Revisiting the Consumption-based CAPM in India: A Conditional Approach Using the Consumption–Wealth

Tanishq Gupta, Sourabh Hukkeri & Tushar Singh

Department of Humanities and Social Sciences
Indian Institute of Technology Roorkee

1st November, 2025

Replication exercise

- The original paper: Lettau, Martin, and Sydney Ludvigson. "Resurrecting the (C)CAPM: A Cross-Sectional Test When Risk Premia Are Time-Varying." Journal of Political Economy, vol. 109, no. 6, 2001, pp. 1238–87. JSTOR, https://doi.org/10.1086/323282.

Introduction: The Problem

- The foundational CAPM and C-CAPM perform poorly in empirical tests.
- They fail to explain the cross-section of average stock returns.
- A key failure is the persistent "value premium" puzzle.
- Value stocks (high book-to-market) consistently outperform growth stocks (low book-to-market).
- This suggests the simple, unconditional models are misspecified.

Introduction: The Solution & Our Question

- **The Solution (Lettau & Ludvigson, 2001):**
- Standard models wrongly assume constant risk premia.
- The price of risk is actually time-varying.
- Risk price is high in "bad times" (high risk aversion) and low in "good times" (low risk aversion).
- **Our Research Question:**
- Can this conditional approach "resurrect" the (C)CAPM in the unique context of the Indian market?

Theoretical Framework

1. The Unconditional Model (What Fails)
   - $E[R_i] = \lambda \cdot \beta_i$
   - Assumes a **constant price of risk** (λ). This is the critical flaw.

2. The Conditional Model (The Fix)
   - $E_t[R_i] = \lambda_t \cdot \beta_{i,t}$
   - Allows the price of risk (λ_t) to change over time based on the economic state (z_t).

3. The "Scaled" Model (What We Test)
   - This is a testable, multi-factor version of the conditional model.
   - $E[R_i] = \lambda_0 \beta_i \Delta c + \lambda_1 \beta_i \Delta c \cdot z_t$
   - Risk is now captured by two betas: the standard one and the "scaled" one.

The State Variable (z_t): The cay Ratio

- The state z_t is proxied by cay.
- cay is the (log) deviation of consumption from its long-run trend with (log) asset wealth (a_t) and (log) labor income (y_t).
- $c_t = \alpha + \beta_a a_t + \beta_y y_t + u_t$
- The residual $\hat{u}_t$ is our estimate of cay.
- **Intuition:**
  - **High** cay**:** "Bad times." Consumption is low vs. wealth. Investors are risk-averse and demand high returns.
  - **Low** cay**:** "Good times." Consumption is high vs. wealth. Investors are less risk-averse.

Data Sources

- **Frequency:** Monthly
- **Sample Period:** April 2014 – March 2025

c

Variable	Description	Source
Consumption	Household Consumption	CMIE CPHS
Asset Wealth	Aspirational Data	CMIE CPHS
Labor Income	Household Income	CMIE CPHS
Test Assets	Stock Returns, Mkt Cap, Book Value	CMIE Prowess
Market Return	NSE500 TRI	CMIE Prowess
Risk-Free Rate	91-day Treasury Bill	DBIE
Inflation	CPI / WPI	MoSPI

Table: Summary of core datasets used in the analysis.

Portfolio Construction: Fama-French 6 Portfolios

- We create 6 test portfolios using a 2x3 sort on Size and Value.
- This follows the methodology of Agarwalla, Jacob & Varma (2013) for India.
- **Size Sort (Big/Small):**
  "Big" = Top 10% of firms by market cap.
  "Small" = Bottom 90% of firms by market cap.
- **Value Sort (Value/Neutral/Growth):**
  "Value" (High B/M) = Top 30%.
  "Neutral" (Medium B/M) = Middle 40%.
  "Growth" (Low B/M) = Bottom 30%.
- Portfolios are formed annually in September to align with India's fiscal year.

Data Nuances & Wealth Index Construction

- Consumption & Income data was aggregated nationally using the "Raw Household national weights" from the CMIE CPHS survey.
- **Major Challenge:** No official high-frequency household wealth data exists for India.
- **Our Solution:** We construct a Wealth Index using CMIE "Aspirational Data" (i.e., household asset ownership).
- We use Principal-Components Analysis (PCA) to derive the index weights (Filmer & Pritchett, 2001).
- The first principal component is the linear index that captures the maximum common variance from all assets.
- This index serves as our a_t (log asset wealth) variable for the cay regression.

Constructing the Indian cay

- We estimate the long-run relationship for (log) consumption (c_t), wealth (a_t), and income (y_t).
- $c_t = \alpha + \beta_a a_t + \beta_y y_t + u_t$

Our Estimated Equation (OLS)

$c_t = \mathbf{3.829} + \mathbf{0.057} a_t + \mathbf{0.538} y_t + \hat{u}_t$

- The residual $\hat{u}_t$ from this regression is our Indian cay series.

Validation: Stationarity

- An ADF test confirms the cay series is **stationary** (p-value = 0.021).
- This validates cay as a stable, mean-reverting deviation from the long-run trend.

Models Tested: 1. Unconditional (The Baseline)

- These models assume a constant price of risk. We expect them to perform poorly.
- **1. Standard CAPM** (Factor: Market, R_m)
  $E[R_i] = \lambda_0 + \lambda_{MKT}\beta^i_{MKT}$
- **2. Consumption CAPM** (Factor: Consumption Growth, Δc)
  $E[R_i] = \lambda_0 + \lambda_{\Delta c}\beta^i\Delta c$
- **3. Human Capital CAPM** (Factors: R_m + Labor Income Growth, Δy)
  $E[R_i] = \lambda_0 + \lambda_{MKT}\beta^i_{MKT} + \lambda_{\Delta y}\beta^i\Delta y$

Models Tested: 2. Conditional & Scaled Models

- We test if cay improves models in two different ways:
  1. As a new, independent risk factor:
- We add cay to the model directly.
- e.g., $E[R_i] = \lambda_0 + \lambda_{\Delta c}\beta_i\Delta c + \lambda_{cay}\beta_i cay$
  2. As a scaling variable (Interaction Term):
- This is the L&L (2001) test for time-varying risk.
- $E[R_i] = \lambda_0 + \lambda_{MKT}\beta_i MKT + \lambda_{cay}\beta_i^{cay} + \lambda_{INT}\beta_i MKT \cdot cay$

Findings (1): Baseline Benchmark Models

Table: Fama-MacBeth Results: Unconditional Models

Model	λ_0 (Const)	λ_{MKT}	$\lambda_{\Delta c}$	$\lambda_{\Delta y}$	λ_{SMB}	λ_{HML}	Avg. R^2
CAPM	-5.33 (-1.52)	0.69 (0.12)	–	–	–	–	**34.4%**
HCAPM	-6.30** (-2.05)	0.59 (0.19)	–	-0.09 (-0.33)	–	–	**48.6%**
CCAPM	-5.78*** (-10.15)	–	-7.96 (-0.94)	–	–	–	**34.3%**
Fama-French	-5.29*** (-12.36)	–	–	–	0.50 (1.16)	**0.81**** **(2.22)**	**87.6%**

Shanken (1992) t-statistics in parentheses. *** p¡0.01, ** p¡0.05, * p¡0.1

Interpretation

- **Hypothesis 1 Confirmed:** The standard models (CAPM, CCAPM) fail. Their key factors are insignificant and R^2 is low.
- The Fama-French benchmark works well ($R^2 = 87.6\%$) and the value premium (HML) is significant.

Findings (2): "Resurrection" using cay as a Factor

Table: Fama-MacBeth Results: Models with cay as a risk factor

Model	λ_0	λ_{Base}	λ_{cay}	Avg. R^2
CCAPM + cay	-5.83*** (-10.06)	-4.50 ($\lambda_{\Delta c}$) (-0.52)	**-0.58*** **(-1.83)**	**74.9%**
HCAPM + cay	-5.93* (-1.82)	-0.04 ($\lambda_{\Delta y}$) (-0.14)	-0.56 (-0.40)	**85.5%**

Shanken (1992) t-statistics in parentheses. λ_{Base} refers to the original macro factor. *** p¡0.01, ** p¡0.05, * p¡0.1

Interpretation

- Adding our Indian cay as a standalone factor dramatically improves the models.
- R^2 for the CCAPM jumps from 34.3% to **74.9%**.
- R^2 for the HCAPM jumps from 48.6% to **85.5%**, nearly matching the Fama-French model.
- The cay factor itself is statistically priced in the CCAPM (t-stat = -1.83*).

Findings (3): "Resurrection" using cay as a Scaler

Table: Fama-MacBeth Results: Testing for time-varying risk premia

Model	λ_0	λ_{MKT}	λ_{cay}	λ_{int}	Avg. R^2
CAPM + cay + Int.	-5.86	0.43	-0.53	**0.39****	**79.6%**
	(-1.29)	(0.12)	(-0.31)	**(2.49)**	

Shanken (1992) t-statistics in parentheses. λ_{int} = MKT · cay. *** p¡0.01, ** p¡0.05, * p¡0.1

Interpretation

- This is the pure Lettau & Ludvigson (2001) test.
- The R^2 for the CAPM jumps from 34.4% to **79.6%**.
- The **interaction term (λ_{int}) is highly significant** (t-stat = 2.49**).
- **Hypothesis 3 Confirmed:** This is strong evidence that risk premia in India are time-varying, and that our cay series successfully captures this variation.

Conclusion

- **Hypothesis 1 Confirmed:** The standard, unconditional CAPM and CCAPM fail to explain the cross-section of Indian stock returns.
- **Hypothesis 3 Confirmed:** We show that risk premia in India are time-varying. Our novel Indian cay series (p-value 0.021) successfully captures this variation.
- **Hypothesis 2 Confirmed:** By using cay as a scaling variable or a direct factor, we "resurrect" the (C)CAPM.
- Our **Conditional HCAPM** ($R^2 = 85.5\%$) performs nearly as well as the Fama-French 3-Factor model ($R^2 = 87.6\%$).
- **Main Takeaway:** The Fama-French "value premium" (HML) in India is not an anomaly. It appears to be a proxy for deeper, time-varying macroeconomic risks which our conditional models can capture.

Limitations Future Research

- **Refine the Wealth Index:** Our PCA index is a powerful proxy, but a more robust index could be built by incorporating household financial assets (not just physical) and adjusting for inflation.
- **Direct "Horse Race" Regression:** The next step is to run a regression with both our scaled macro factors and the F-F factors (SMB, HML) to see if our model "drives out" their significance.
- **Extend the Sample Period:** Our 11-year sample (2014-2025) is robust, but extending it further back in time would increase statistical power.
- **Expand Test Assets:** Validate these models on a larger set of portfolios, such as 25 Size/BM portfolios or industry/momentum-sorted portfolios.

Literature

Top 5 papers

- Fama, Eugene, F., and Kenneth R. French. 2004. "*The Capital Asset Pricing Model: Theory and Evidence.*" Journal of Economic Perspectives 18 (3): 25–46.
- Fama, Eugene F. and French, Kenneth R., *The Value Premium and the CAPM* (March 2005).
- Eugene F. Fama, Kenneth R. French, *Common risk factors in the returns on stocks and bonds*, Journal of Financial Economics, Volume 33, Issue 1, 1993, Pages 3-56, ISSN 0304-405X
- Sobhesh K. Agarwalla, Joshy Jacob & Jayanth R. Varma, Four Factor Model in Indian Equities Market (2014)
- Shweta Bajpai, Anil K. Sharma, *An Empirical Testing of Capital Asset Pricing Model in India*, Procedia - Social and Behavioral Sciences, Volume 189, 2015, Pages 259-265, ISSN 1877-0428

Use of AI Assistance

- **AI Tools Used:** Google `Gemini` (embedded in Colab), along with `ChatGPT` and `NotebookLM` used independently.
- **Scope of Usage:**
  - Accelerated code prototyping immensely.
  - Assisted in identifying, explaining, and resolving errors in real time.
  - Helped refine statistical models and documentation drafts.
- **Impact:** Significantly reduced development time — tasks that could have taken months were completed in weeks.
- **Role of AI:** Helped with speed and debugging, while final decisions remained human-driven.

(This slide was not written by AI, we promise.)

Appendix 1: Realized vs. Fitted Returns

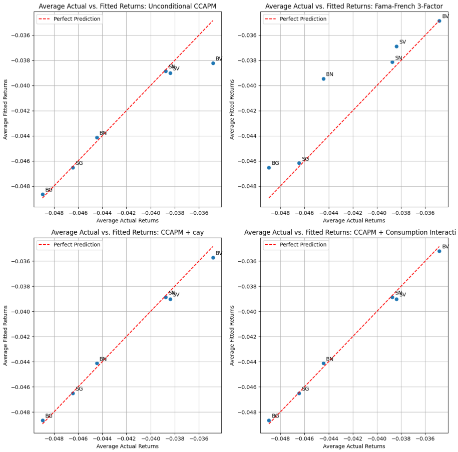

Figure: Realised vs Actual fit for the portfolios

Appendix 2: Why Does cay Work?

slide into columns

- This plot explains *why* the scaled models work.
- **Value Stocks (High B/M):**
- Have a **high** consumption beta only in "Bad Times" (when cay is high).
- They are riskiest when investors are most risk-averse.
- **Growth Stocks (Low B/M):**
- Have a **high** consumption beta in "Good Times" but a low beta in "Bad Times."
- They act as a hedge when times are bad.

Important

Value stocks command a premium because they expose investors to risk *exactly when they least want it*. Unconditional models miss this.

The Intuition: Why Does cay Work?

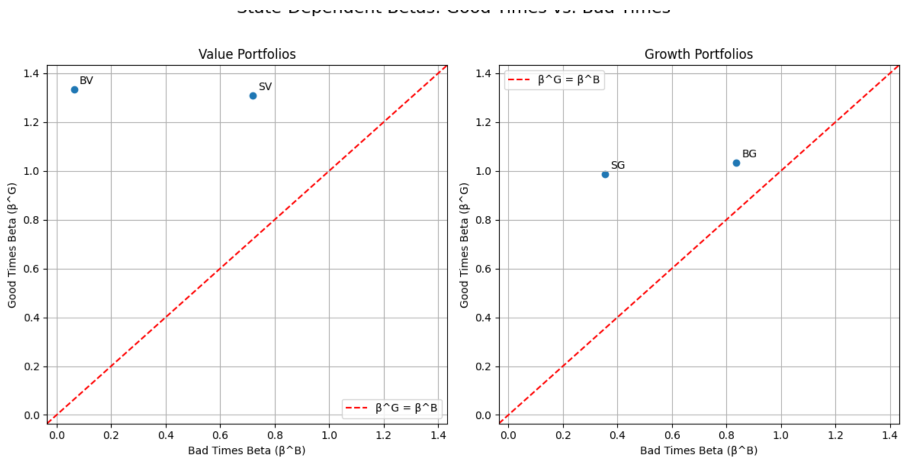

Figure: State-Dependent Consumption Betas

Thank you

Questions?

For all data, code, and replication files:

https://github.com/20tanishq10/

Revisiting-the-Consumption-based-CAPM-in-India

Resurrecting the (C)CAPM in India

Tanishq Gupta, Sourabh Hukkeri, & Tushar Singh