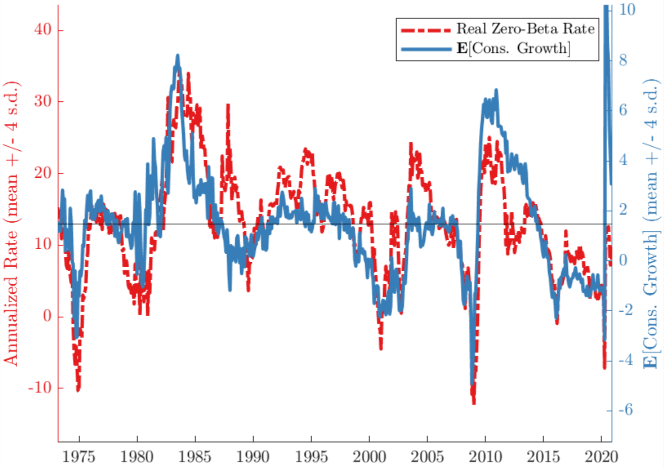
The Linearized Euler Equation

- Linearizing the consumption Euler equation:

$$E_t[\Delta c_{t+1}] = \sigma^{-1}\ln(\delta) + \sigma^{-1}(r_{0,t} - E_t[\pi_{t+1}])$$

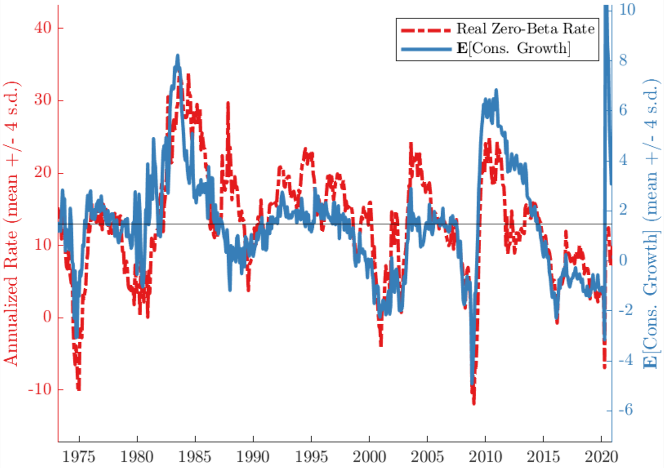
  - our figures line up the means, scale by standard deviations
  - in effect, choosing δ using the means and σ using the std. devs.
- Next:
  1. revisit figures
  2. compare $r_{0,t}$ and $r_{f,t}$ as predictors of Δc_{t+1}
  3. discuss weak identification problem
  4. conduct weak-i.d.-robust GMM inference

Main Result: A Consumption Euler Equation That Works



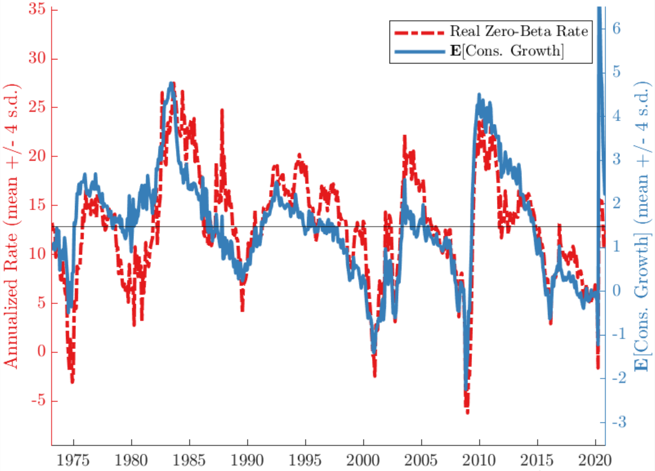
- Predictive regressions for inflation and consumption growth using Z_t

Without Consumption Factor



- No visually detectable differences when omitting consumption factor

Robustness: Ridge Regressions

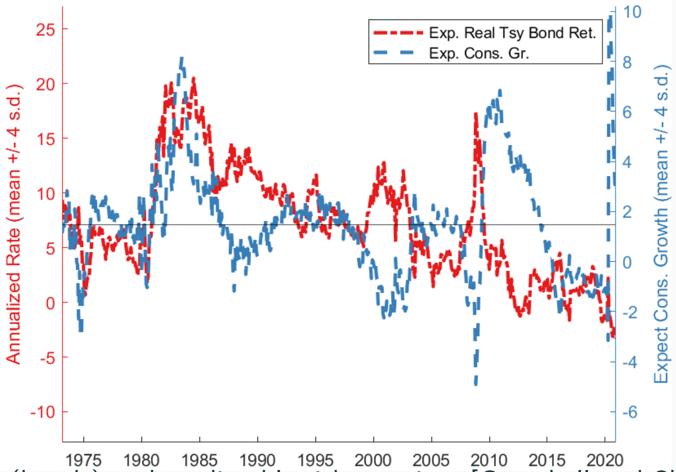


- γ and consumption prediction penalized using ridge, 10-fold cross-validation

What Can Go Wrong

- Too many factors: estimates noisy but unbiased
- Omitted factors:
  - omitted factor with constant risk price: only level biased, Euler still works
  - omitted factor with one-month ahead return predictability by our instruments: bias
- Too many instruments: weak identification (discussed next)
- Not enough instruments:
  - need at least two
  - bias if omitted instrument predicts either consumption growth or portfolio returns

Placebo: 6-11y Treasury Bond Returns



- convenience (bonds) and predictable risk premium [Campbell and Shiller, 1991]

Recap

- Two predictive regressions:

$$\Delta c_{t+1} = \sigma^{-1} \ln(\delta) + (\sigma^{-1}\gamma^c)' \cdot Z_t + \epsilon^c_{t+1},$$
$$r_{p,t+1} - \pi_{t+1} = (e_b + \gamma - \gamma^\pi)' \cdot Z_t + \epsilon^0_{t+1}.$$

- Define $\hat{\gamma} = \sigma^{-1}\gamma^c - e_b + \gamma - \gamma^\pi$
- Our graphs show $\hat{\gamma}' \cdot E[Z_t Z_t'] \cdot \hat{\gamma}$ is small (point estimates)
- Next steps:
  1. Test statistically if non-linear Euler can be rejected
     1.1 challenge: potential for weak instruments
  2. Test economically: do monetary shocks affect $\hat{\gamma}' \cdot Z_t$ (at point estimates)?

Weak-Identification Robust Inference

- Big picture: Stock and Wright [2000] meets Cochrane [2009]
  1. Conjecture value of σ_0 (null hypothesis)
  2. Estimate $\hat{\theta}(\sigma_0)$ using previous procedure
     2.1 constructs same zero-beta rate given σ_0
  3. Estimate $\hat{\delta}(\sigma_0)$ using $\mathbb{E}[\delta(\frac{C_{t+1}}{C_t})^{-\sigma_0}\frac{1}{1+\pi_{t+1}}R_{0,t}(\gamma)] = 1$
  4. Test using unused moments $\mathbb{E}[(\delta(\frac{C_{t+1}}{C_t})^{-\sigma_0}\frac{1}{1+\pi_{t+1}}R_{0,t}(\gamma) - 1)Z_{l,t}] = 0$
- S-set: values of σ_0 not rejected with 95% confidence

GMM Again

- OLS moments (α, β) + asset pricing moments (γ) + cons. Euler (δ):

$$g_{t+1}(\theta, \delta, \sigma_0) = \begin{bmatrix} \epsilon_{t+1}(\theta) \otimes F_{t+1}(\sigma_0) \\ H(\beta) \cdot (R_{t+1} - R_{0,t}(\gamma)) \otimes Z_t \\ (\delta(\frac{C_{t+1}}{C_t})^{-\sigma_0} \frac{1}{1+\pi_{t+1}} R_{0,t}(\gamma) - 1) \otimes Z_t \end{bmatrix}$$

- Weight matrix:

$$W(\theta) = \begin{bmatrix} I & 0 & 0 \\ 0 & w^*(\gamma, \beta) w^*(\gamma, \beta)' \otimes I_L & 0 \\ 0 & 0 & e_0 e_0' \end{bmatrix}$$

- Same exact identification scheme for (α, β, γ)
  - will recover same zero-beta rate given σ_0
- Exactly identify δ by average cons. Euler

Testing with Unused Moments

- For $l > 0$, the unused moments are

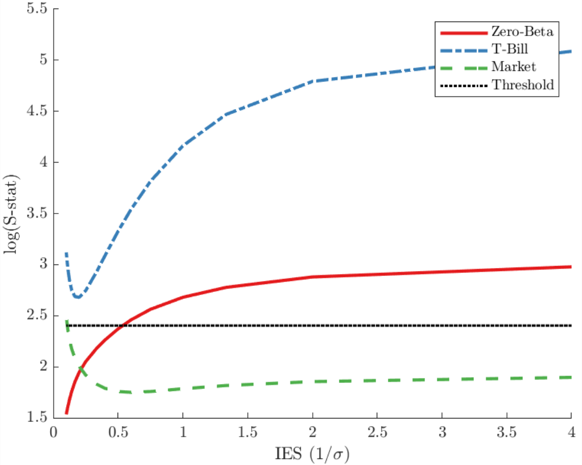
$$g_{l,t+1}(\theta, \delta, \sigma_0) = (\delta(\frac{C_{t+1}}{C_t})^{-\sigma_0} \frac{1}{1+\pi_{t+1}} R_{0,t}(\gamma) - 1) Z_{l,t}$$

- Let $\psi_{Test}(\sigma_0)$ be the vector $\frac{1}{T}\sum_{t=1}^{T} g_{l,t}(\hat{\theta}_1(\sigma_0), \hat{\delta}(\sigma_0), \sigma_0)$
- Let $\hat{V}_{Test}(\sigma_0)$ be the (robust) covariance matrix of $\psi_{Test}(\sigma_0)$
- Following Stock and Wright [2000]: under null of $\sigma = \sigma_0$,

$$\hat{S}(\sigma_0) = \psi_{Test}(\sigma_0)' \cdot \hat{V}_{Test}(\sigma_0)^{-1} \cdot \psi_{Test}(\sigma_0) \to^d \chi^2_L$$

  - robust to σ_0 weak i.d., not most powerful (Andrews [2016])
- Also show results for $R_{f,t}$ and $R_{m,t+1}$ in place of $R_{0,t}$ (Yogo [2004])

S-Set Results



- $R_{f,t}$: rejected $R_{m,t+1}$: not identified $R_{0,t}$: reject $\sigma \leq 1.5$, not reject $\sigma \geq 1.5$
- Nothing can reject for $\sigma \geq 20$ (COVID, rare disaster)

Summary

- The consumption Euler equation holds when applied to the zero-beta rate
  - in contrast to using a Treasury bill rate (rejected) or the market return (unidentified)
- Robustness:
  - Test assets: ⏩ More sorts
  - Factors: ⏩ linear cons., ⏩ Mkt+cons., ⏩ FF3+cons., ⏩ linear betas
  - Instruments: ⏩ +shadow spread, ⏩ +lag cons., ⏩ +CAPE, ⏩ BAAS instead of EBP
  - Others: ⏩ Non-durable goods cons. only, ⏩ pre-COVID

Interpretation

- When recessions are imminent (inverted term structure, high credit spreads, but currently low unemployment), agents expect:
    1. negative consumption growth (generates desire to save)
    2. low risk-adjusted (zero-beta) stock returns (offsets desire to save)

- Interest rates don't enter this calculation
    - short-dated bonds are held for convenience
    - longer-dated bonds inherit some convenience via financing

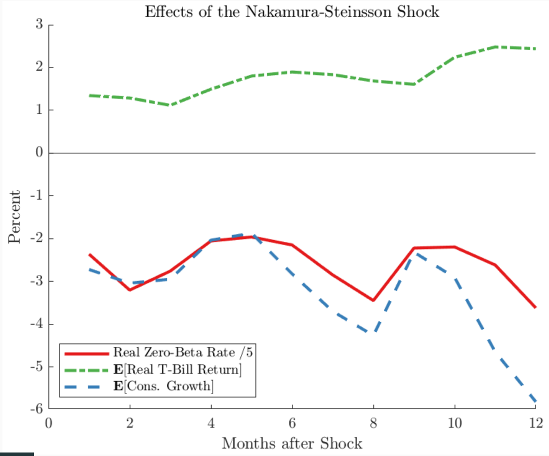
- Natural question: how does monetary policy change the zero-beta rate?

Monetary Shocks and the Zero-Beta Rate

- Is the convenience yield endogenous (concern of Chari et al. [2009])?
- Tension:
  - fed funds hike raise rates more generally
  - but lower consumption growth
  - inconsistent with standard Euler equation
- Suppose $R_{0,t} = \gamma' \cdot Z_t$ is structural
- How do Nakamura and Steinsson [2018] shocks affect $\gamma' \cdot Z_t$?
  - updated shocks from Acosta [2022]
  - paper: Romer and Romer [2004] shocks

Effects of NS Shocks

- change from t-1 to t+h regressed on NS shock in month t
- rates scaled (1 = 1:1 with fed funds)



Interpretation

- In response to a surprise monetary hike:
  - Data: consumption growth falls, then (maybe) rises ("hump")
  - Vanilla NK: consumption drops on impact, then grows
  - standard fix: habits
  - but habits don't fix Euler (Canzoneri et al. [2007]), inconsistent with MPCs (Auclert et al. [2020])
- Our story: zero-beta rate falls on impact, cons. gr. falls, vanilla Euler works
  - standard errors too large to test reversion (second part of "hump")
  - alternative to sticky information hypothesis (Auclert et al. [2020])

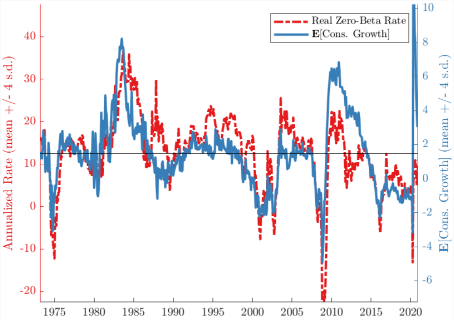
Related Papers on Stock/Bond Segmentation

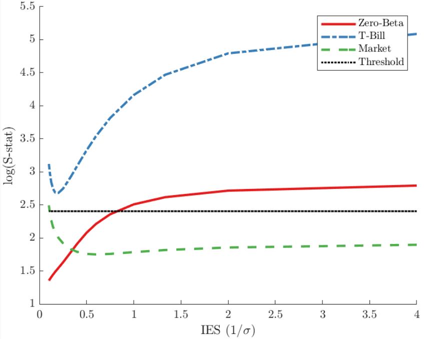
- Itskhoki and Mukhin [2021] exchange rate disconnect
- ROE on arbitrages (say, JPY-USD CIP) is 3-7% over bills (Boyarchenko et al. [2018])
- High return on physical capital: Gomme et al. [2011], Farhi and Gourio [2018]
- Beta anomaly (Frazzini and Pedersen [2014], Hong and Sraer [2016])
- Corporate finance implications thereof (Baker and Wurgler [2015], Baker et al. [2020])
- Equity premium puzzle (Bansal and Coleman [1996])

Conclusion

- The intertemporal price of consumption is not the yield on a Treasury
- The consumption Euler works– if you use the zero-beta rate
- This changes our understanding of monetary policy:
    - monetary shocks substantially alter convenience yields

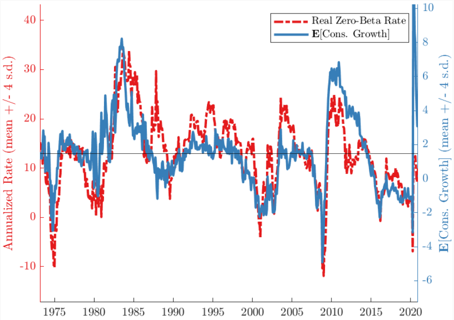
FF5 Sorted + Industry Portfolios

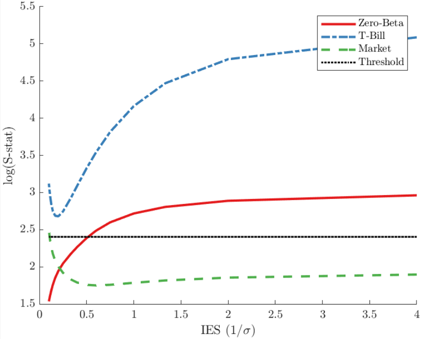




- 3x3x3 beta by size by {value, prof., inv.} + 49 industry portfolios
- Back

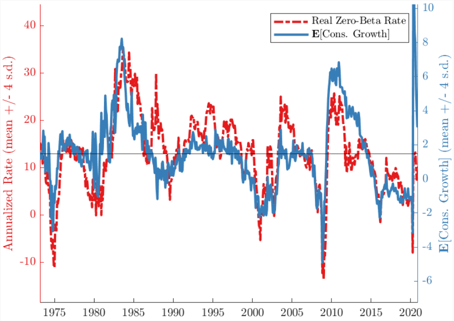
No Consumption Factor

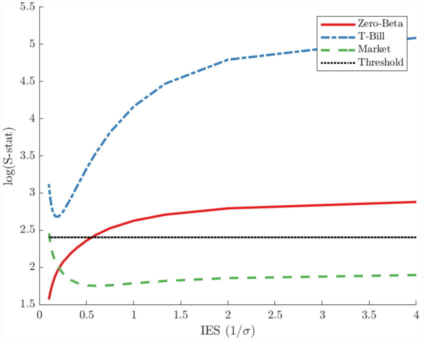




- No consumption-related factor
- Back

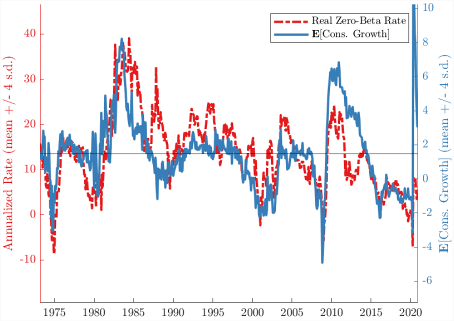
Linear Consumption Factor

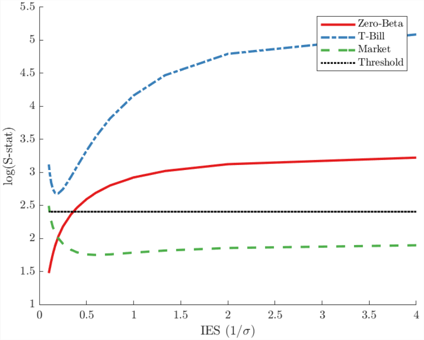




- Linear consumption factor + separate inflation factor
- ⏩ Back

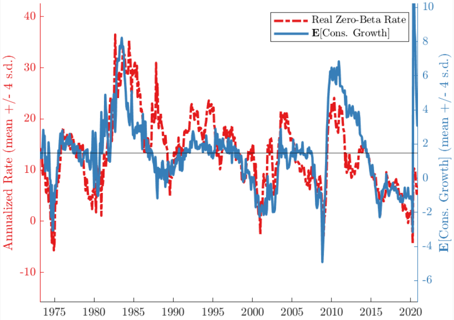
Market Factor

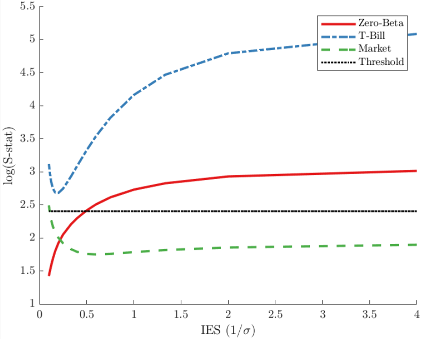




- Market + Non-Linear Consumption factor only
- Back

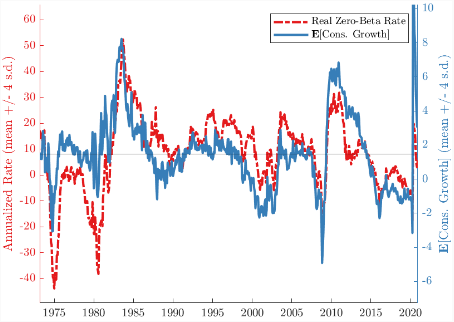
FF3 Factors

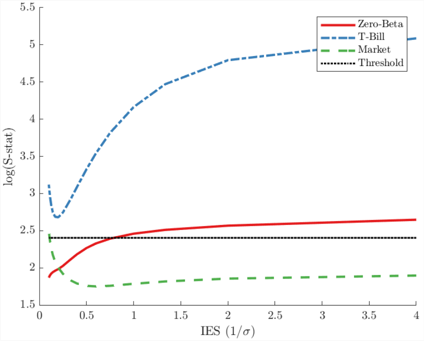




- Market, Size, Value, and Non-Linear Consumption factors only
- ⏩ Back

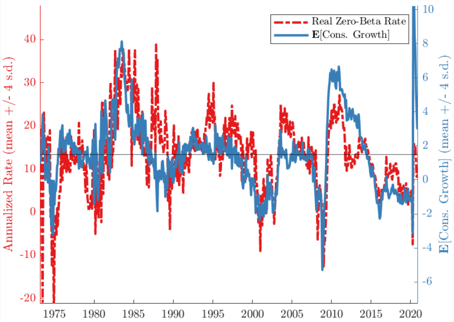
Linear Betas

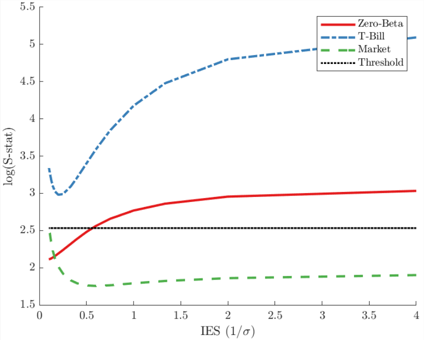




- $\beta_t = \beta_0 + \beta_1 \cdot Z_t$; 37 factors (6 factors * 6 Z + 1 consumption-related)
- Back

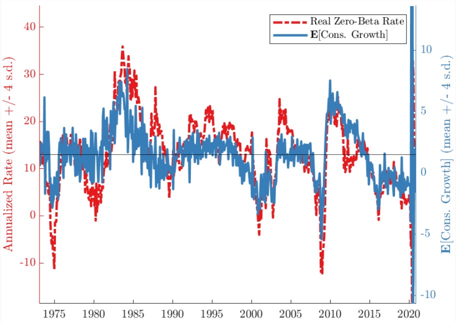
With Shadow Spread Instrument

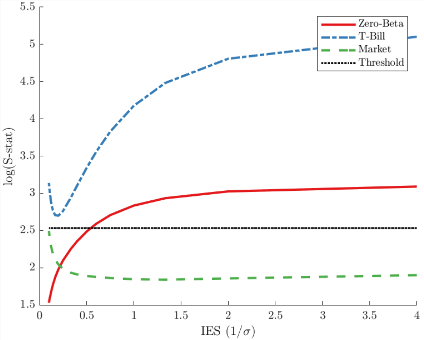




- Includes Lenel et al. [2019] bill vs. term-structure-extrapolated bill as instrument
- Back

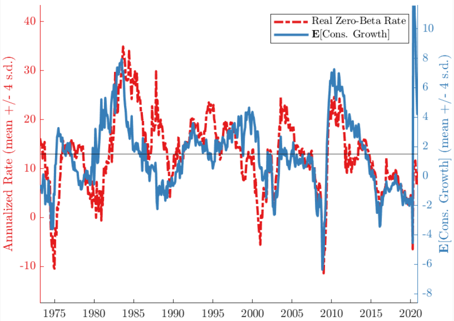
With Lagged Consumption Instrument

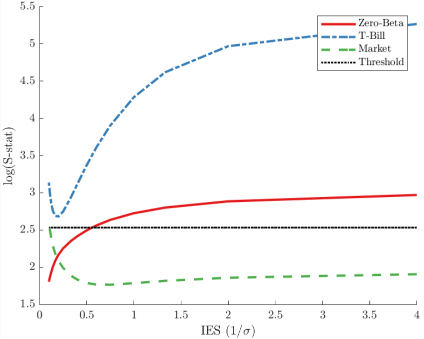




- Includes Δc_{t-1} as instrument
- ⏩ Back

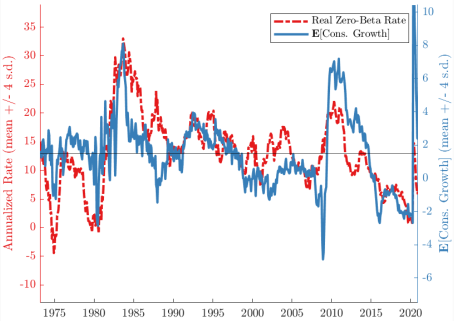
With CAPE Instrument

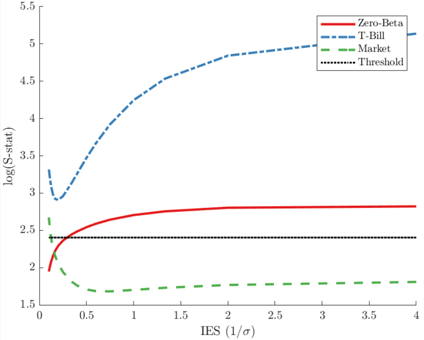




- Includes Campbell-Shiller cyclically-adjusted P/E ratio as instrument
- ⏩ Back

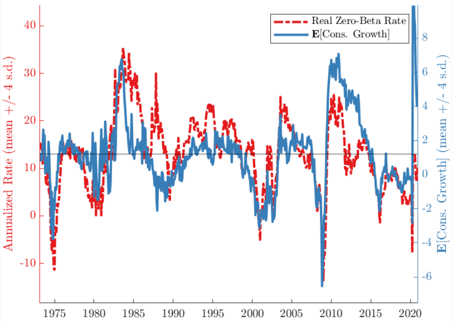
With BAA-Tsy in place of EBP

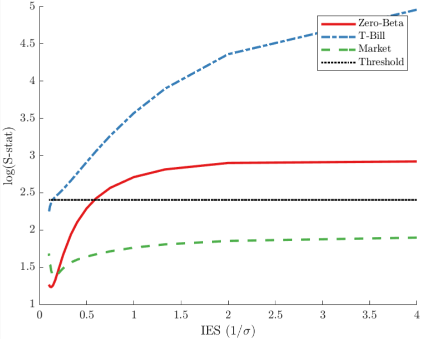




- Includes Moody's BAA-Treasury spread instead of EBP as instrument
- Back

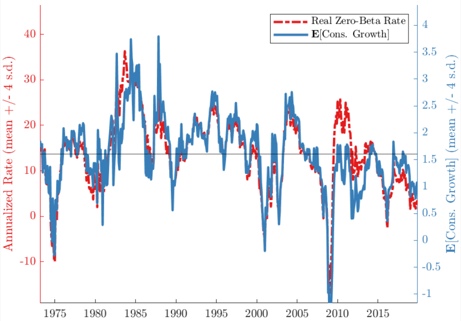
With Non-Durable Goods Consumption Only

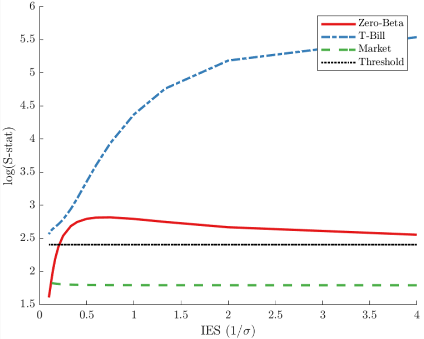




- Consumption is real non-durable goods consumption per capita
- Back

Without COVID





- Data sample ends in December 2019
- Back

References

Miguel Acosta. The perceived causes of monetary policy surprises. *Published Manuscript URL https://www1. columbia. edu/~ jma2241/papers/acosta_jmp. pdf*, 2022.

Isaiah Andrews. Conditional linear combination tests for weakly identified models. *Econometrica*, 84(6):2155–2182, 2016.

Adrien Auclert, Matthew Rognlie, and Ludwig Straub. Micro jumps, macro humps: Monetary policy and business cycles in an estimated hank model. Technical report, National Bureau of Economic Research, 2020.

Malcolm Baker and Jeffrey Wurgler. Do strict capital requirements raise the cost of capital? bank regulation, capital structure, and the low-risk anomaly. *American Economic Review*, 105(5):315–20, 2015.

Malcolm Baker, Mathias F Hoeyer, and Jeffrey Wurgler. Leverage and the beta anomaly. *Journal of Financial and Quantitative Analysis*, 55(5):1491–1514, 2020.

Turan G Bali, Stephen J Brown, Scott Murray, and Yi Tang. A lottery-demand-based explanation of the beta anomaly. *Journal of Financial and Quantitative Analysis*, 52 (6):2369–2397, 2017.

Ravi Bansal and Wilbur John Coleman. A monetary explanation of the equity premium, term premium, and risk-free rate puzzles. *Journal of political Economy*, 104(6): 1135–1171, 1996.

Fischer Black. Capital market equilibrium with restricted borrowing. *The Journal of business*, 45(3):444–455, 1972.

Fischer Black, Michael C Jensen, Myron Scholes, et al. The capital asset pricing model: Some empirical tests. 1972.

Nina Boyarchenko, Thomas M Eisenbach, Pooja Gupta, Or Shachar, and Peter Van Tassel. Bank-intermediated arbitrage. *FRB of New York Staff Report*, (858), 2018.

John Y Campbell and Robert J Shiller. Yield spreads and interest rate movements: A bird's eye view. *The Review of Economic Studies*, 58(3):495–514, 1991.

Matthew B Canzoneri, Robert E Cumby, and Behzad T Diba. Euler equations and money market interest rates: A challenge for monetary policy models. *Journal of Monetary Economics*, 54(7):1863–1881, 2007.

Varadarajan V Chari, Patrick J Kehoe, and Ellen R McGrattan. New keynesian models: not yet useful for policy analysis. *American Economic Journal: Macroeconomics*, 1 (1):242–66, 2009.

John H Cochrane. *Asset Pricing:(Revised Edition)*. Princeton university press, 2009.

Randolph B Cohen, Christopher Polk, and Tuomo Vuolteenaho. Money illusion in the stock market: The modigliani-cohn hypothesis. *The Quarterly journal of economics*, 120(2):639–668, 2005.

Kenneth B Dunn and Kenneth J Singleton. Modeling the term structure of interest rates under non-separable utility and durability of goods. *Journal of Financial Economics*, 17(1):27–55, 1986.

Eugene F Fama and Kenneth R French. Common risk factors in the returns on stocks and bonds. *Journal of financial economics*, 33(1):3–56, 1993.

Eugene F Fama and Kenneth R French. A five-factor asset pricing model. *Journal of financial economics*, 116(1):1–22, 2015.

Emmanuel Farhi and François Gourio. Accounting for macro-finance trends: Market power, intangibles, and risk premia. *Brookings Papers on Economic Activity*, 2018.

Jonas DM Fisher. On the structural interpretation of the smets–wouters "risk premium" shock. *Journal of Money, Credit and Banking*, 47(2-3):511–516, 2015.

Andrea Frazzini and Lasse Heje Pedersen. Betting against beta. *Journal of financial economics*, 111(1):1–25, 2014.

Paul Gomme, B Ravikumar, and Peter Rupert. The return to capital and the business cycle. *Review of Economic Dynamics*, 14(2):262–278, 2011.

Lars Peter Hansen and Kenneth J Singleton. Stochastic consumption, risk aversion, and the temporal behavior of asset returns. *Journal of political economy*, 91(2):249–265, 1983.

Harrison Hong and David A Sraer. Speculative betas. *The Journal of Finance*, 71(5): 2095–2144, 2016.

Oleg Itskhoki and Dmitry Mukhin. Exchange rate disconnect in general equilibrium. *Journal of Political Economy*, 129(8):2183–2232, 2021.

Soohun Kim, Robert A Korajczyk, and Andreas Neuhierl. Arbitrage portfolios. *The Review of Financial Studies*, 34(6):2813–2856, 2021.

Olivier Ledoit and Michael Wolf. Nonlinear shrinkage of the covariance matrix for portfolio selection: Markowitz meets goldilocks. *The Review of Financial Studies*, 30 (12):4349–4388, 2017.

Moritz Lenel, Monika Piazzesi, and Martin Schneider. The short rate disconnect in a monetary economy. *Journal of Monetary Economics*, 106:59–77, 2019.

Alejandro Lopez-Lira and Nikolai L Roussanov. Do common factors really explain the cross-section of stock returns? *Available at SSRN 3628120*, 2020.

Stefan Nagel. The liquidity premium of near-money assets. *The Quarterly Journal of Economics*, 131(4):1927–1971, 2016.

Emi Nakamura and Jón Steinsson. High-frequency identification of monetary non-neutrality: the information effect. *The Quarterly Journal of Economics*, 133(3): 1283–1330, 2018.

Christina D Romer and David H Romer. A new measure of monetary shocks: Derivation and implications. *American economic review*, 94(4):1055–1084, 2004.

Jay Shanken. Testing portfolio efficiency when the zero-beta rate is unknown: a note. *The Journal of Finance*, 41(1):269–276, 1986.

Frank Smets and Rafael Wouters. Shocks and frictions in us business cycles: A bayesian dsge approach. *American economic review*, 97(3):586–606, 2007.

James H Stock and Jonathan H Wright. Gmm with weak identification. *Econometrica*, 68(5):1055–1096, 2000.

Motohiro Yogo. Estimating the elasticity of intertemporal substitution when instruments are weak. *Review of Economics and Statistics*, 86(3):797–810, 2004.