Heterogeneity and Aggregate Consumption: An Empirical Assessment

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Background

- Recent HANK models:

  - household heterogeneity, in the form of *idiosyncratic income shocks*
  - incomplete markets
  - borrowing constraints

  $\Rightarrow$ wealth and income distributions as state variables

- Is heterogeneity important for understanding *aggregate* fluctuations? If so, what kind of heterogeneity? Are idiosyncratic income shocks necessary?

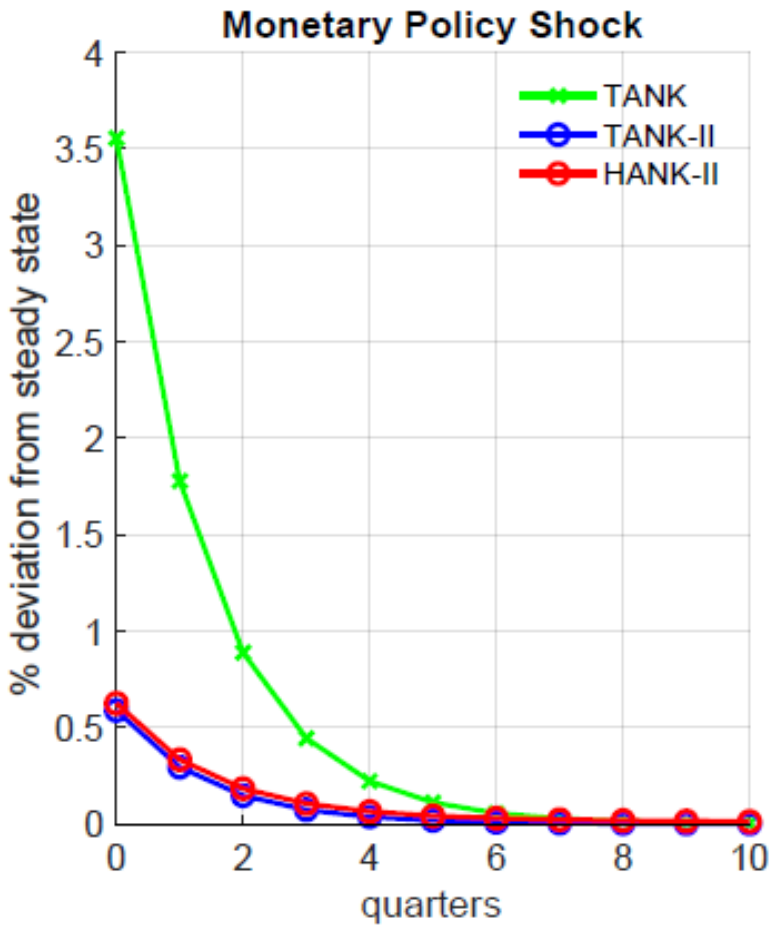
- Debortoli-Galí (NBER MA 2024): HANK vs TANK

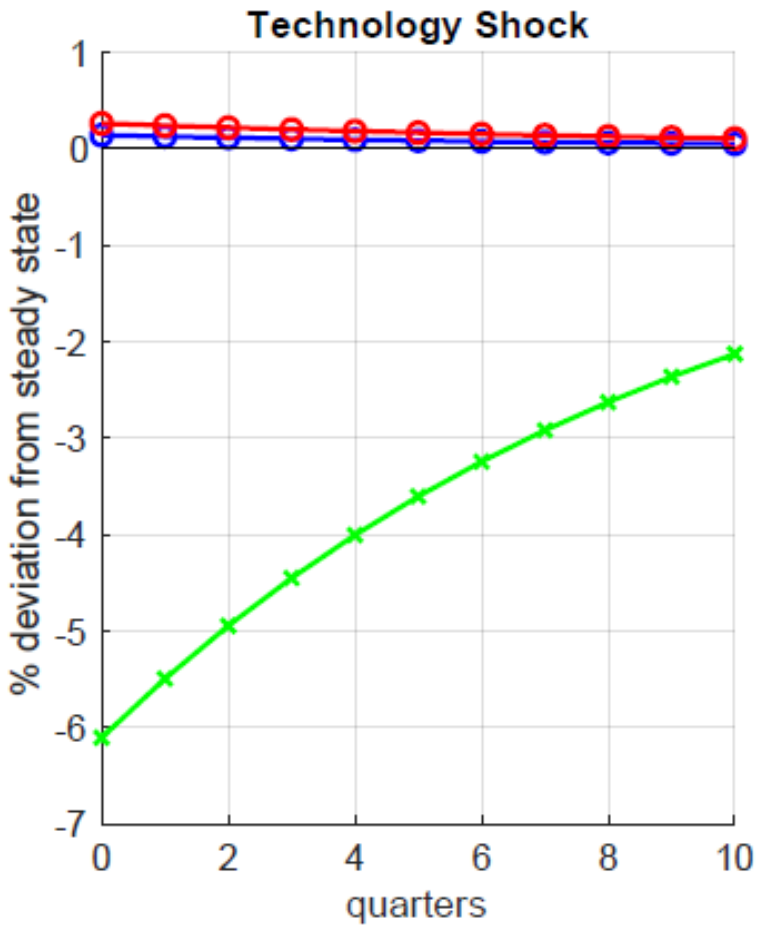
  TANK: constant fraction of hand-to-mouth households, no idiosyncratic income shocks

  $\Rightarrow$ A *properly designed* TANK model approximates well the *aggregate* properties of a HANK model

  DG-TANK: budget constraint of the hand-to-mouth given by

$$C_t^H = \Xi^H W_t N_t + \Theta^H D_t - \psi Y \widehat{R}_t$$


Monetary Policy Shock
TANK
TANK-II
HANK-II
% deviation from steady state
quarters
0
0.5
1
1.5
2
2.5
3
3.5
4
0
2
4
6
8
10


Technology Shock
% deviation from steady state
quarters
1
0
-1
-2
-3
-4
-5
-6
-7
0
2
4
6
8
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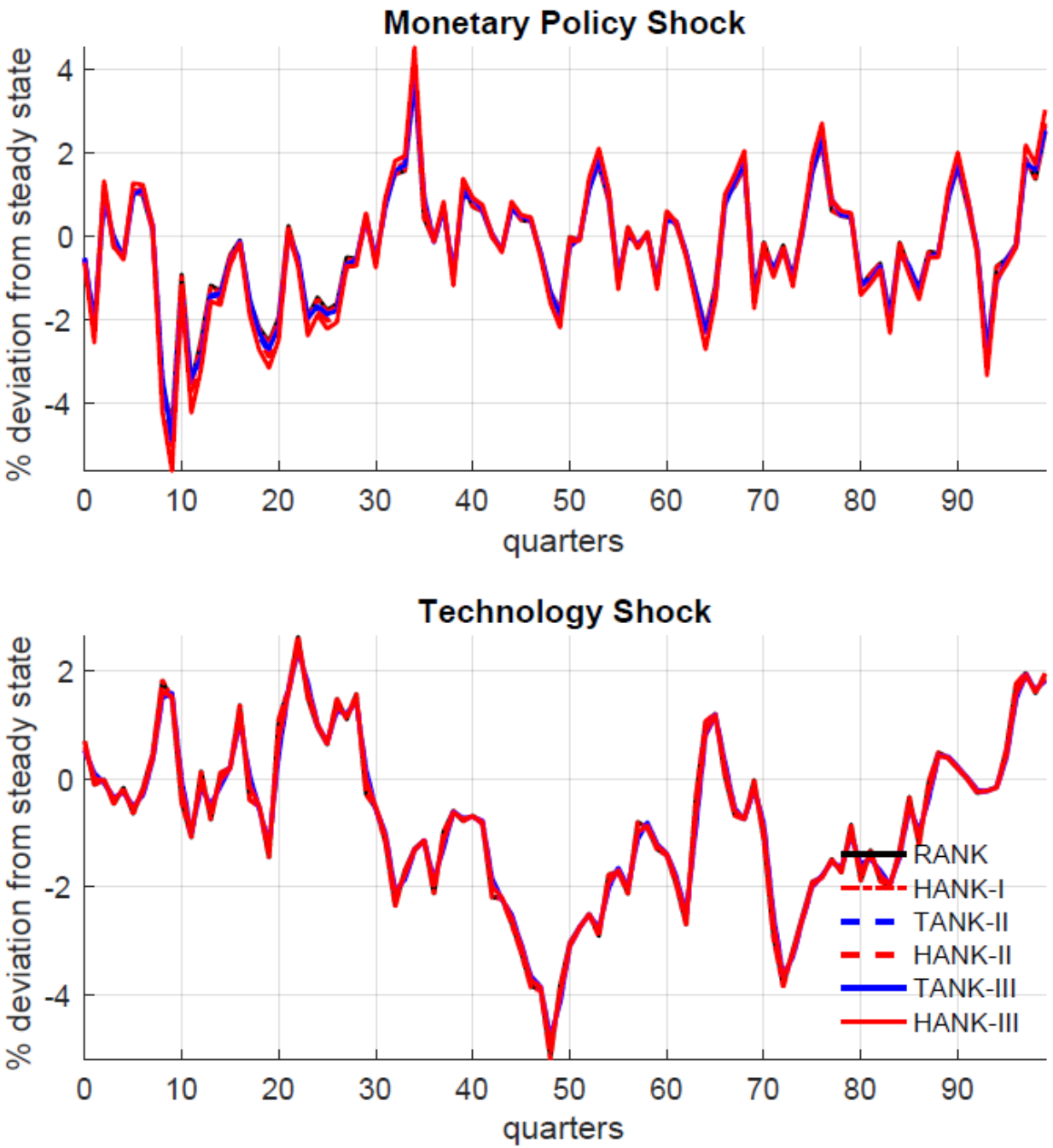
Monetary Policy Shock
% deviation from steady state
4
2
0
-2
-4
0
10
20
30
40
50
60
70
80
90
quarters
Technology Shock
% deviation from steady state
2
0
-2
-4
0
10
20
30
40
50
60
70
80
90
quarters
RANK
HANK-I
TANK-II
HANK-II
TANK-III
HANK-III

This Paper

- *Heterogeneity vs The Aggregate Data*: Does the behavior of *aggregate* consumption reflect the presence of heterogeneity?
- Two dimensions:

- unconstrained vs hand-to-mouth consumers (Campbell-Mankiw (1989))
- idiosyncratic income shocks: Do variations in the moments of wealth and income distributions have predictive power for aggregate consumption, beyond that of interest rates and income?

- Granger causality tests
- Estimate Euler equation for aggregate consumption consistent with a general HA model, and evaluate the role of wealth and income distribution moments obtained from micro data.
- Similar exercise using data generated by a calibrated HANK model

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- Similar exercise using data generated by a calibrated HANK model

Main findings

- Strong evidence of a role for hand-to-mouth behavior
- Not much evidence of a quantitatively significant role for idiosyncratic income shocks

Related Literature

- Euler equation-based empirical consumption models: Hall (1988), Campbell and Mankiw (1989),...
- HANK models: Kaplan, Moll and Violante (2018), Auclert, Rognlie, and Straub (2023),...
- TANK models: Galí, López-Salido and Vallés (2007), Bilbiie (2008),...
- Quantitative empirical asessments of role of heterogeneity in fluctuations: Auclert, Rognlie, and Straub (2020),Bayer, Born and Lutticke (2024), Bilbiie, Primiceri and Tambalotti (2023), Berger, Bocola and Davis (2023), Chan, Chen, and Schorfheide (2024)...

Heterogeneity and Aggregate Consumption

Households in a General HA Model

- Continuum of infinite-lived households, $j \in [0,1]$, with preferences

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t(j)^{1-\sigma} - 1}{1-\sigma} - V(N_t(j)) \right)$$

- Period budget constraint

$$C_t(j) + \frac{B_t(j)}{P_t} = \Xi_t(j) W_t N_t(j) + D_t(j) - T_t(j) + \frac{(1+i_{t-1}) B_{t-1}(j)}{P_t}$$

where $\Xi_t(j)$ is an idiosyncratic income shock.

- Borrowing constraint

$$\frac{B_t(j)}{P_t} \geq -\Psi_t(j)$$

where $\Psi_t(j) > 0$ is the borrowing limit.

- In any given period, two subsets of households: *unconstrained* and *hand-to-mouth*

Heterogeneity and Aggregate Consumption

Unconstrained households

- $\mathcal{U}_t \subset [0,1]$, with measure $1-\lambda_t$ such that $\frac{B_t(j)}{P_t} > -\Psi_t(j)$
- Individual consumption: for all $j \in \mathcal{U}_t$ and all t

$$1 = \beta(1+i_t)\mathbb{E}_t\{(C_{t+1}(j)/C_t(j))^{-\sigma}(P_t/P_{t+1})\}$$

- Average "unconstrained" consumption: $C_t^U \equiv \frac{1}{1-\lambda_t}\int_{j\in\mathcal{U}_t} C_t(j)dj$
- Approximate Euler equation (in logs):

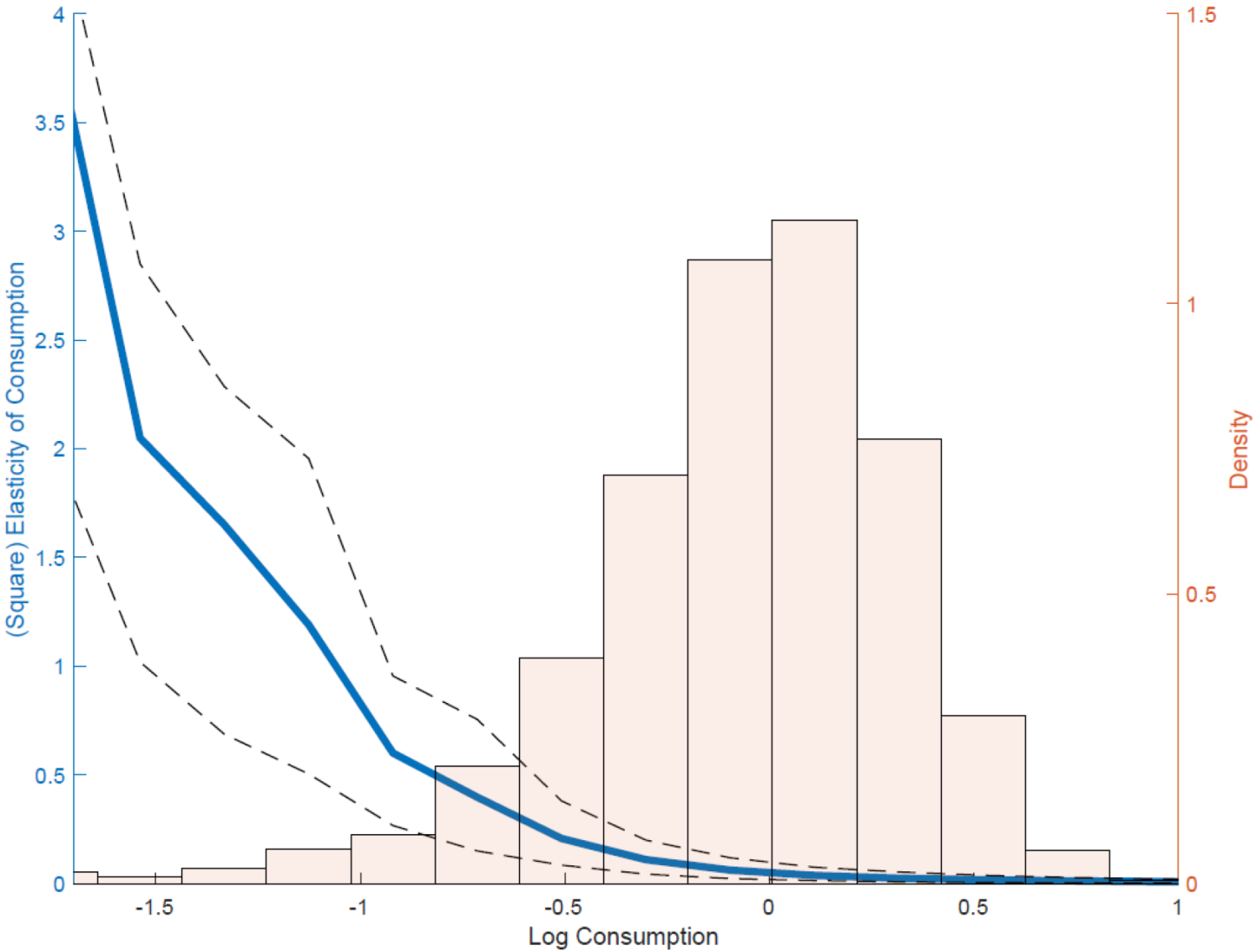
$$\mathbb{E}_t\{\Delta c_{t+1}^U\} = \gamma + \frac{1}{\sigma}\widehat{r}_t + \frac{\sigma+1}{2}\widehat{v}_t^U + \widehat{h}_t^U \qquad (1)$$

where $r_t \equiv i_t - \mathbb{E}_t\{\pi_{t+1}\}$, γ is trend growth,

$$v_t^U \equiv \frac{1}{1-\lambda_t}\int_{j\in\mathcal{U}_t}\frac{C_t^U(j)}{C_t^U}v_t(j)dj$$

with $v_t(j) \equiv var_t\{c_{t+1}(j)\}$ and $h_t^U \equiv \mathbb{E}_t\{c_{t+1}^U - c_{t+1|t}^U\}$

- Idiosyncratic income shocks $\Leftrightarrow$ variations in $\widehat{v}_t^U$ and $\widehat{h}_t^U$ in response to aggregate shocks


(Square) Elasticity of Consumption
Density
Log Consumption
4
3.5
3
2.5
2
1.5
1
0.5
0
1.5
1
0.5
0
-1.5
-1
-0.5
0
0.5
1

Heterogeneity and Aggregate Consumption

Hand-to-mouth households

- $\mathcal{H}_t \subset [0,1]$, with measure λ_t and such that $\frac{B_t(j)}{P_t} = -\Psi_t(j)$
- Individual consumption: for all $j \in \mathcal{H}_t$ and all t

$$C_t(j) = Y_t(j) + \Phi_t(j)$$

where $Y_t(j) \equiv \Xi_t(j) W_t N_t(j) + D_t(j) - T_t(j) + \frac{i_{t-1} B_{t-1}(j)}{P_t}$ is disposable income and $\Phi_t(j) \equiv \frac{B_{t-1}(j)}{P_t} + \Psi_t(j)$ is the increase in debt between $t-1$ and t.

- Average "hand-to-mouth" consumption: $C_t^H \equiv \frac{1}{\lambda_t} \int_{j \in \mathcal{H}_t} C_t(j) dj$

$$C_t^H = Y_t^H + \Phi_t^H$$

where $Y_t^H \equiv \frac{1}{\lambda_t} \int_{j \in \mathcal{H}_t} Y_t(j) dj$ and $\Phi_t^H \equiv \frac{1}{\lambda_t} \int_{j \in \mathcal{H}_t} \Phi_t(j) dj$.

- Assuming $\phi_t^H \equiv \Phi_t^H / Y_t^H$ is stationary with mean close to zero we can write

$$\Delta c_t^H = \Delta y_t^H + \Delta \phi_t^H \tag{2}$$

Heterogeneity and Aggregate Consumption

Aggregate consumption

$$C_t = \lambda_t C_t^H + (1 - \lambda_t) C_t^U$$

- Assuming $\Theta_t \equiv C_t^H / C_t$ and λ_t are stationary, we can write:

$$\Delta c_t \simeq \lambda \Theta \Delta c_t^H + (1 - \lambda \Theta) \Delta c_t^U - \delta \Delta \lambda_t \tag{3}$$

where $\delta \equiv \frac{C^U - C^H}{C} = \frac{1-\Theta}{1-\lambda}$

- Combined with expressions for Δc_t^H and Δc_t^U:

$$\Delta c_t \simeq (1 - \lambda \Theta)\gamma + \lambda \Theta \Delta y_t^H + \frac{1 - \lambda \Theta}{\sigma} \widehat{r}_{t-1} - \delta \Delta \lambda_t + \Omega_{t-1} + \varepsilon_t$$

where

$$\Omega_{t-1} \equiv (1 - \lambda \Theta) \left[\frac{\sigma + 1}{2} \widehat{v}_{t-1}^U + \widehat{h}_{t-1}^U \right]$$

$$\varepsilon_t \equiv \lambda \Theta \Delta \phi_t^H + (1 - \lambda \Theta)(c_t^U - \mathbb{E}_{t-1}\{c_t^U\})$$

Empirical consumption equation

$$\Delta c_t \simeq (1-\lambda\Theta)\gamma + \lambda\Theta\Delta y_t^H + \frac{1-\lambda\Theta}{\sigma}\widehat{r}_{t-1} - \delta\Delta\lambda_t + \Omega_{t-1} + \varepsilon_t$$

Particular cases

- RA model ($\lambda = \phi_t^H = \widehat{h}_t^U = 0$, $\widehat{v}_t^U \simeq 0$) (Hall 1988)

$$\Delta c_t \simeq \gamma + \frac{1}{\sigma}\widehat{r}_{t-1} + \varepsilon_t$$

- Campbell-Mankiw (1989): $\lambda_t = \lambda$, $\Theta \simeq 1$, $\Delta y_t^H = \Delta y_t$, $\phi_t^H = \widehat{h}_t^U = 0$, $\widehat{v}_t^U \simeq 0$

$$\Delta c_t \simeq (1-\lambda)\gamma + \lambda\Delta y_t + \frac{1-\lambda}{\sigma}\widehat{r}_{t-1} + \varepsilon_t$$

- DG-TANK: $\lambda_t = \lambda$, $\widehat{h}_t^U = 0$, $\widehat{v}_t^U \simeq 0$

$$\Delta c_t \simeq (1-\lambda\Theta)\gamma + \lambda\Theta\Delta y_t^H + \frac{1-\lambda\Theta}{\sigma}\widehat{r}_{t-1} + \varepsilon_t$$

Empirical Strategy (I)

- Micro data on wealth and disposable income from Blanchet-Saez-Zucman's database (*realtimeinequality.org)*
- Sample period: 1976Q1-2019Q4
- Construct time series for first and second moments of the cross-sectional distribution of wealth and disposable income: mean, standard deviation and skewness
- Granger causality tests

$$\Delta c_t \simeq \gamma_0 + \gamma_r r_{t-1} + \gamma_y \Delta y_{t-1} + \gamma_z \mathbf{z}_{t-1} + \varepsilon_t$$

Table 1. Granger Causality for Δc_t

Predictors (lagged)	*p-value*	R^2
$\Delta c, r, \Delta y$		0.142
$r, \Delta y$	0.012	
Δy	0.045	
$\Delta c, r, \Delta y, \{w\}$		0.160
$\{w\}$	0.335	
$\Delta c, r, \Delta y, \{y\}$		0.149
$\{y\}$	0.732	
$\Delta c, r, \Delta y, \{w, y\}$		0.166
$\{w, y\}$	0.604	

Empirical Strategy (II)

- Micro data on wealth and disposable income from Blanchet-Saez-Zucman's database (*realtimeinequality.org)*
- Sample period: 1976Q1-2019Q4
- Construct time series for first and second moments of the cross-sectional distribution of wealth and disposable income: mean, standard deviation and skewness
- Estimation of Campbell-Mankiw consumption equation (augmented with wealth and/or income moments) using lagged values as instruments

$$\Delta c_t \simeq (1-\lambda)\gamma + \lambda \Delta y_t + \frac{1-\lambda}{\sigma}\widehat{r}_{t-1} + \theta \mathbf{z}_{t-1} + \varepsilon_t$$

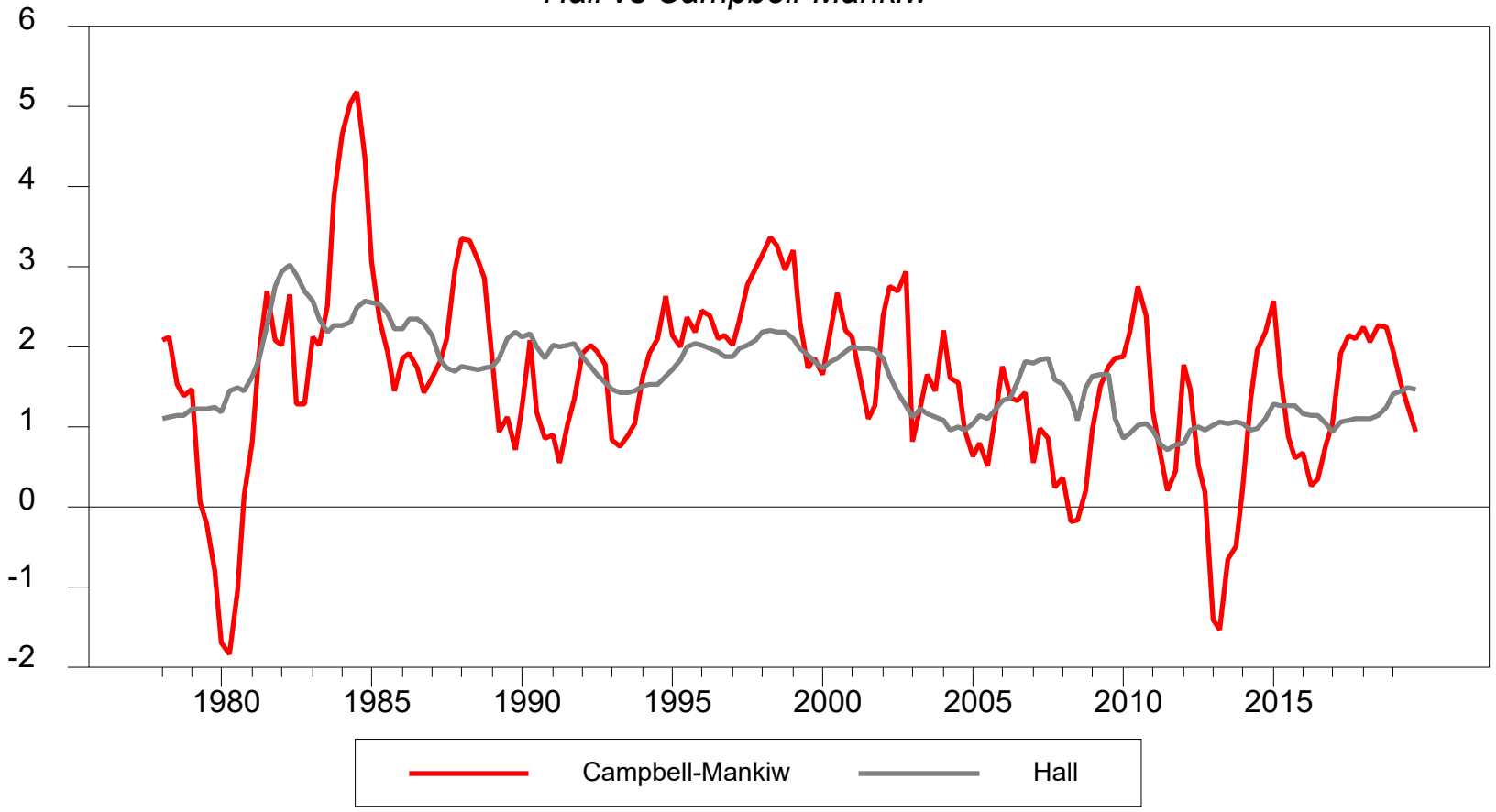
Table 2. Empirical Euler Equations: Beyond Campbell-Mankiw

Aggregate disposable income and population-wide distributions

	Hall	*CM*	*CM+W*	*CM+Y*	*CM+All*
r_{t-1}	0.207^{**}	0.170^{**}	0.132	0.264^{***}	0.227^{*}
	(0.082)	(0.079)	(0.113)	(0.088)	(0.124)
Δy_t		0.484^{***}	0.462^{***}	0.425^{**}	0.401^{**}
		(0.161)	(0.159)	(0.131)	(0.117)
Wealth					
mean			0.002		-0.007
			(0.007)		(0.008)
s.d.			-1.713		-1.668
			(1.195)		(1.184)
skewness			1.124		0.151
			(0.719)		(1.120)
Income					
mean				0.049^{**}	0.055^{*}
				(0.021)	(0.031)
s.d.				1.231	2.129
				(2.613)	(3.240)
skewness				0.074	-0.304
				(0.698)	(1.101)
p-value			0.166	0.017	0.051
correlation	0.289	**1.00**	0.972	0.927	0.912

Fitted Aggregate Consumption Growth

Hall vs Campbell-Mankiw



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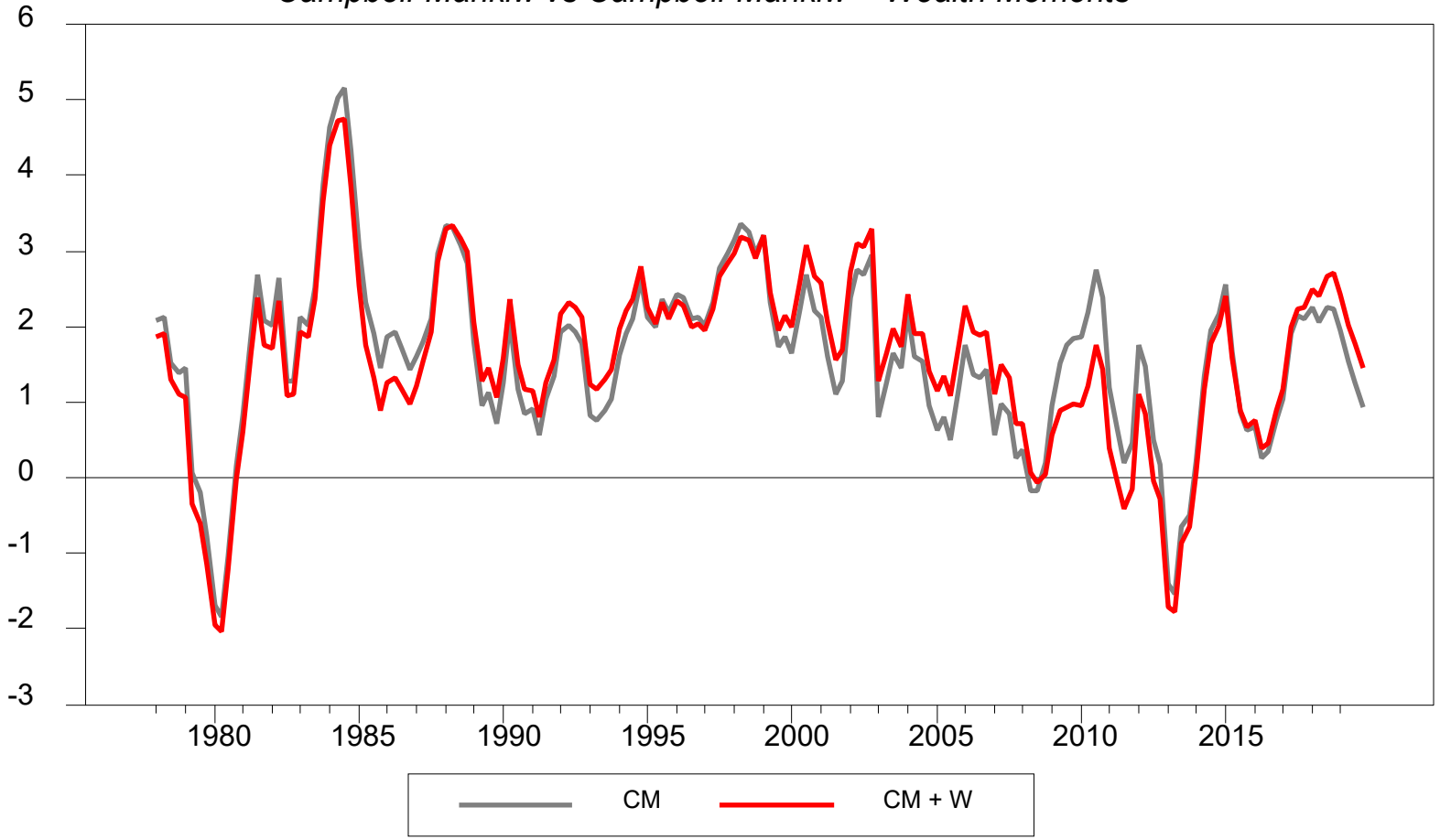
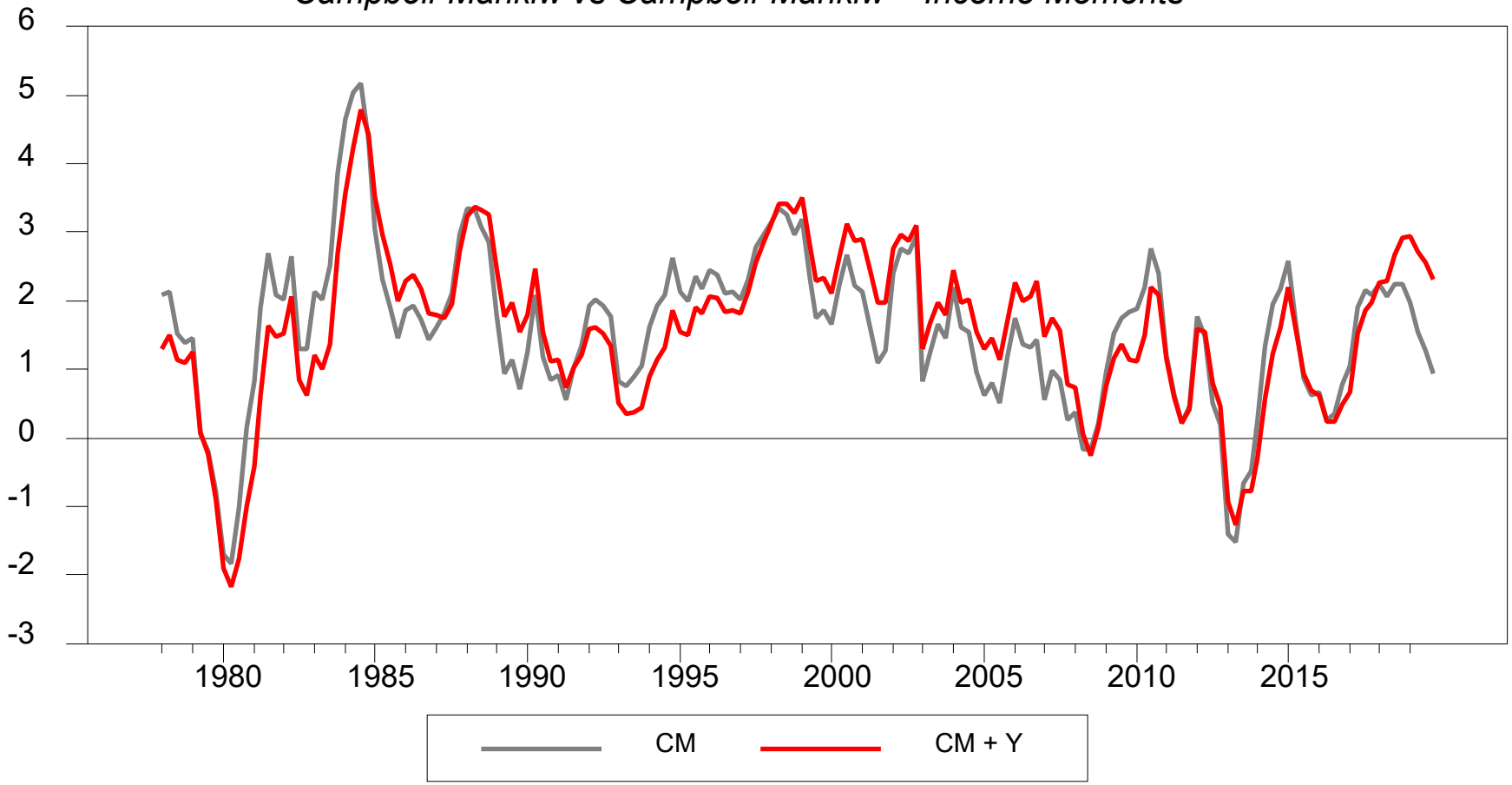
Fitted Aggregate Consumption Growth

Campbell-Mankiw vs Campbell-Mankiw + Wealth Moments



Fitted Aggregate Consumption Growth

Campbell-Mankiw vs Campbell-Mankiw + Income Moments



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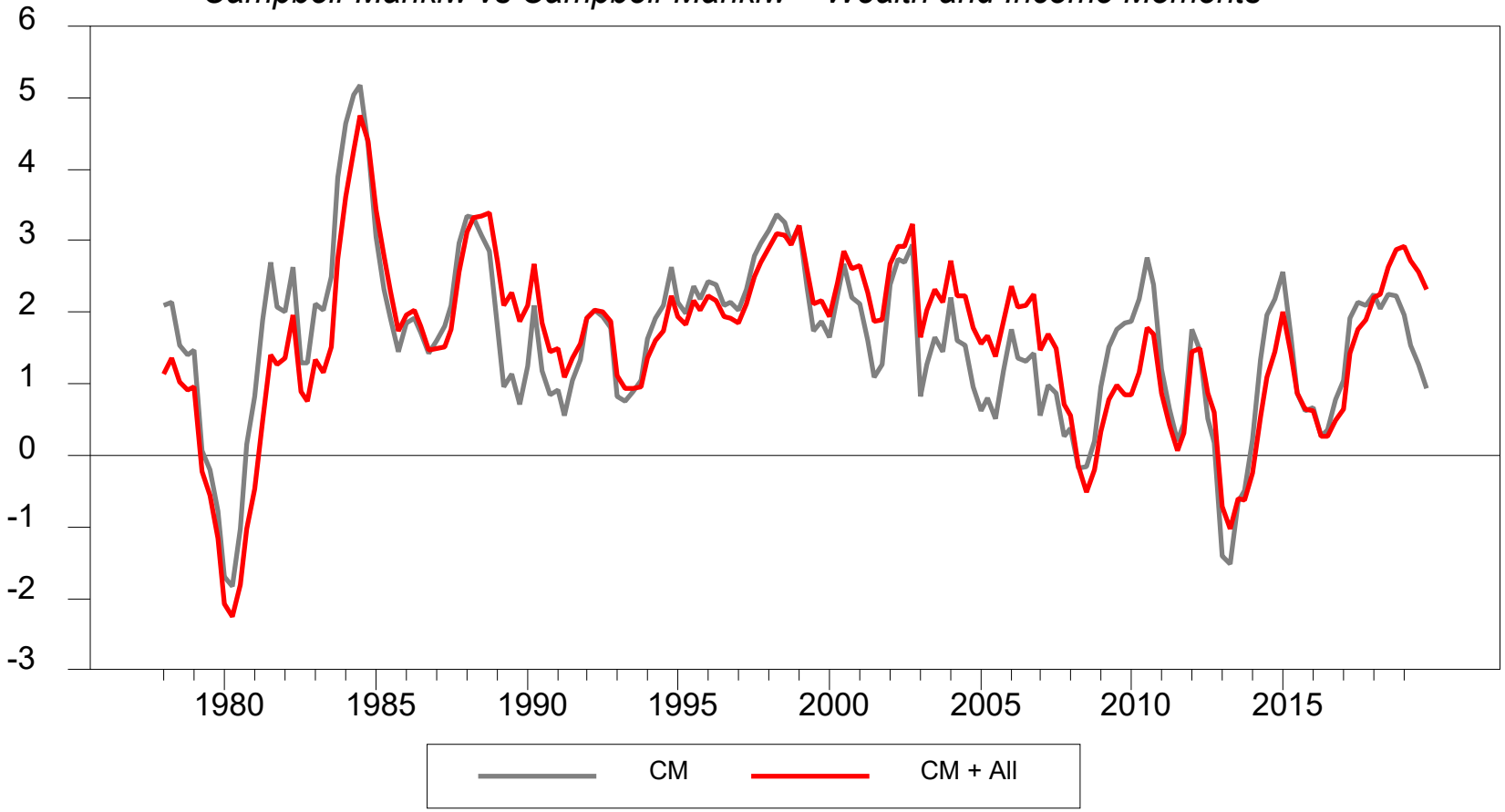

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- Sample period: 1976Q1-2019Q4
- Construct time series for first and second moments of the cross-sectional distribution of wealth and disposable income: mean, standard deviation and skewness
- Approximate Y_t^H as (per capita) disposable income of the fraction λ_t of households satisfying the Aguiar-Bils-Boar (2025) criteria:
  (a) Total net wealth less than 2 months of disposable income
  (b) Net liquid wealth less than 1 week of disposable income
- Estimation of the DG-TANK consumption equation (augmented with wealth and/or income moments) using lagged values as instruments.

$$\Delta c_t \simeq (1-\lambda\Theta)\gamma + \lambda\Theta\Delta y_t^H + \frac{1-\lambda\Theta}{\sigma}\widehat{r}_{t-1} - \delta'\boldsymbol{\lambda}_t + \theta\mathbf{z}_{t-1} + \varepsilon_t$$

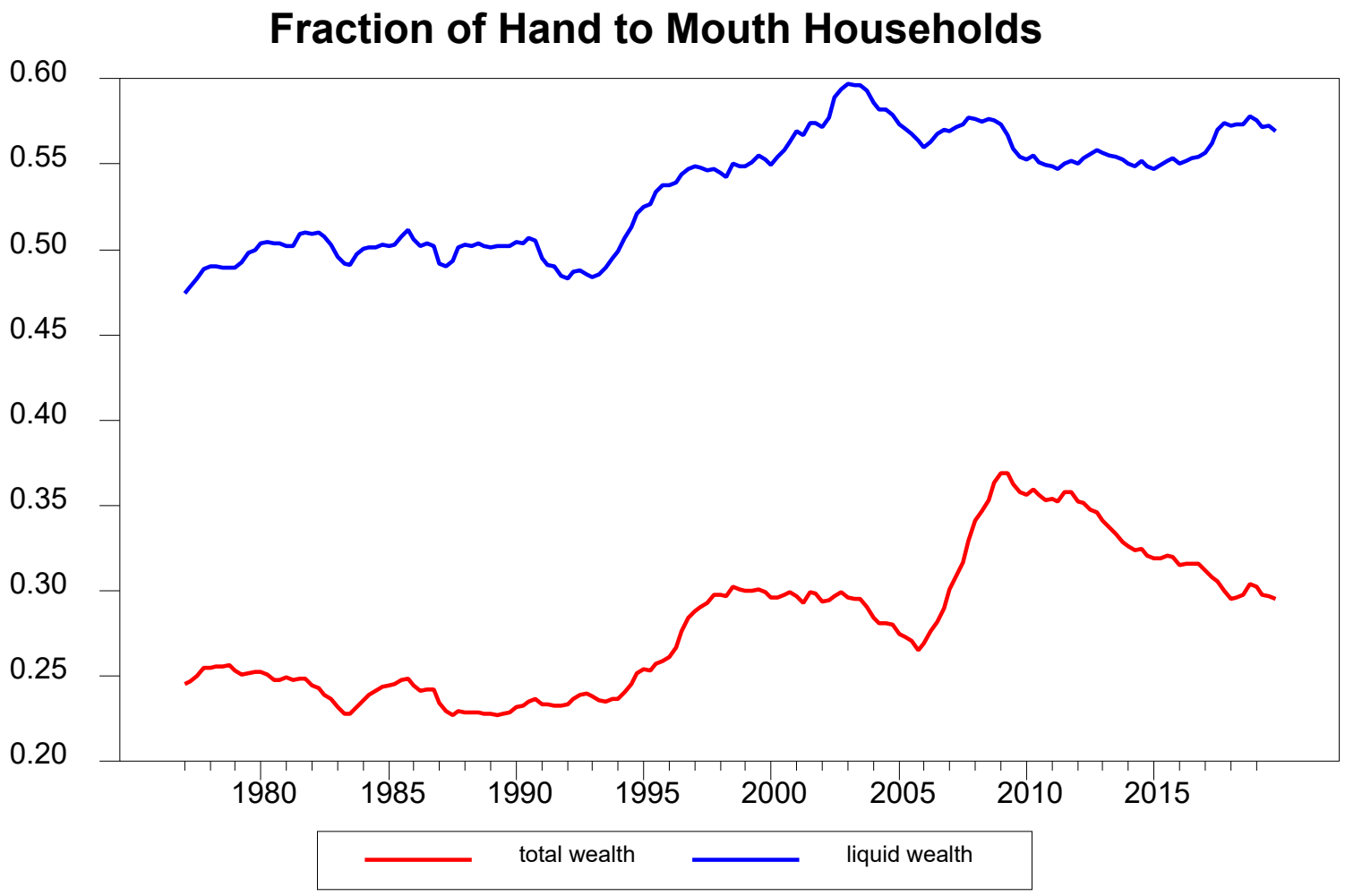
Fraction of Hand to Mouth Households
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
1980
1985
1990
1995
2000
2005
2010
2015
total wealth
liquid wealth

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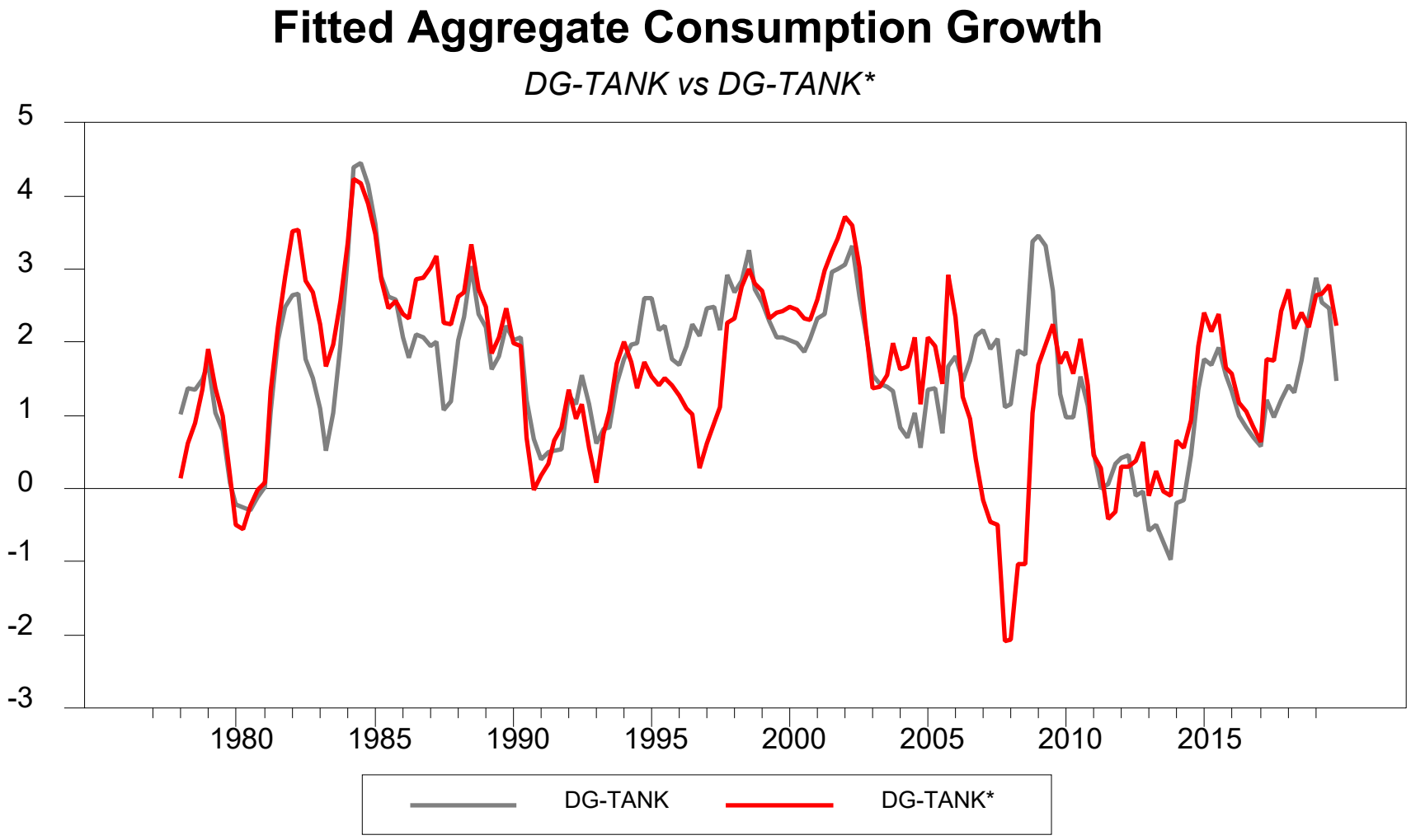
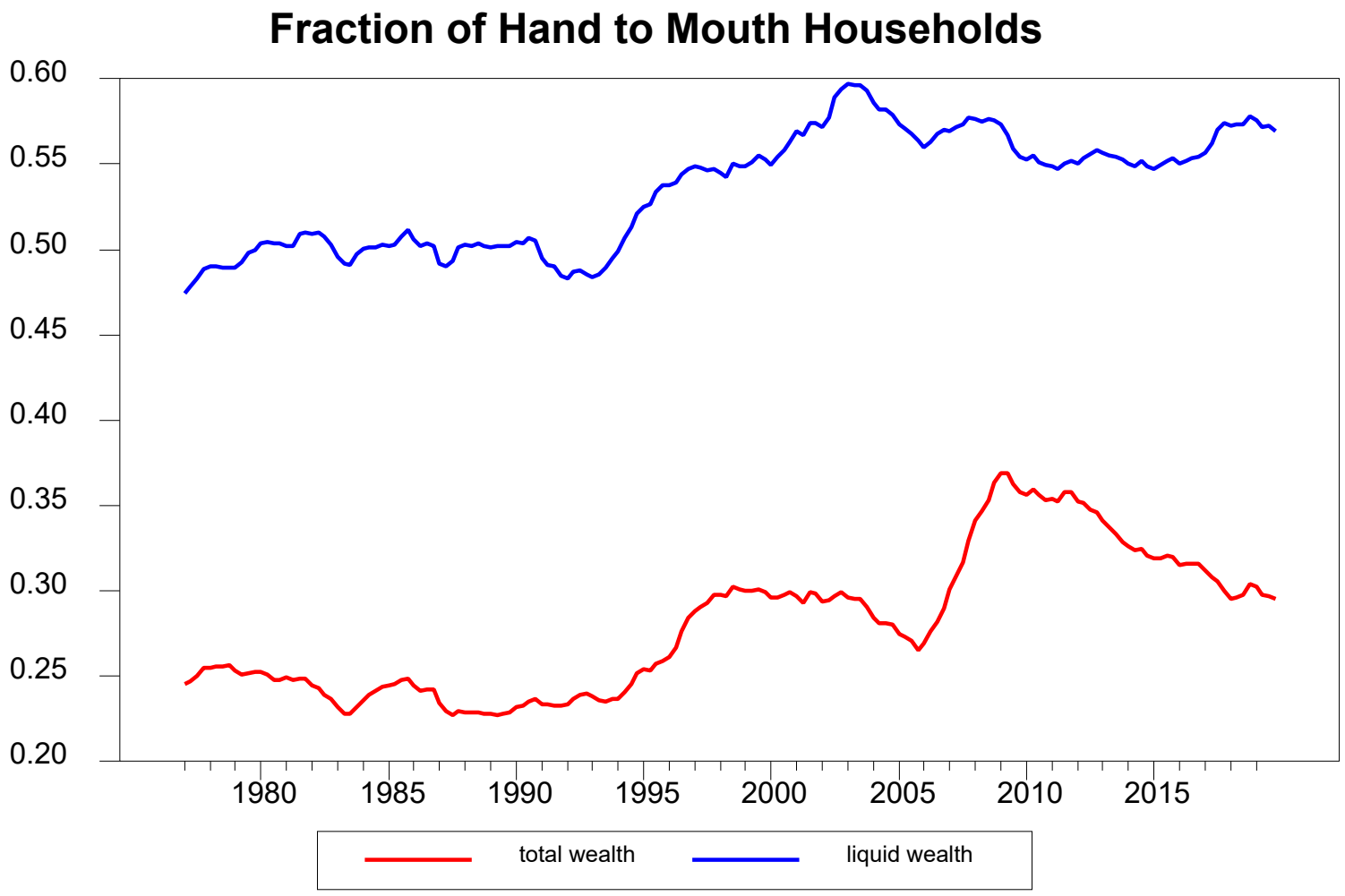
Table 3. Empirical Euler Equations: Beyond TANK

Partition of households based on *total wealth* criterion

	TANK	*TANK**	*TANK*+W*	*TANK*+Y*	*TANK*+All*
r_{t-1}	0.233^{***}	0.308^{***}	0.373^{***}	0.349^{***}	0.416^{***}
	(0.087)	(0.093)	(0.109)	(0.102)	(0.120)
Δy_t^H	0.240^{**}	0.286^{***}	0.290^{***}	0.278^{**}	0.272^{***}
	(0.096)	(0.099)	(0.104)	(0.117)	(0.101)
$\Delta\lambda_t$		-0.794^{***}	-0.754^{***}	-0.766^{***}	-0.701^{***}
		(0.229)	(0.232)	(0.241)	(0.243)
Wealth					
mean			-0.003		-0.004
			(0.009)		(0.010)
s.d.			0.567		1.517
			(1.905)		(2.208)
skewness			0.873		0.465
			(0.788)		(1.560)
Income					
mean				-0.009	0.012
				(0.022)	(0.031)
s.d.				-0.525	1.109
				(2.74)	(3.702)
skewness				0.443	0.124
				(0.535)	(0.980)
p-value			0.501	0.722	0.787
correlation		**1.00**	0.932	0.925	0.922

Total Wealth Criterion

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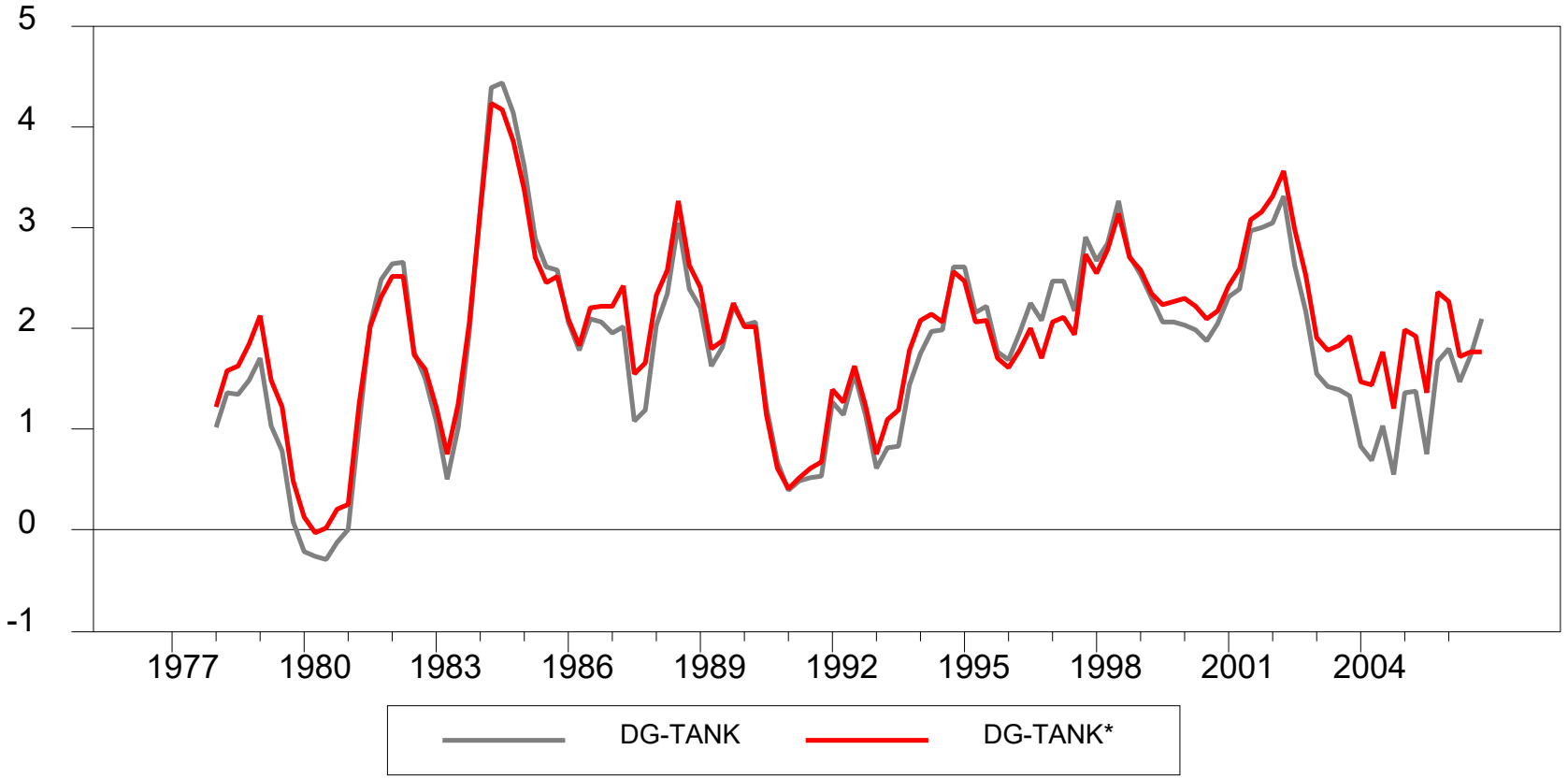
Total Wealth Criterion

Fitted Aggregate Consumption Growth: Pre-Financial Crisis

*DG-TANK vs DG-TANK**



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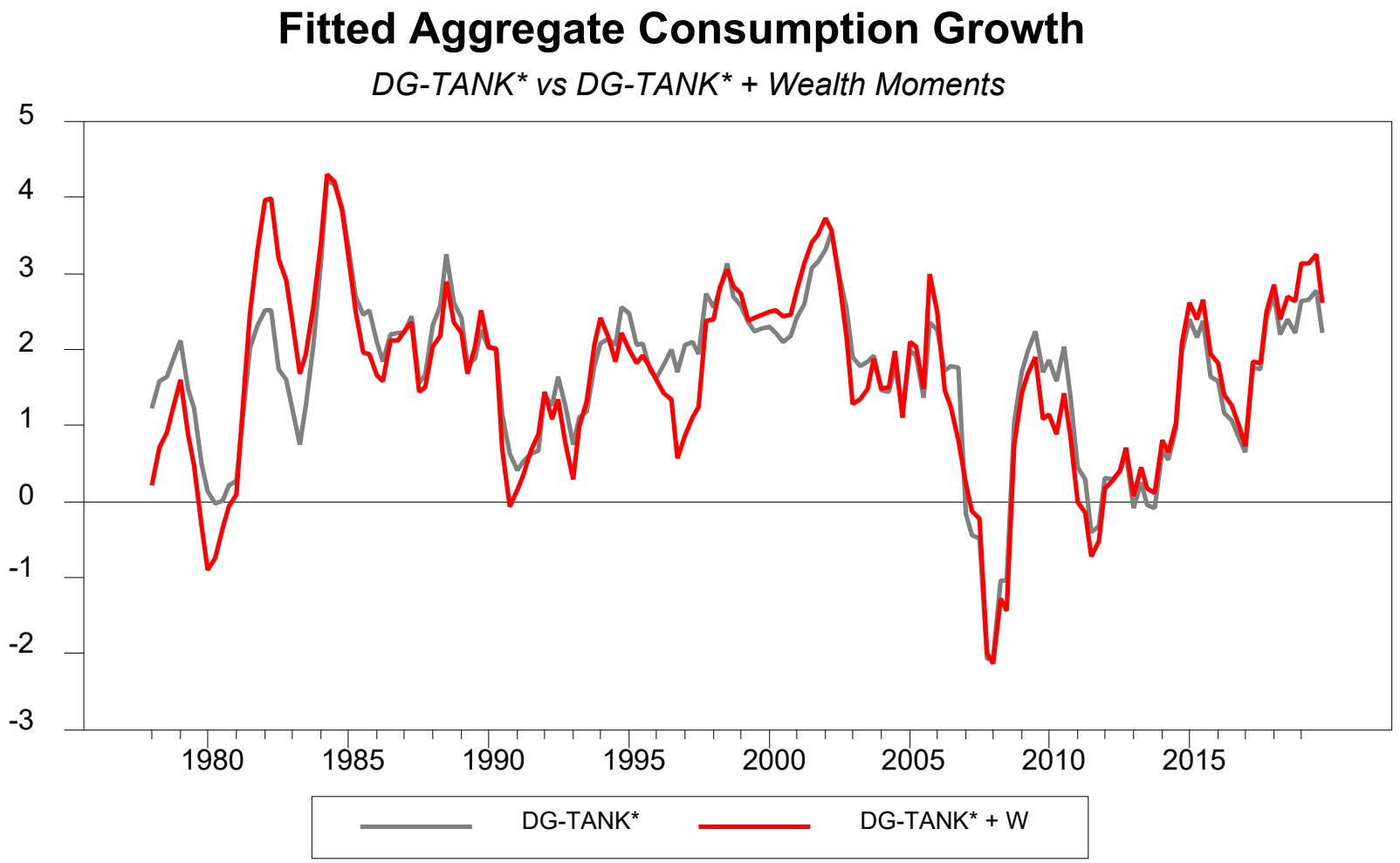

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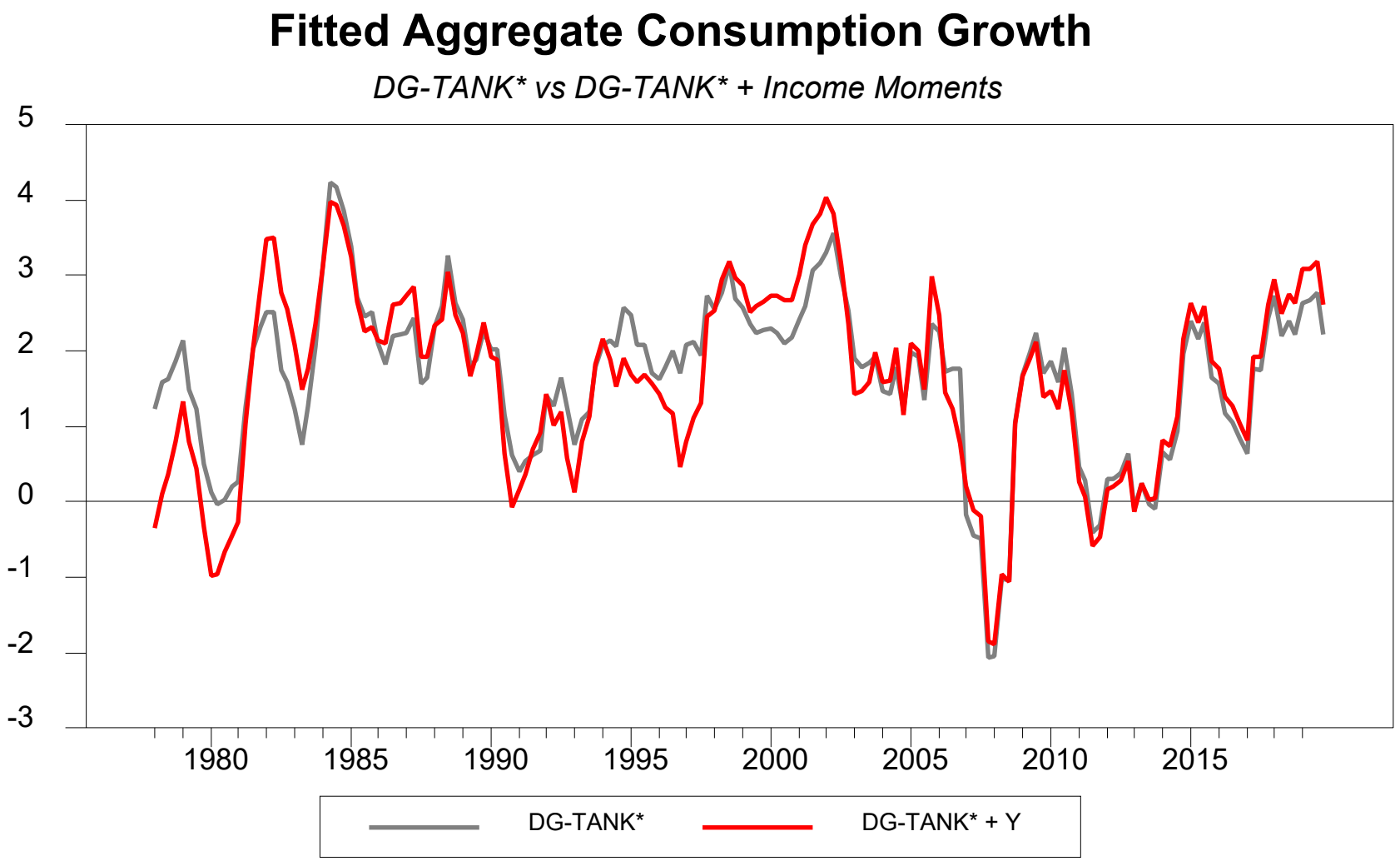

Total Wealth Criterion

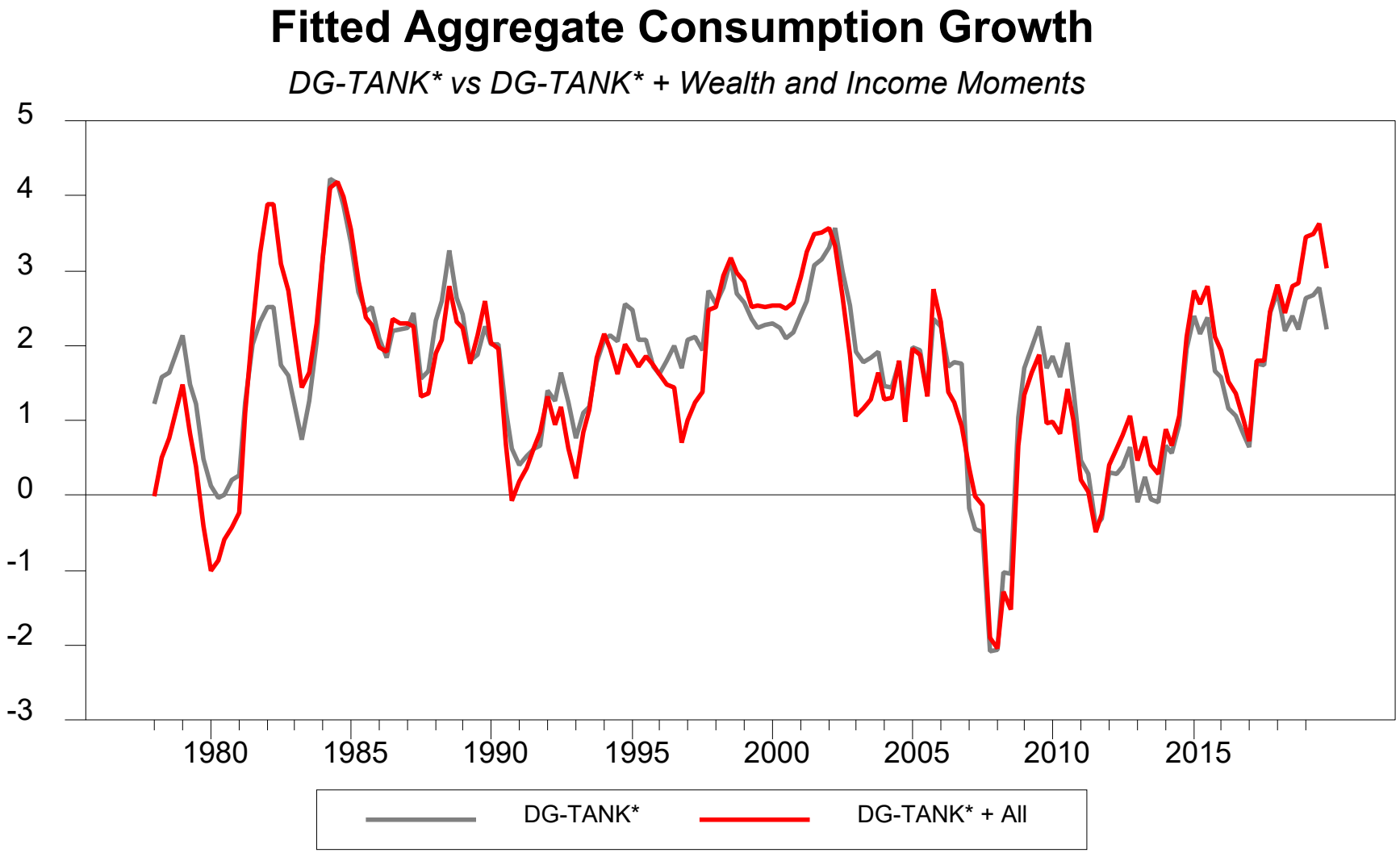

Table 4. Empirical Euler Equations: Beyond TANK

Partition of households based on *liquid wealth* criterion

	TANK	*TANK**	*TANK*+W*	*TANK*+Y*	*TANK*+All*
r_{t-1}	0.198^{**}	0.190^{**}	0.304^{**}	0.253^{***}	0.431^{**}
	(0.079)	(0.079)	(0.132)	(0.096)	(0.189)
Δy_t^H	0.225^{**}	0.286^{**}	0.360^{***}	0.251^{**}	0.390^{**}
	(0.111)	(0.119)	(0.136)	(0.122)	(0.168)
$\Delta\lambda_t$		-0.243	-0.591^{*}	-0.308^{**}	-0.811^{*}
		(0.251)	(0.309)	(0.265)	(0.413)
Wealth					
mean			-0.005		-0.010
			(0.007)		(0.010)
s.d.			-2.769^{**}		-1.684
			(1.282)		(1.554)
skewness			1.891^{***}		2.057^{**}
			(0.697)		(0.970)
Income					
mean				0.003	0.038
				(0.015)	(0.025)
s.d.				-2.043	-3.958
				(2.107)	(3.288)
skewness				1.256	-0.081
				(0.723)	(1.000)
p-value			0.022	0.111	0.103
correlation		**1.00**	0.844	0.871	0.808

Liquid Wealth Criterion

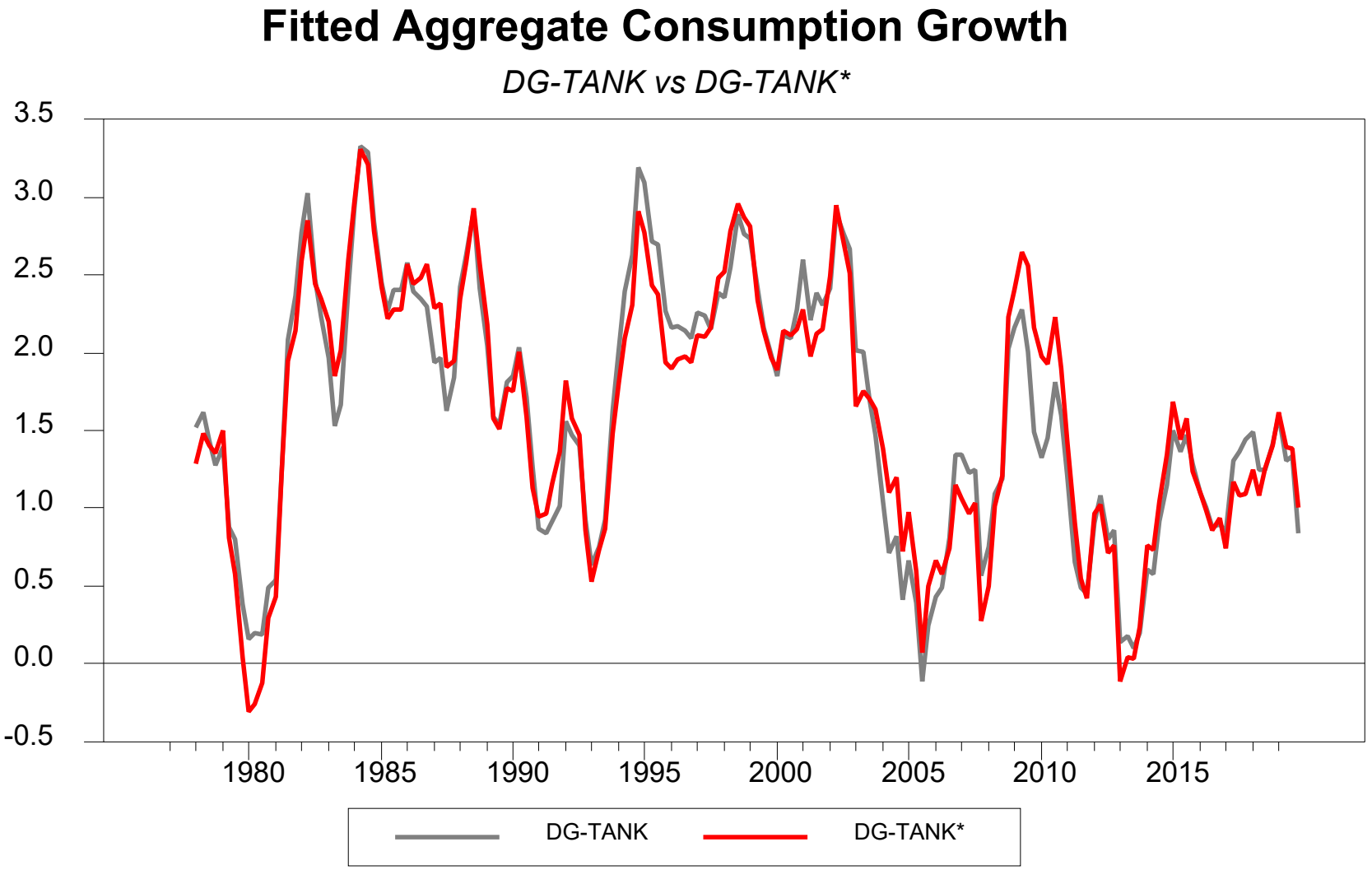

Table 4. Empirical Euler Equations: Beyond TANK

Partition of households based on *liquid wealth* criterion

	TANK	*TANK**	*TANK*+W*	*TANK*+Y*	*TANK*+All*
r_{t-1}	0.198^{**}	0.190^{**}	0.304^{**}	0.253^{***}	0.431^{**}
	(0.079)	(0.079)	(0.132)	(0.096)	(0.189)
Δy_t^H	0.225^{**}	0.286^{**}	0.360^{***}	0.251^{**}	0.390^{**}
	(0.111)	(0.119)	(0.136)	(0.122)	(0.168)
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Liquid Wealth Criterion

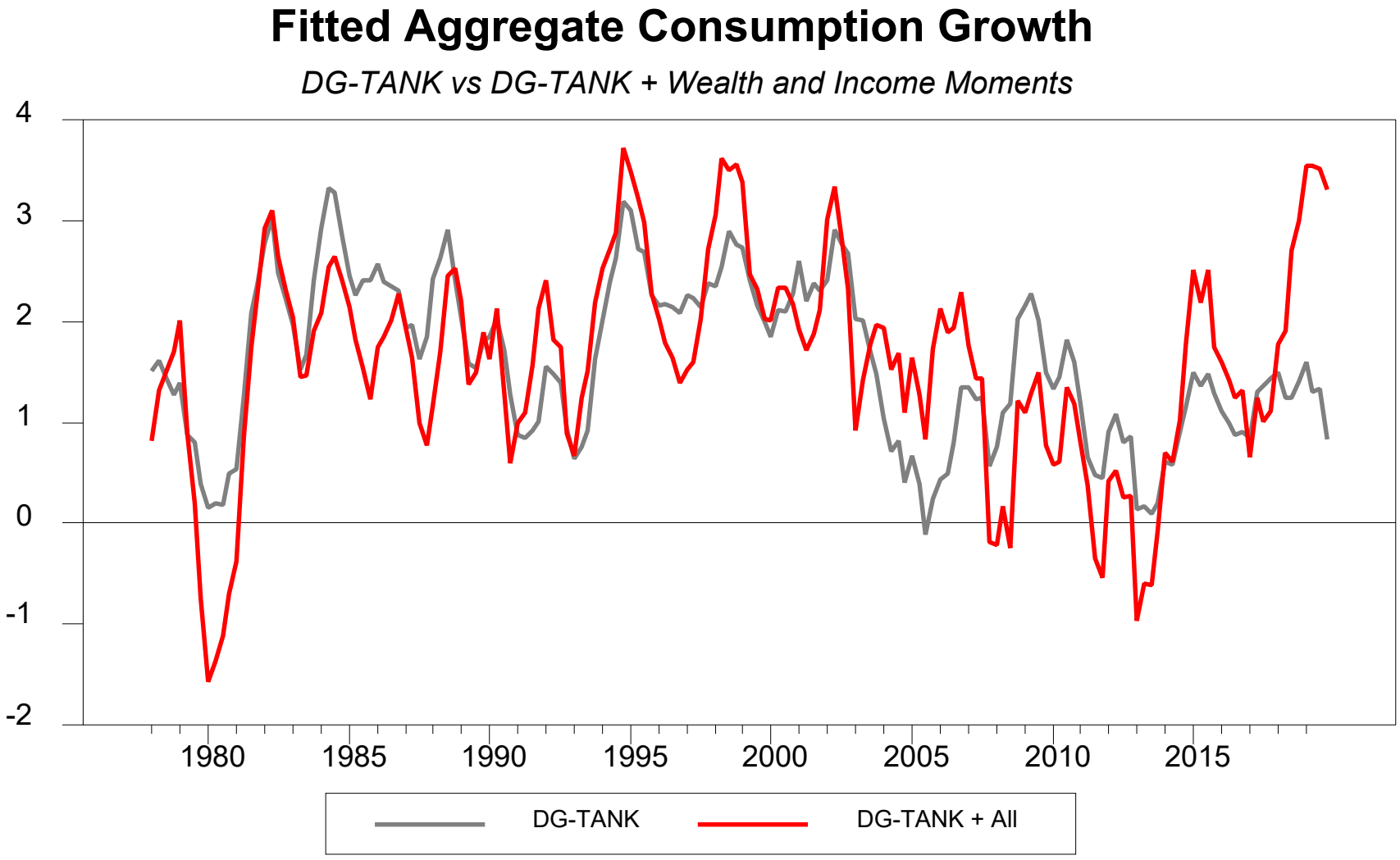
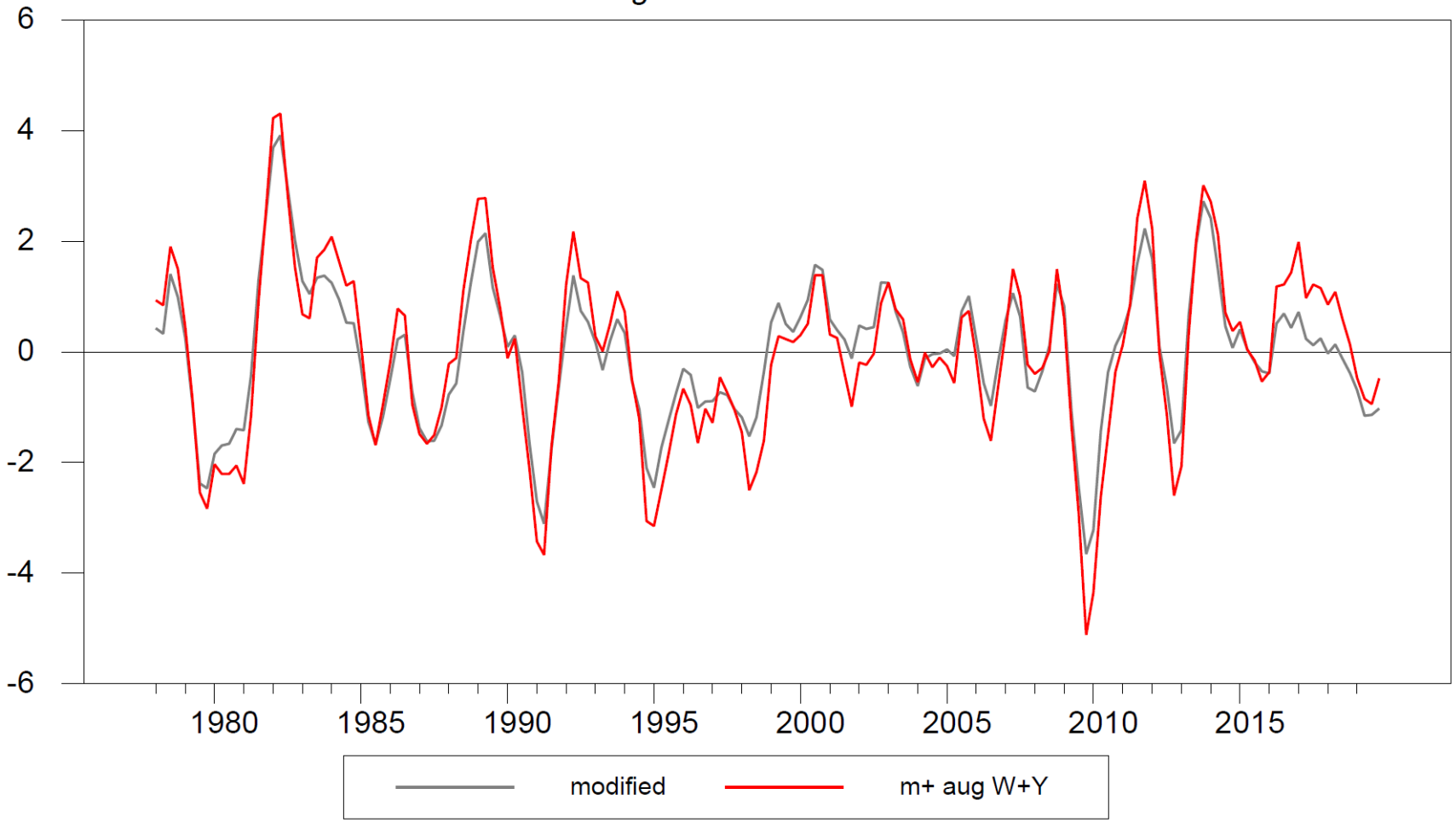


Table 5. Empirical Euler Equations: Simulated Data

	HANK-II Model				
	TANK	*TANK**	*TANK*+W*	*TANK*+Y*	*TANK*+All*
r_{t-1}	1.275***	1.417***	1.431***	2.455***	2.336***
	(0.249)	(0.253)	(0.262)	(0.779)	(0.883)
Δy_t^H	0.120***	0.189***	0.212***	0.425**	0.341
	(0.017)	(0.060)	(0.068)	(0.174)	(0.249)
$\Delta\lambda_t$		−0.233	−0.331	−0.499*	−0.327
		(0.191)	(0.234)	(0.255)	(0.407)
Wealth					
mean			−2.717		−2.490
			(4.124)		(4.488)
s.d.			−0.142		−0.216
			(0.419)		(0.538)
skewness			0.620		0.556
			(0.519)		(0.492)
Income					
mean				−0.141	0.064
				(0.206)	(0.272)
s.d.				−0.332	0.068
				(0.394)	(0.585)
skewness				−0.332	−0.177
				(0.331)	(0.452)
p-value			0.424	0.101	0.091
correlation	1.00	0.988	0.972	0.945	0.946

Fitted Aggregate Consumption Growth: Simulated Data

Modified vs Modified Plus Augmented: Wealth and Income Moments



Conclusions

- Does the behavior of *aggregate* consumption reflect the presence of heterogeneity?
- Two dimensions

  - unconstrained vs hand-to-mouth consumers
  - idiosyncratic income shocks

- Strong evidence of a significant role for hand-to-mouth behavior
- Little evidence of a quantitatively significant role for idiosyncratic income shocks