

International Evidence on Sticky Consumption Growth

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Consumption Habits Are Pervasive

- Equity premium puzzle
- Hump-shaped response of consumption to income shocks
- Dynamic effects of fiscal policy
- Persistence in current account balances
- ...

BUT

- No consensus on whether the Hall (1978) random walk model is in line with data
- Few estimates of how sluggish C growth is (in particular in international data)
- Estimates of habits often smaller than required by theory

The Hall Model and The Data

The Hall (1978) Random Walk Model

Consumption Growth Is Unpredictable and Thus Serially Uncorrelated

$$\mathbf{E}_t \Delta C_{t+1} = 0 \Rightarrow \mathbf{E}_t (\Delta C_t \times \Delta C_{t+1}) = 0$$

Existing Empirical Work Reveals Predictability...

with stock prices, income, consumer sentiment...

- Flavin (1981), Campbell and Mankiw (1989) and many others

... But Not as much as in Most Calibrated Models with Habits

- First autocorrelation of C growth in aggregate US data ≈ 0.35

Explanations of the “Excess Sensitivity” of Consumption

- Time Aggregation
Cannot Explain Strong AC in C Growth
- Precautionary Savings
Aggregate Uncertainty Is Small \Rightarrow Limited Relevance in Macro Data
- Data Construction Methods [e.g., interpolation and imputation]
We Argue This Is Important
- Rule-of-Thumb Consumers
We Argue This Is Less Important Than Typically Believed

Our Contribution

- Estimate the role “stickiness in aggregate C growth” (which can be interpreted as habits or sticky expectations) correcting for the presence of measurement error and transitory consumption (IV and the Kalman filter)
- Data from 13 countries

Our Findings

- Strong Evidence of C Growth **“Stickiness”**
- The Weight of Habits/Sticky Expectations Is about 70 Percent
- Typically Reject Rule-of-Thumb Consumers in Favor of Stickiness

Theories of Stickiness I.: Habit Formation

- Muellbauer (1988):

$$\begin{aligned} \max \mathbf{E}_s \sum_{t=s}^{\infty} \beta^{t-s} \mathbf{u}(C_t - \chi C_{t-1}) \\ \text{s.t. } B_{t+1} = (B_t - C_t)R + Y_{t+1} \end{aligned}$$

- χ : Weight of Habits (Represented with C_{t-1})
- Both Level of C and Growth Matter:

$$\mathbf{u}(C_t - \chi C_{t-1}) = \mathbf{u}((1 - \chi)C_t - \chi \Delta C_{t-1})$$

- Linearized FOC for CRRA Utility:

$$\Delta \log C_t = \chi \Delta \log C_{t-1} + \varepsilon_t$$

Theories of Stickiness II.: Sticky Expectations

- Carroll and Slacalek (2006), Reis (2006): **Consumers are inattentive**: know accurately their personal circumstances but follow macroeconomic developments only once in a while.
- Consumers update their info about permanent income with probability Π each period
- **Individual consumption growth** is dominated by idiosyncratic shocks and **is white noise**.
- **Aggregate consumption growth is AR(1)** with autocorrelation $1 - \Pi$

$$\Delta \log C_t = (1 - \Pi) \Delta \log C_{t-1} + \varepsilon_t$$

- Both habits and sticky expectations have identical implications in aggregate data (but not in micro data)

Estimation Methods à la Sommer (2007)

Instrumental Variables

$$\Delta \log C_t = \varsigma + \chi \mathbf{E}_{t-2}[\Delta \log C_{t-1}] + \eta \mathbf{E}_{t-2}[\Delta \log Y_t] + \alpha \mathbf{E}_{t-2}[A_{t-1}] + \varepsilon_t$$

Kalman filter

$$\begin{aligned}\Delta \log C_t &= \Delta \log C_t^* + u_t + (\theta - 1)u_{t-1} - \theta u_{t-2}, \\ \Delta \log C_t^* &= c_0 + \chi \Delta \log C_{t-1}^* + v_t + \lambda_1(\chi)v_{t-1} + \lambda_2(\chi)v_{t-2},\end{aligned}$$

where C^* is unobserved “true” consumption

OLS Is Biased

- Measurement error
- Transitory consumption (eg, hurricane Katrina)
- Time aggregation

Instrumental Variables

$$\Delta \log C_t = \varsigma + \chi \mathbf{E}_{t-2}[\Delta \log C_{t-1}] + \eta \mathbf{E}_{t-2}[\Delta \log Y_t] + \alpha \mathbf{E}_{t-2}[A_{t-1}] + \varepsilon_t$$

- Nests three alternatives:
 - $\chi = 0$ and $\eta = 0$: Random walk
 - $\chi = 0$: Rule-of-thumb consumers (with $C_t = Y_t$)
 - $\eta = 0$: C Stickiness (Habits/Sticky Expectations)
- Financial assets (A_{t-1}) included to account for precautionary savings and/or time-variation in interest rates
- With appropriate (ie, uncorrelated with measurement error and correlated with endogenous variables) instruments no need to specify the stochastic structure of measurement error.

Kalman Filter

Two-stage procedure

- 1 Kalman filter—MA(1) measurement error in log-level of C

$$\Delta \log C_t = \Delta \log C_t^* + u_t + (\theta - 1)u_{t-1} - \theta u_{t-2},$$

$$\Delta \log C_t^* = c_0 + \chi \Delta \log C_{t-1}^* + v_t + \lambda_1(\chi)v_{t-1} + \lambda_2(\chi)v_{t-2},$$

where C^* is unobserved “true” consumption

- λ s are nonlinear functions of χ
- MA(2) coefficient λ_2 is close to zero for reasonable $\chi \in (0, 1)$, so that $\Delta \log C_t^*$ is approximately ARMA(1,1).

- 2 Instrumental variables on

$$\Delta \log C_t^* = \varsigma + \chi \mathbf{E}_{t-2}[\Delta \log C_{t-1}^*] + \eta \mathbf{E}_{t-2}[\Delta \log Y_t] + \alpha \mathbf{E}_{t-2}[A_{t-1}] + \varepsilon_t$$

- 13 advanced economies
- Quarterly data roughly over past 40 years
- **Consumption:** Ideally, sum of nondurables and services (available only for Can, Fra, Ger, Ita, UK, US), else total personal consumption expenditures
- **Income:** Disposable income
- **Assets (A):** Ratio of financial assets to disposable income
- **Instruments:** Various sets; baseline: unemployment rate, long-term interest rate, index of price volatility and consumer sentiment

Baseline IV Results

$$\Delta \log C_t = \varsigma + \chi \mathbf{E}_{t-2}[\Delta \log C_{t-1}] + \eta \mathbf{E}_{t-2}[\Delta \log Y_t] + \alpha \mathbf{E}_{t-2}[A_{t-1}]$$

Country	One regressor only			All three regressors—Horse-race		
	χ	η	α	χ	η	α
Canada	0.72***	0.32***	0.33	0.64***	0.05	0.11
France	0.61***	0.29***	0.04	0.44	0.19	-0.04
Germany	0.40*	0.72***	-0.36	0.16	0.66***	-0.17
Italy	0.65***	0.20**	-0.05	0.53**	0.13	-0.02
United Kingdom	0.83***	0.10	0.27*	1.00***	-0.17	0.01
United States	0.83***	0.54***	0.26*	0.55***	0.27*	0.02
Australia	0.54***	0.12	0.10	0.51**	0.03	0.01
Belgium	0.64***	0.34**	0.11	0.56**	0.12	0.01
Denmark	0.86***	0.43	-0.34	0.78***	0.27	-0.32
Finland	0.90***	0.61**	0.53	0.86***	0.07	-0.13
Netherlands	0.70***	0.09	0.21	0.53	-0.14	0.10
Spain	0.94***	0.79***	0.83***	0.71**	0.04	0.21
Sweden	0.83***	0.37**	0.58***	0.88***	0.32*	-0.25
Mean	0.73***	0.38**	0.19	0.63**	0.14	-0.03

Baseline IV Summary

Univariate Regressions

- Clear rejection of random walk
- C Stickiness χ significant and around 0.7
- Income share of rule-of-thumb consumers $\eta \approx 0.4$, less significant
- Coefficient on wealth α typically insignificant
- First-stage \bar{R}^2 for C typically ranges between 0.1 and 0.2

Horse-race Regressions

- Past C beats other regressors
- χ drops only slightly (from 0.7 to 0.6) and remains significant in 10 countries
- η insignificant (except for Germany)
- OLS test does not reject instrument exogeneity

IV Results for Country Groups (Averages)

$$\Delta \log \mathbf{C}_t = \varsigma + \chi \mathbf{E}_{t-2}[\Delta \log \mathbf{C}_{t-1}] + \eta \mathbf{E}_{t-2}[\Delta \log \mathbf{Y}_t] + \alpha \mathbf{E}_{t-2}[\mathbf{A}_{t-1}]$$

Country	Estimation with one regressor only			Estimation with all three regressors		
	χ	η	α	χ	η	α
All Countries	0.73*** (0.18)	0.38** (0.18)	0.19 (0.19)	0.63** (0.25)	0.14 (0.21)	-0.03 (0.16)
G7 Countries	0.67*** (0.18)	0.36*** (0.11)	0.08 (0.19)	0.55** (0.23)	0.19 (0.14)	-0.01 (0.12)
Anglo-Saxon	0.73*** (0.16)	0.27** (0.11)	0.24 (0.18)	0.68*** (0.22)	0.04 (0.14)	0.04 (0.12)
Euro Area	0.69*** (0.18)	0.43** (0.20)	0.19 (0.18)	0.54** (0.27)	0.15 (0.22)	-0.01 (0.13)
European Union	0.73*** (0.18)	0.39* (0.20)	0.18 (0.20)	0.65** (0.26)	0.15 (0.23)	-0.06 (0.17)

Instruments: L(2/4).un L(2/4).lr L(2/4).pceinfvol L(2/4).sent

Alternative Instrument Set [Un, Inc, IR Spread, Sent]

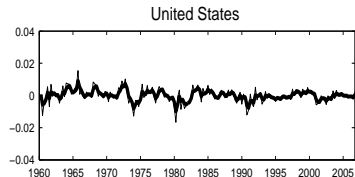
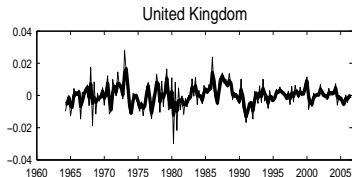
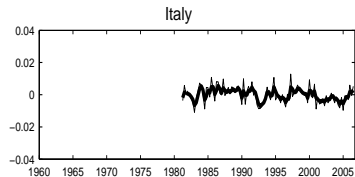
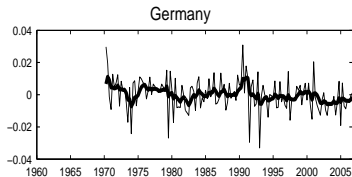
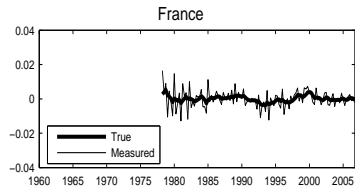
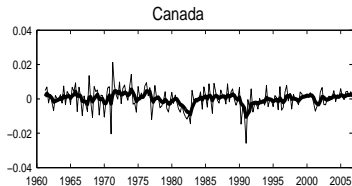
$$\Delta \log C_t = \varsigma + \chi \mathbf{E}_{t-2}[\Delta \log C_{t-1}] + \eta \mathbf{E}_{t-2}[\Delta \log Y_t] + \alpha \mathbf{E}_{t-2}[A_{t-1}]$$

Country	One regressor only			All three regressors—Horse-race		
	χ	η	α	χ	η	α
Canada	0.69***	0.33***	0.91**	0.40	0.16	0.35
France	0.03	0.23*	0.08	-0.31	0.36	0.09
Germany	0.02	0.88***	-0.29	-0.14	0.89***	-0.18
Italy	0.62***	0.29*	-0.06	0.55***	0.10	-0.02
United Kingdom	0.41**	0.07	0.24	0.58**	-0.20	0.13
United States	0.74***	0.41***	0.23	0.53**	0.16	0.04
Australia	0.71***	0.18	0.11	0.73***	-0.05	0.02
Belgium	0.71***	0.27*	0.09	0.77**	0.13	-0.09
Denmark	0.35	0.10	-1.26**	0.19	-0.00	-1.14*
Finland	0.88***	0.49***	2.86***	0.56*	0.15	0.82
Netherlands	0.75***	0.16	0.12	0.71***	0.14	0.02
Spain	0.94***	0.58***	0.97***	0.67**	0.18	0.15
Sweden	0.86***	0.05	0.81***	0.85**	-0.03	0.04
Mean	0.59***	0.31**	0.37	0.47	0.15	0.02

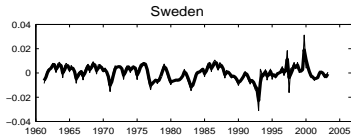
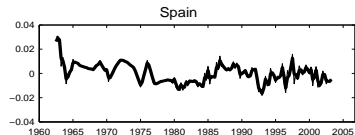
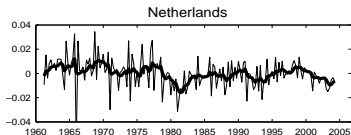
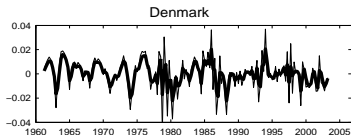
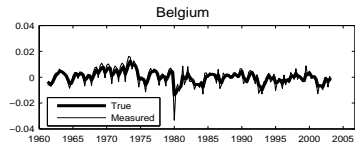
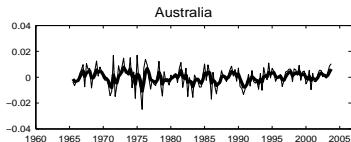
Kalman Filter—First-Stage Results

Country	Parameter Estimates				
	χ	θ	$\log \sigma_u^2$	$\log \sigma_v^2$	$\frac{\text{var}(\Delta \log \mathbf{C}_t^*)}{\text{var}(\Delta \log \mathbf{C}_t)}$
G7 Countries					
Canada	0.78***	0.25**	-11.03***	-13.02***	0.18
France	0.81***	-0.01	-11.42***	-14.00***	0.10
Germany	0.83***	0.25*	-9.97***	-12.49***	0.14
Italy	0.62***	-0.08	-12.04***	-12.26***	0.37
United Kingdom	0.36***	-1.00	-12.21***	-10.79***	0.39
United States	0.67***	0.30**	-12.26***	-12.58***	0.44
Other Countries					
Australia	0.49*	0.23	-10.78***	-11.50***	0.21
Belgium	0.70***	0.39***	-11.44***	-11.83***	0.45
Denmark	0.39*	-0.23	-10.38***	-9.85***	0.38
Finland	0.72***	0.20	-10.95***	-11.00***	0.55
Netherlands	0.90***	-0.08	-9.85***	-12.64***	0.18
Spain	0.84***	0.23	-12.08***	-11.39***	0.82
Sweden	0.67***	0.27*	-11.71***	-11.40***	0.60

"True" Consumption Growth (Kalman smoother, G7, demeaned, per cap)



“True” Consumption Growth (Kalman smoother, other countries)



Kalman Filter—Second-Stage Results

$$\Delta \log C_t^* = \varsigma + \chi \mathbf{E}_{t-2}[\Delta \log C_{t-1}^*] + \eta \mathbf{E}_{t-2}[\Delta \log Y_t] + \alpha \mathbf{E}_{t-2}[A_{t-1}]$$

Country	One regressor only			All three regressors—Horse-race		
	χ	η	α	χ	η	α
Canada	0.92***	0.32***	0.28	0.91***	0.00	0.02
France	0.91***	0.21***	0.08	0.84***	0.05**	−0.00
Germany	0.92***	0.34***	−0.33	0.81***	0.12***	−0.00
Italy	0.84***	0.16*	−0.04	0.82***	0.01	−0.01
United Kingdom	0.89***	0.14*	0.24*	1.00***	−0.08	−0.00
United States	0.89***	0.43***	0.24**	0.72***	0.15**	0.01
Australia	0.76***	0.11*	0.11*	0.73***	0.03	0.00
Belgium	0.80***	0.35***	0.12	0.82***	−0.02	−0.00
Denmark	0.97***	0.31	−0.29	0.92***	0.20	−0.32*
Finland	0.91***	0.56***	0.47	0.96***	−0.04	−0.10
Netherlands	0.93***	0.11	0.22**	0.92***	0.01	0.00
Spain	0.99***	0.77***	0.79***	0.97***	−0.03	0.05
Sweden	0.89***	0.26*	0.51***	0.96***	0.14	−0.17
Mean	0.89***	0.31**	0.19	0.88***	0.04	−0.04

Kalman Filter Summary

- Clear rejection of random walk
- C Stickiness χ highly significant and around 0.8 (in both panels)
- χ generally close to IV estimates
- Large fraction of transitory components in C growth (around 50 percent in US)
- Little correlation between C and instrumented Y in univariate regressions, none in horse-race

Structural Interpretation

The Kalman filter model fits into the structural DSGE framework of Ireland (2004): $\mathbf{f}_t = \mathbf{C}\mathbf{s}_t + \mathbf{u}_t$

\mathbf{f}_t : control variables, \mathbf{s}_t : state variables, \mathbf{u}_t : residuals

Ireland: “the residuals $[\mathbf{u}_t]$ may ... soak up both measurement errors, but they can be interpreted more liberally as capturing all of the movements and co-movements in the data that the real business cycle model, because of its elegance and simplicity, cannot explain.”

- For our model: $\mathbf{f}_t = \Delta \log C_t$, $\mathbf{s}_t = \Delta \log C_{t-1}^*$, $\mathbf{C} = \chi$,
 $\mathbf{u}_t = u_t + (\theta - 1)u_{t-1} - \theta u_{t-2} + v_t + \lambda_1(\chi)v_{t-1} + \lambda_2(\chi)v_{t-2}$
- Our model is simple and can be estimated with classical techniques. \Rightarrow
Data have complete control over the estimates of χ .
- Our estimates can be use to calibrate priors in larger-scale Bayesian DSGE models.

Conclusion

Aggregate Consumption Growth Is Sticky.

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