Consumption Heterogeneity: Micro Drivers and Macro Implications

Edmund Crawley & Andreas Kuchler

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What Do We Do?

We estimate the **sensitivity of consumption**

to permanent and transitory **shocks to income**

for **different groups** of households

Hasn't This Been Done Before?

Yes, but...

Our **method** addresses bias in previous results

Our **data** allows sharp focus on household heterogeneity

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Time Aggregation Problem

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Our **data** allows sharp focus on household heterogeneity

Sample size in millions
Detailed balance sheet

Why Do We Care? (as macroeconomists)

1) Heterogenous agent models have testable micro behavior

2) Quantify Macro Implications

Why Do We Care? (as macroeconomists)

e.g. Consumption smoothing requires liquid wealth

1) Heterogenous agent models have testable micro behavior

2) Quantify Macro Implications

e.g. Redistribution in Monetary Policy

What do we find? (Redistribution in Monetary Policy)

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Medium MPX
≈ 0.5

High MPX
≈ 0.8

Low MPX
≈ 0.25

MPX: Marginal Propensity to eXpend (includes durables)

What do we find? (Redistribution in Monetary Policy)

Medium MPX
≈ 0.5

High MPX
≈ 0.8

Low MPX
≈ 0.25

↙

Decrease spending
a *lot*

↘

Increase spending
a *little*

What do we find? (Redistribution in Monetary Policy)

1yr rate $\uparrow$ 1%

Aggregate Spending $\downarrow$ 26 basis points

Through this redistribution channel *alone*

Reduced Form Approach

Identifying Restrictions on

Income

and

Consumption

In **Continuous** Time

Reduced Form Approach

Identifying Restrictions on

Income $\longrightarrow$ Permanent (random walk) shocks
Transitory (<2 years) shocks

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In **Continuous** Time

Reduced Form Approach

Identifying Restrictions on

Income $\longrightarrow$ Permanent (random walk) shocks
Transitory (<2 years) shocks

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Consumption $\longrightarrow$ Permanent (random walk) response
Transitory (<2 years) response

In **Continuous** Time

Reduced Form Approach

Identifying Restrictions on

Income $\longrightarrow$ Permanent (random walk) shocks; Transitory (<2 years) shocks

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Consumption $\longrightarrow$ Permanent (random walk) response; Transitory (<2 years) response

In **Continuous** Time $\longrightarrow$ Time Aggregation Problem

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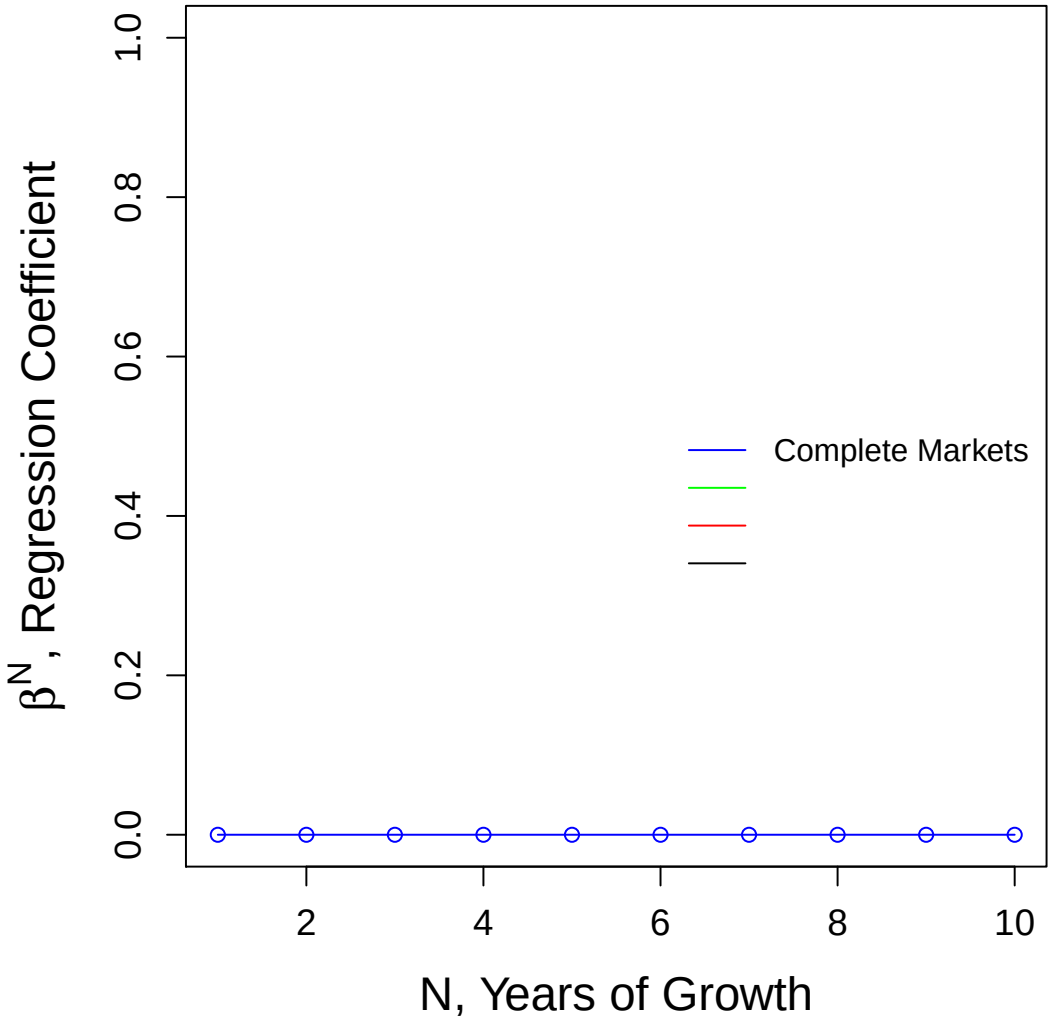
In **Continuous** Time $\longrightarrow$ Time Aggregation Problem

But first some intuition: Naïvely Regress

Change in Consumption on Change in Income (over N years)

Naïve Regression: Consumption Growth on Income Growth

$$\Delta^N c_i = \alpha^N + \beta^N \Delta^N y_i + \varepsilon_i$$



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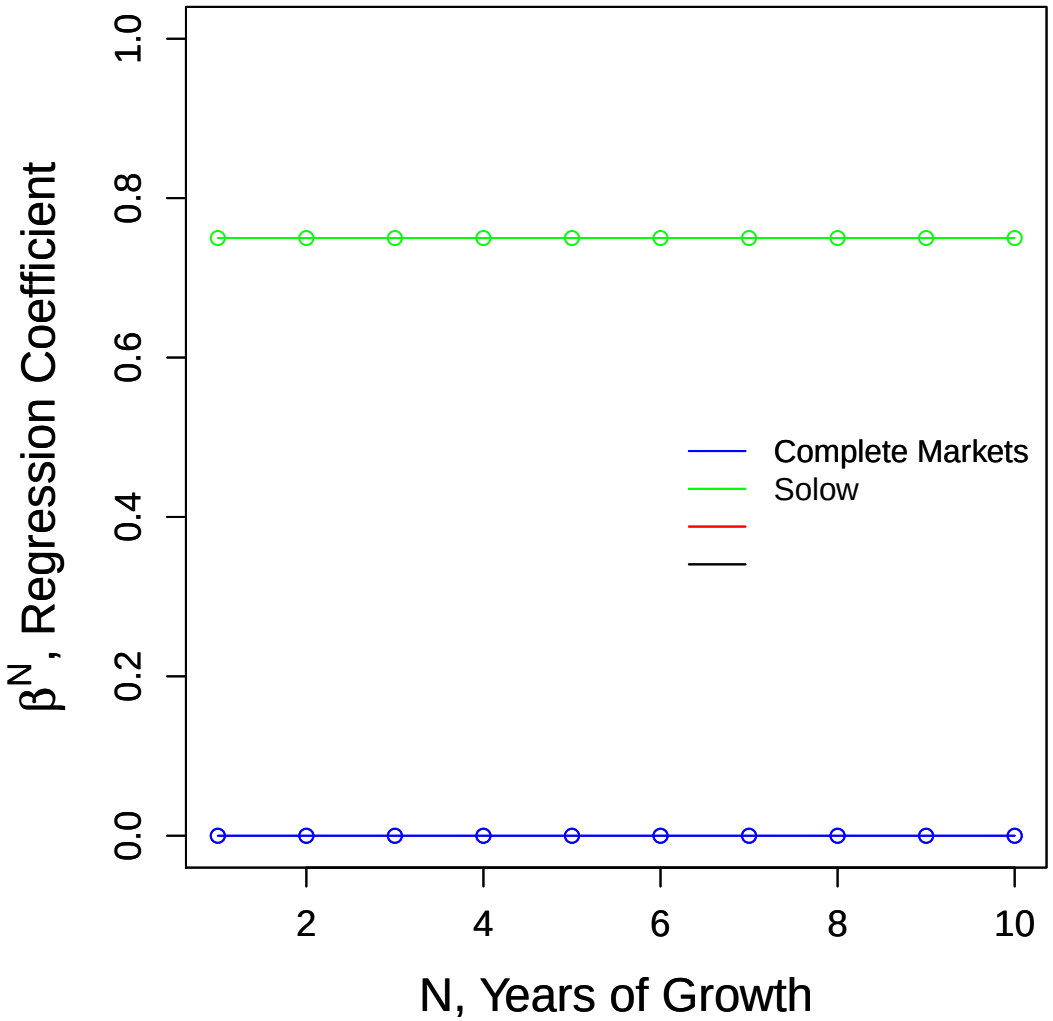

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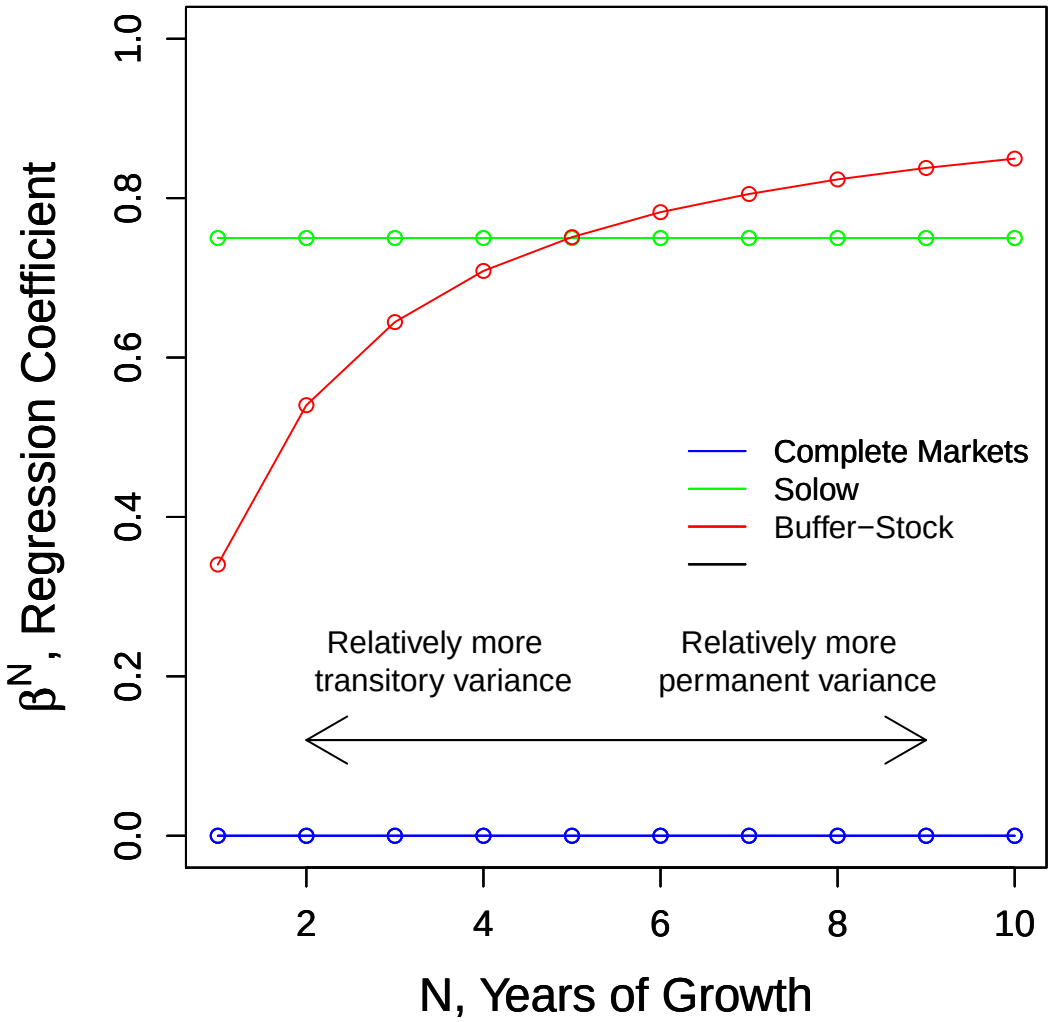

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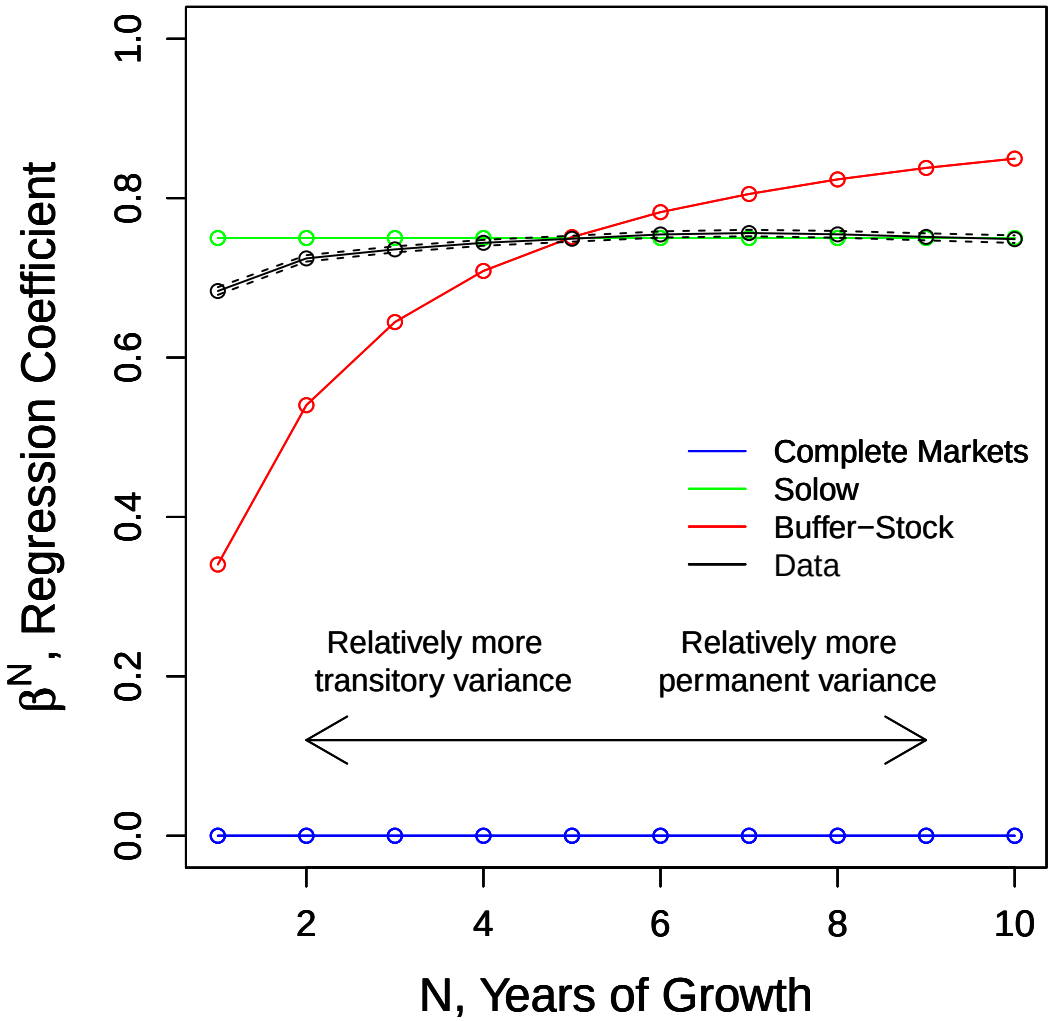

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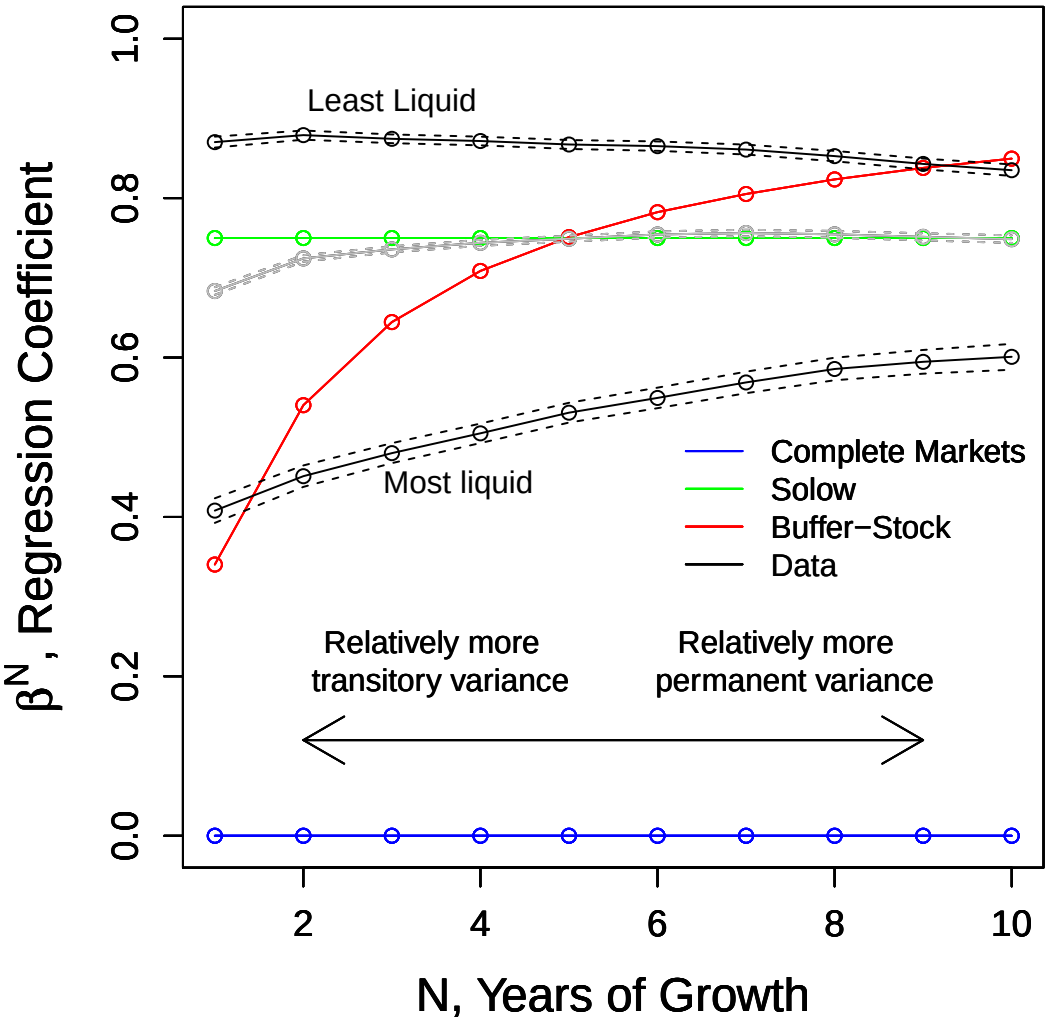
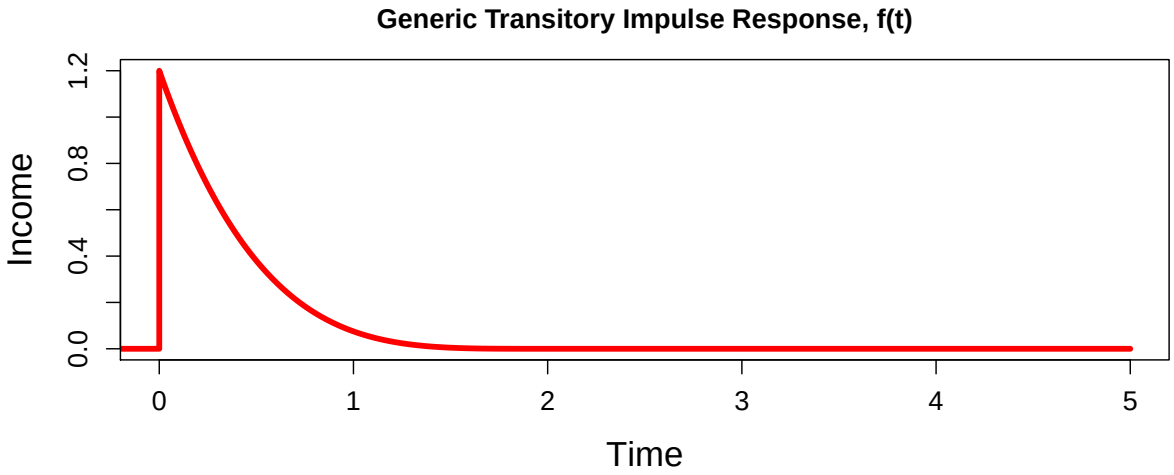


Identification Restrictions: Income Process

- Permanent Income (random walk)
- Transitory Income (persistence $<$ 2 years)



$$y_t = p_t + \int_{t-2}^{t} f(t-s)dq_s$$

Permanent income flow

Transitory income flow

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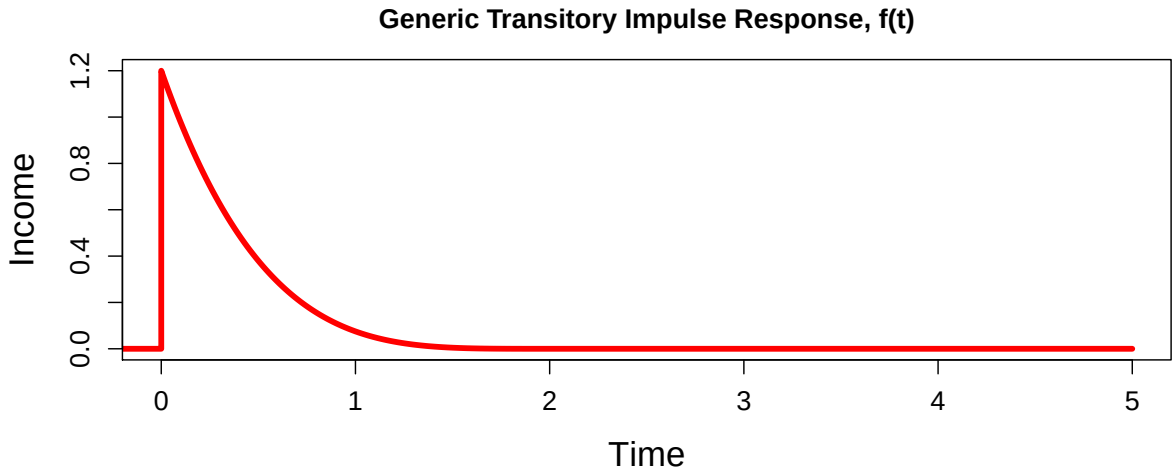


Observed Income

$$\uparrow$$

$$\bar{y}_T = \int_{T-1}^{T} y_t dt = \int_{T-1}^{T} p_t dt + \int_{T-1}^{T} \int_{t-2}^{t} f(t-s) dq_s dt$$

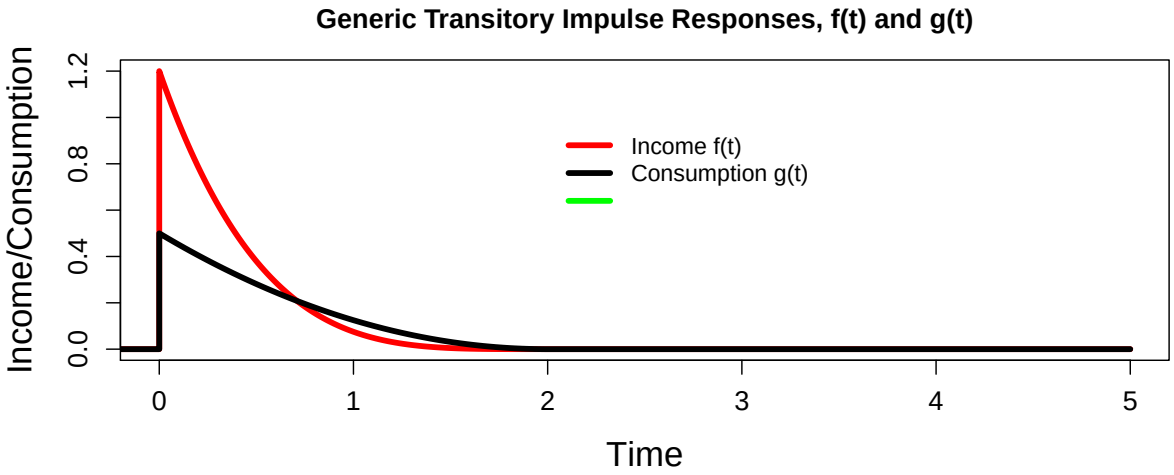
$$\downarrow$$

Time Aggregation

Identification Restrictions: Consumption Response

- Permanent: Moves by fraction ϕ of shock
- Transitory: Persistence < 2 years

Evidence



$$c_t = \phi p_t + \int_{t-2}^{t} g(t-s)dq_s$$

Permanent consumption flow

Transitory consumption flow

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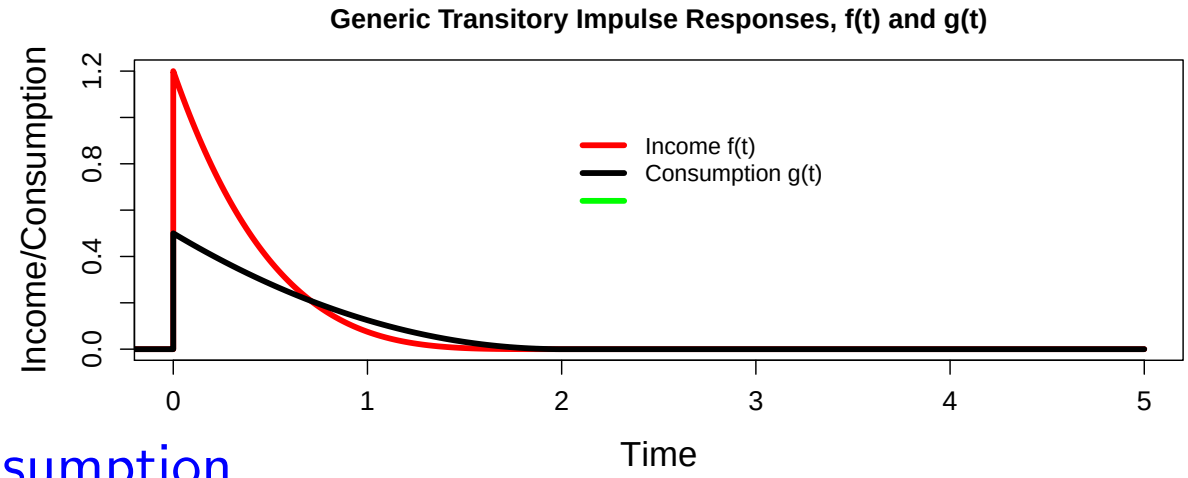

Observed Consumption

$$\uparrow$$

$$\bar{c}_T = \int_{T-1}^{T} c_t dt = \int_{T-1}^{T} \phi p_t dt + \int_{T-1}^{T} \int_{t-2}^{t} g(t-s) dq_s dt$$

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Time Aggregation

Full Identification

We use GMM on the equations:

$$\mathrm{Var}(\Delta^N \bar{y_T}) = (N - \frac{1}{3})\sigma_p^2 + 2\sigma_{\tilde{q}}^2$$

$$\mathrm{Cov}(\Delta^N \bar{c_T}, \Delta^N \bar{y_T}) = \phi(N - \frac{1}{3})\sigma_p^2 + 2\psi\sigma_{\tilde{q}}^2$$

with $N = 3, 4, 5$ (and $T = 2007, .., 2015$) to identify:

- σ_p^2: Permanent shock variance
- $\sigma_{\tilde{q}}^2$: (Time aggregated) transitory shock variance
- ϕ: MPX out of permanent income shocks
- ψ: MPX out of transitory income shocks

where ψ is the regression coefficient of 'transitory' consumption on transitory income

Aside: Why Not Blundell, Pistaferri and Preston 2008?

Key to BPP Identification

Transitory shock year t

$\Delta y_{t+1} = \Delta p_{t+1} + \Delta \varepsilon_{t+1}$ is a *valid instrument* for ε_t

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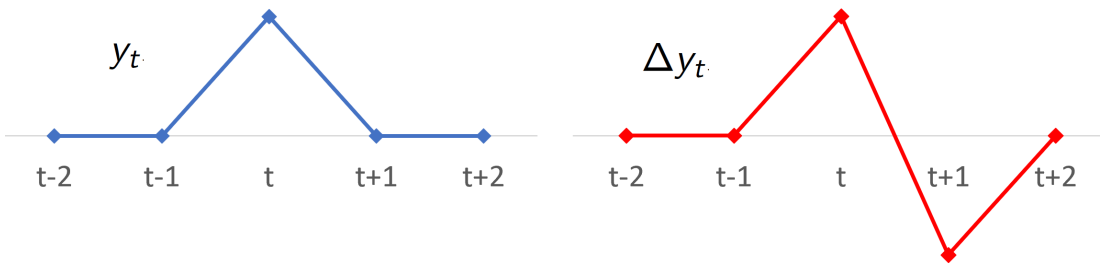

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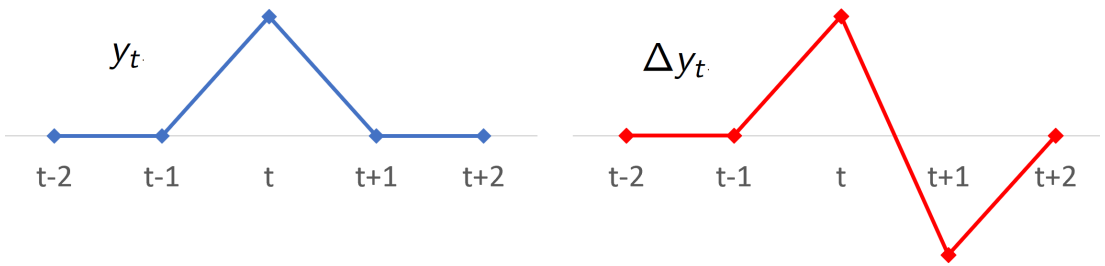

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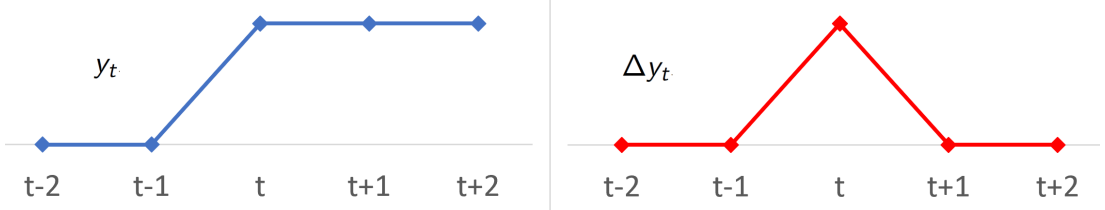

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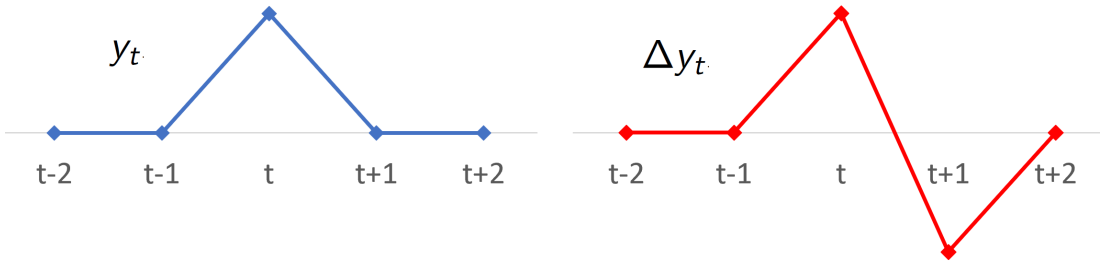

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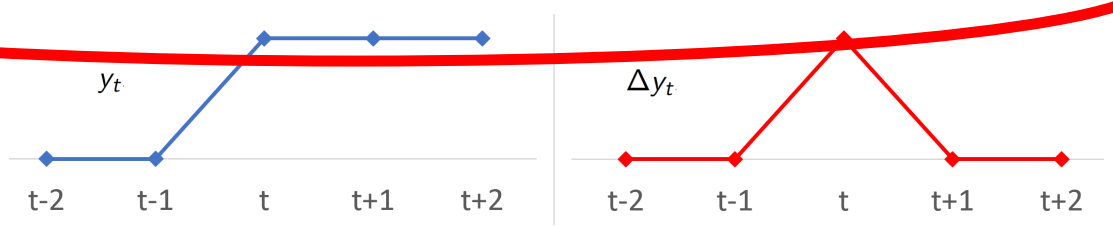
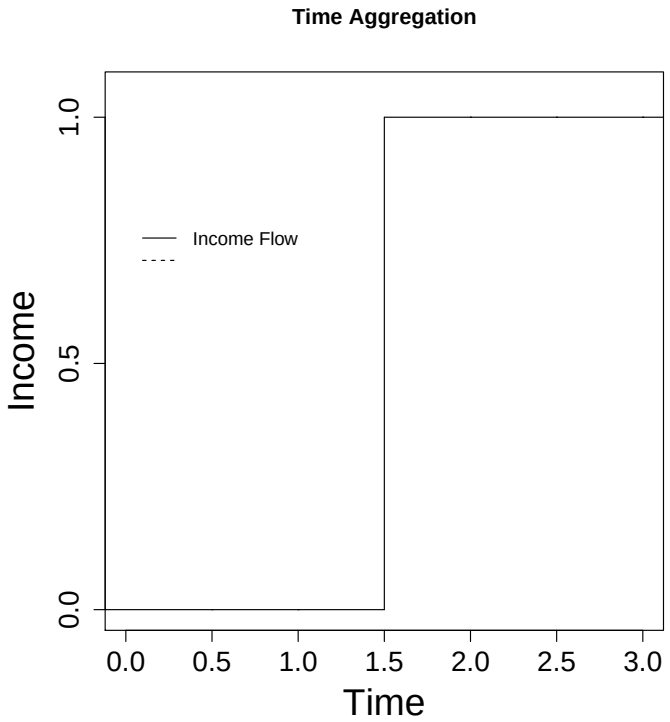


Fails due to the **Time Aggregation Problem**

Aside: Time Aggregation Problem in BPP (Crawley 2018)



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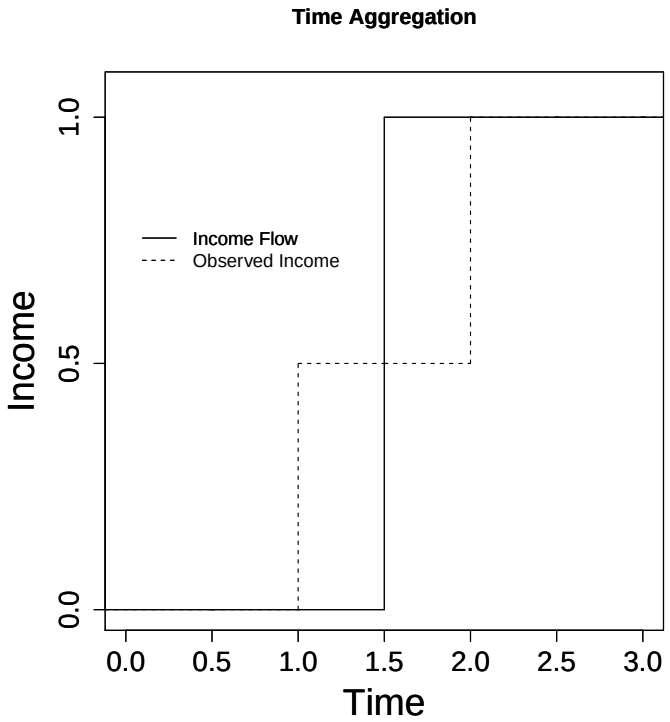

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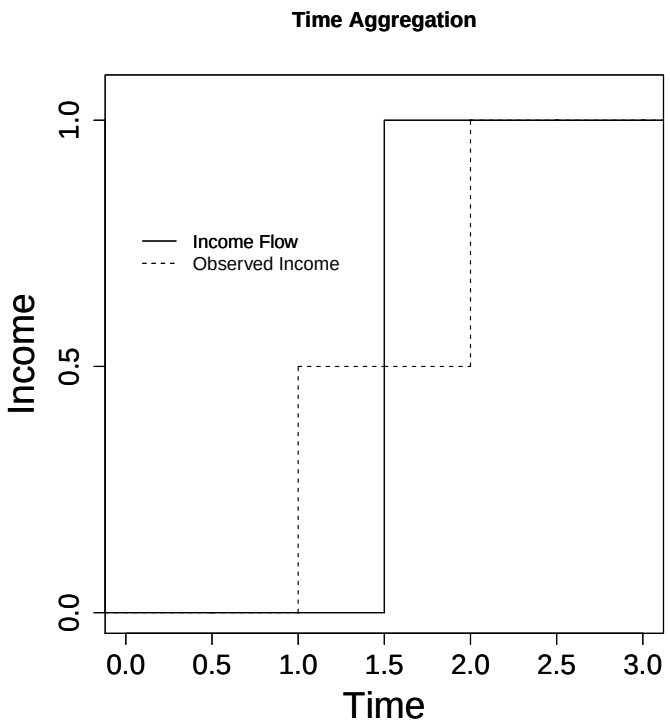

Observed permanent income growth is *positively* autocorrelated

BPP misinterprets *positive* permanent income shocks as *negative* transitory shocks

$\Longrightarrow$ Thinks negative transitory shocks result in consumption *increasing*

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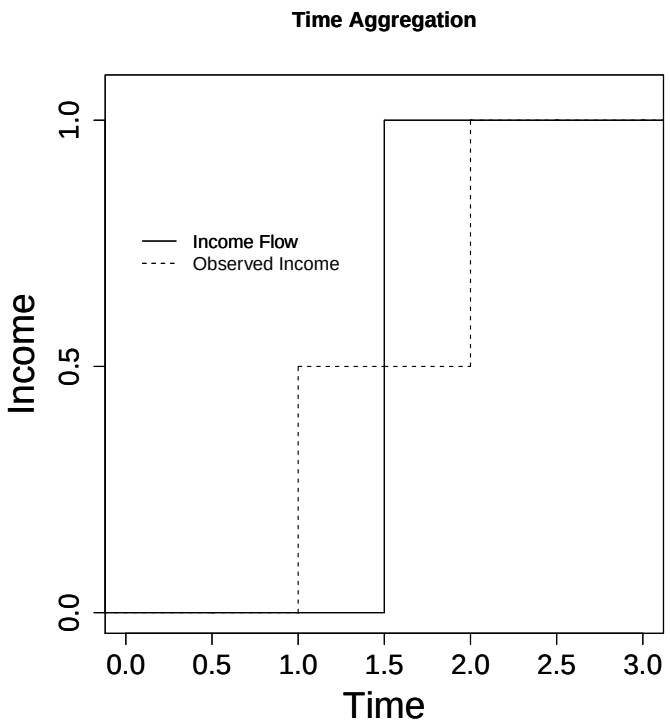

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If the Permanent Income Hypothesis holds, BPP will estimate the MPC to be -0.6

Data

What we need:

- Panel Data on **Income** and **Expenditure**
- Household **Balance Sheets**

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What we have: Registry data for all Danish households

- **Income**

  Third party reported
  After-tax, restrict to heads aged 30-55

- **Balance Sheet**

  Wealth on 31 Dec
  Asset category, mortgage tenure

- **Expenditure**

  No *direct* measure of spending

Data: Expenditure

Intertemporal budget constraint

$$\text{Expenditure} = \text{Income} - \text{Saving}$$

Data: Expenditure

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$$= \text{Change in Net Worth (adj. for capital gains)}$$

Data: Expenditure

Intertemporal budget constraint

$$\text{Expenditure} = \text{Income} - \text{Saving}$$

$$\downarrow$$

$$= \text{Change in Net Worth (adj. for capital gains)}$$

- Works well for households with simple financial lives
- Problem: Capital gains
  - Houses off balance sheet (exclude transaction years)
  - Exclude business owners
  - Capital gains based on a diversified index
- Noisy, but perhaps better than surveys (Kuchler et al. 2018)
- Huge sample size advantage: sample covers 7.6 million observations over 2004-2015

Data: When is Measurement Error a Problem?

We have the same issues as the regression:

$$\Delta c_i = \alpha + \beta \Delta y_i + \varepsilon_i$$

That is measurement error in:

- Δy_i leads to attenuation bias
- Δc_i should be uncorrelated with Δy_i

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We have the same issues as the regression:

$$\Delta c_i = \alpha + \beta \Delta y_i + \varepsilon_i$$

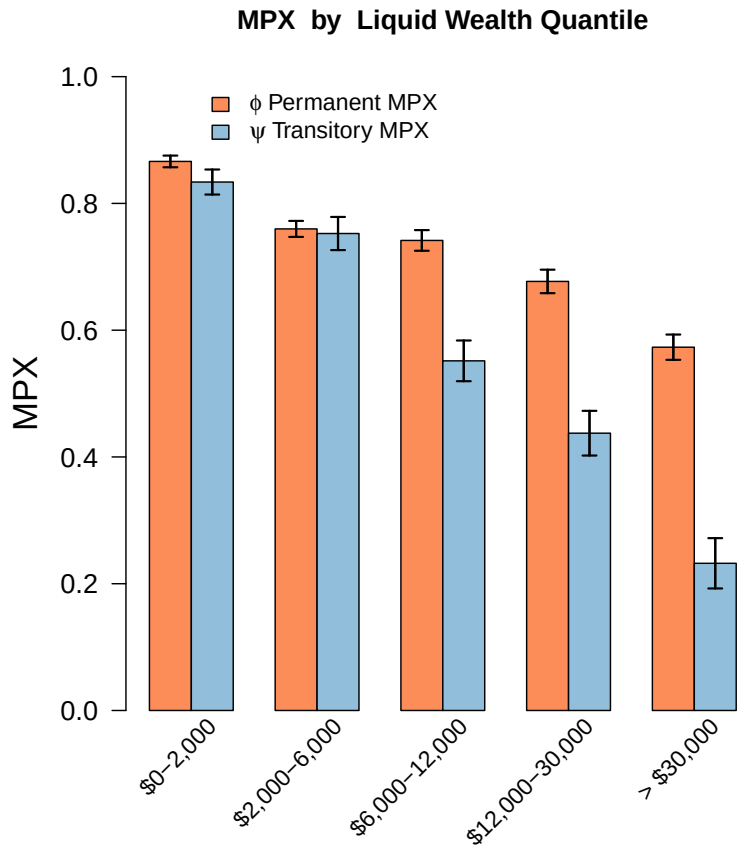
That is measurement error in:

- Δy_i leads to attenuation bias ↗ High quality income data
- Δc_i should be uncorrelated with Δy_i ↙

When might this fail?

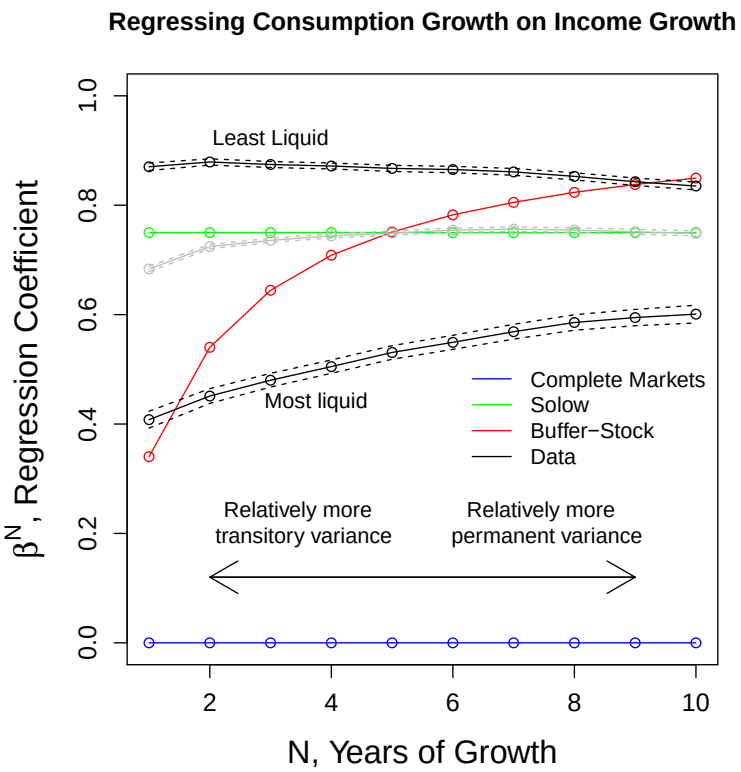
- Off balance sheet saving
- Returns correlated with *changes* in income (e.g. stock compensation)
- When insurance is provided by friends and family

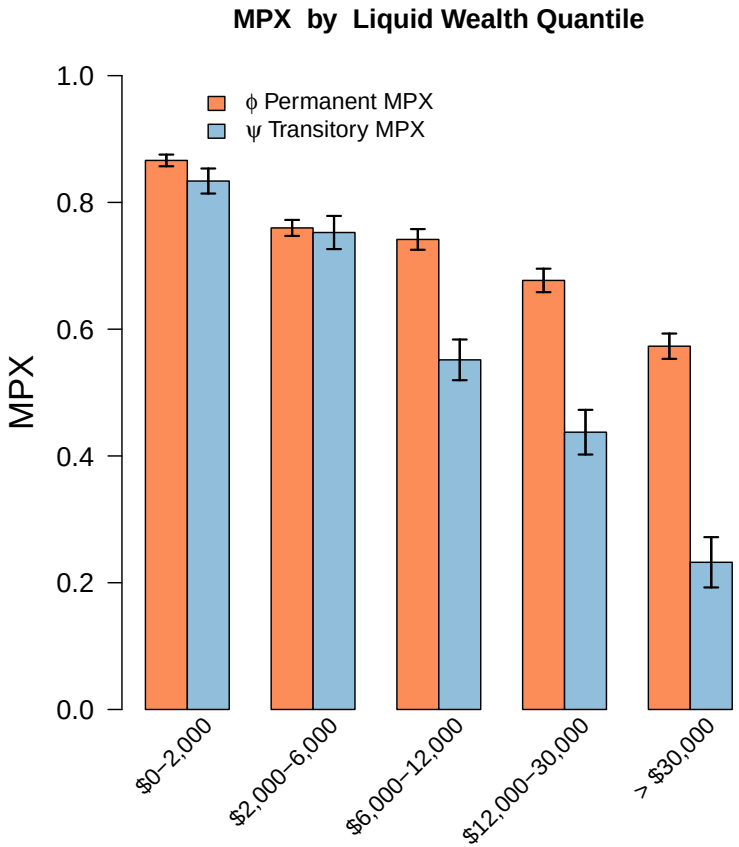
Results by Liquid Wealth



MPX by Net Wealth

MPX Results are Robust to Misspecification





MPX by Net Wealth

Monetary Policy: Auclert's Decomposition

How does Monetary Policy Effect Aggregate Consumption?

- Intertemporal Substitution
- Aggregate Income

} Representative Agent Channels

Monetary Policy: Auclert's Decomposition

→ Dominates in Rep. Agent NK models

How does Monetary Policy Effect Aggregate Consumption?

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} Representative Agent Channels

→ Large in Spender-Saver, or TANK models

Monetary Policy: Auclert's Decomposition

How does Monetary Policy Effect Aggregate Consumption?

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} Representative Agent Channels

- Fisher (Inflationary debt relief)
- Earnings Heterogeneity
- Interest Rate Exposure

} Redistribution Channels

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How can we *empirically* measure the size of the redistribution channels?

Need to know the distribution of MPCs along the relevant dimension of redistribution

Interest Rate Exposure: Auclert's Experiment

Key assumption:
Households treat redistribution like an income shock

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Experiment

Short term real interest rate $\uparrow$ 1% for 1 year

Hold constant income and inflation

How does subsequent **redistribution** impact **aggregate consumption**?

Dimension of Redistribution: **Unhedged Interest Rate Exposure**

Interest Rate Exposure: Dimension of Redistribution

Define **Unhedged Interest Rate Exposure** for household i as the total savings the household will invest at this year's interest rate:

$$URE_i = Y_i - C_i + A_i - L_i$$

Where

- Y_i = Total after tax income
- C_i = Total Expenditure, including interest payments
- A_i = Maturing assets
- L_i = Maturing liabilities

Following a change in the interest rate dR, the size of the Interest Rate Exposure channel on household i's expenditure is:

$$dc_i = MPC_i URE_i \frac{dR}{R}$$

Interest Rate Exposure: Aggregation

Aggregate to find size of channel:

$$dc_i = MPC_i URE_i \frac{dR}{R}$$

$$\implies \frac{dC}{C} = \mathbb{E}_I\left(MPC_i \frac{URE_i}{\mathbb{E}_I(c_i)}\right)\frac{dR}{R}$$

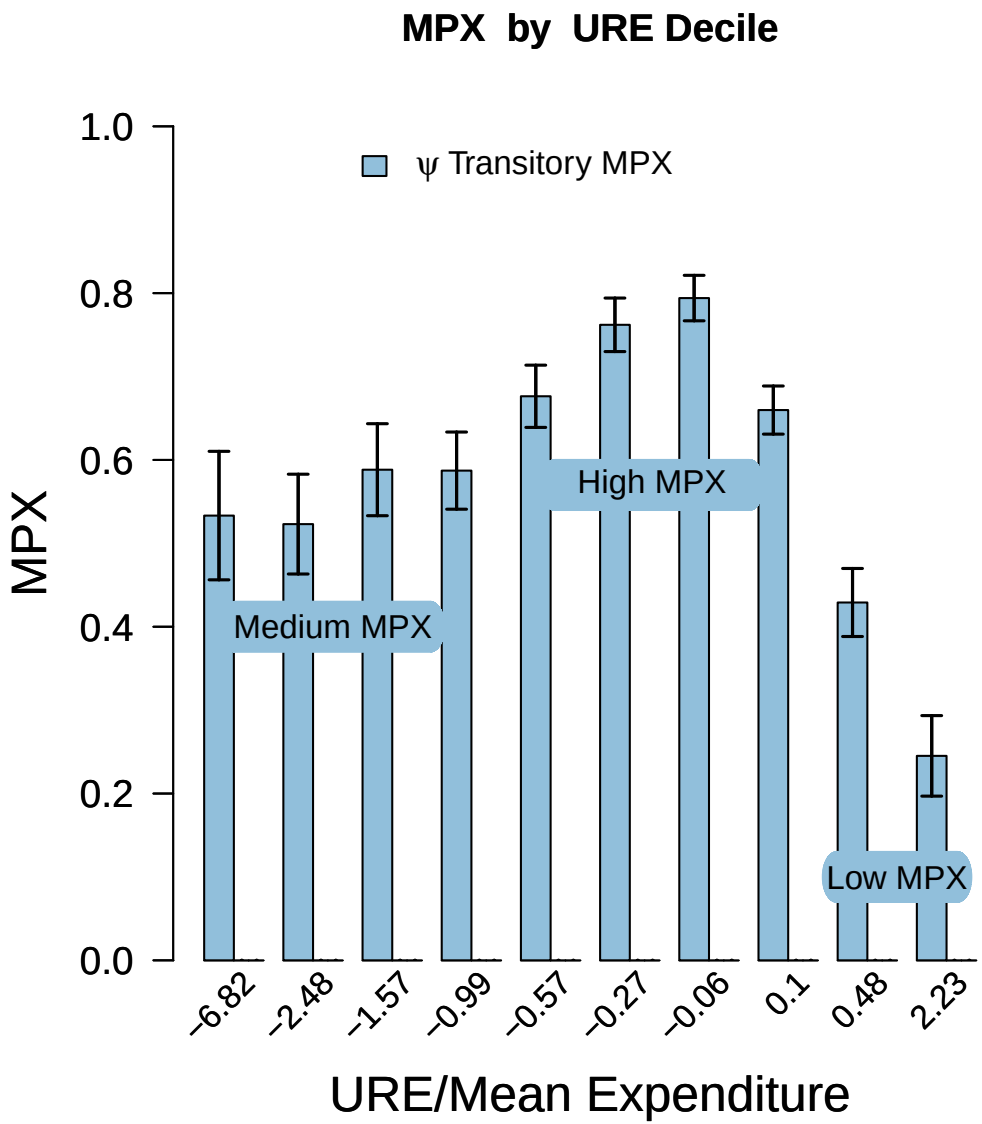
Define sufficient statistic:

$$\mathcal{E}_R = \mathbb{E}_I\left(MPC_i \frac{URE_i}{\mathbb{E}_I(c_i)}\right)$$

$\implies$ Need to know the distribution of MPC_i with URE_i

We can do that!

Interest Rate Exposure: MPX Distribution



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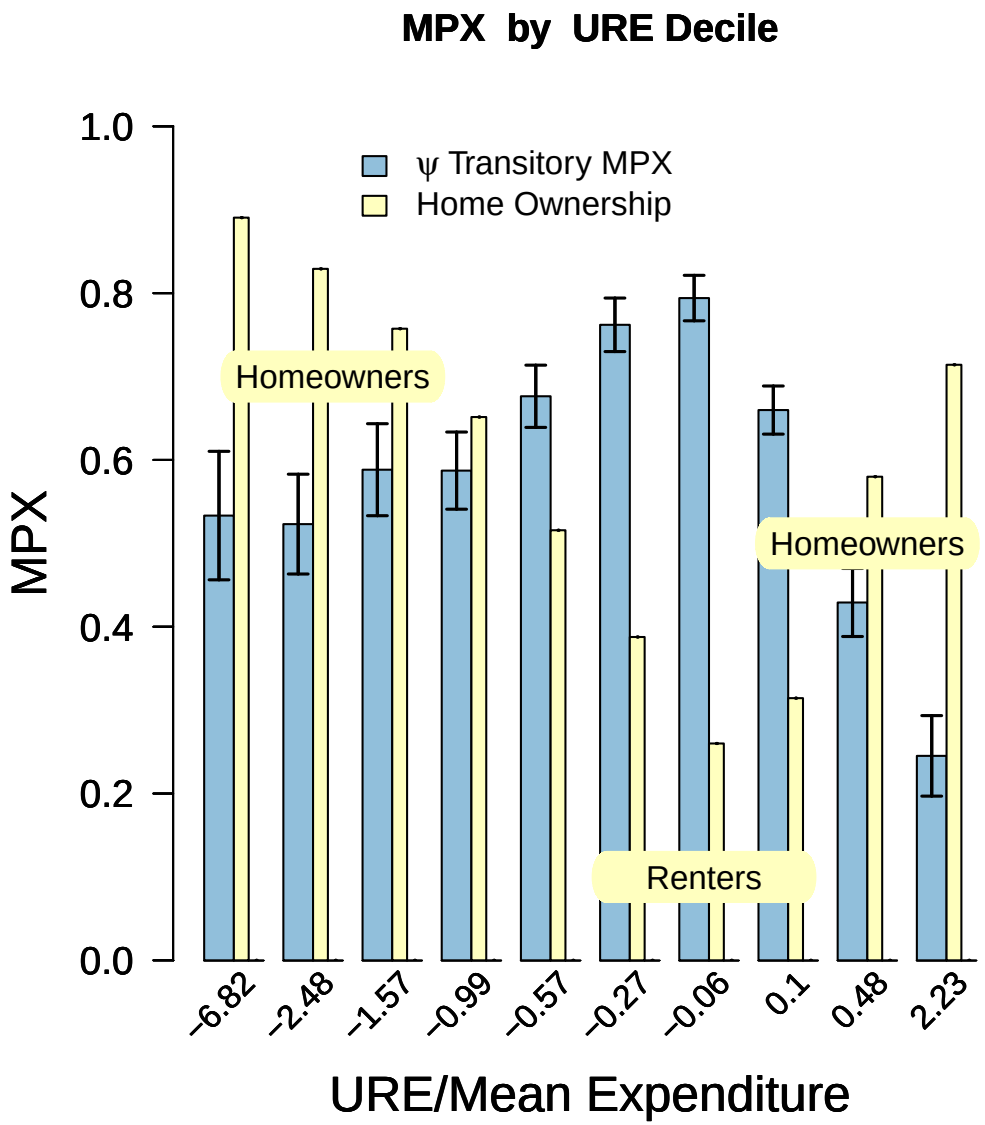

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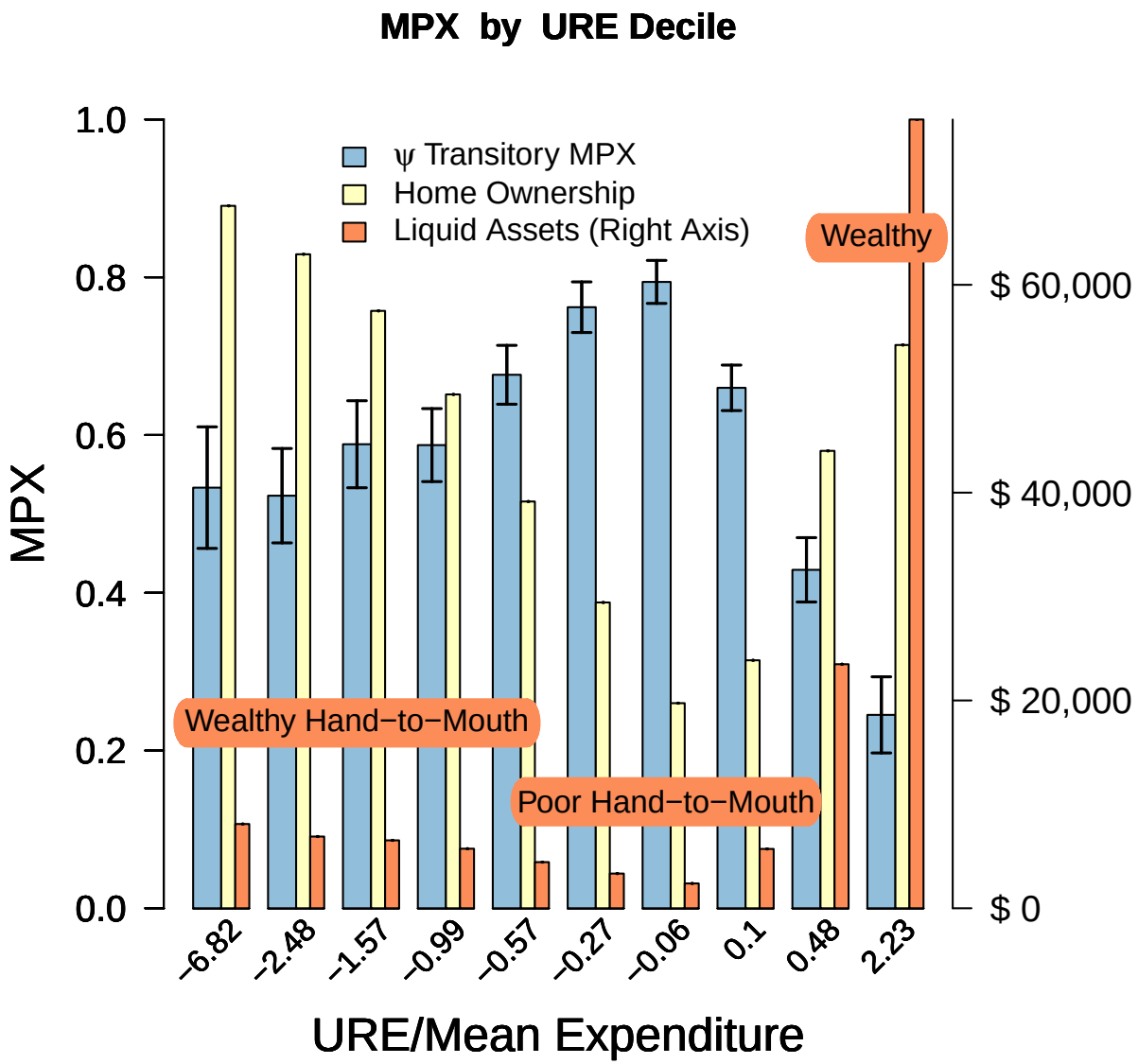

Interest Rate Exposure: Out of Sample

Total URE sums to zero - this is not true for our household sample

	MPX	URE	$\mathcal{E}_R$ component
Estimation Sample	**See Distribution**	**-61**	**-0.29**
Young	0.5	-15	-0.06
Old	0.5	6	0.02
Pension Funds	0.1	37	0.03
Government	0.0	-23	0.00
Non-financial Corp.	0.1	-13	-0.01
Financial Sector	0.1	61	0.05
Rest of World	0.0	9	0.00
Total		**0**	**-0.26**

Notes: URE numbers are in billions of 2015 USD.

All Five Transmission Channels

$$\frac{dC}{C} = \overbrace{\mathcal{M}\frac{dY}{Y}}^{\text{Aggregate Income Channel}} \overbrace{+\gamma\mathcal{E}_Y\frac{dY}{Y}}^{\text{Earnings Heterogeity Channel}} \overbrace{-\mathcal{E}_P\frac{dP}{P}}^{\text{Fisher Channel}} \underbrace{+\mathcal{E}_R\frac{dR}{R}}_{\text{Interest Rate Exposure Channel}} \underbrace{-\sigma\mathcal{S}\frac{dR}{R}}_{\text{Intertemporal Substitution Channel}}$$

$\mathcal{M}$	0.52
$\mathcal{E}_Y$	-0.03
$\mathcal{E}_P$	-0.75
$\mathcal{E}_R$	-0.26
$\mathcal{S}$	0.49

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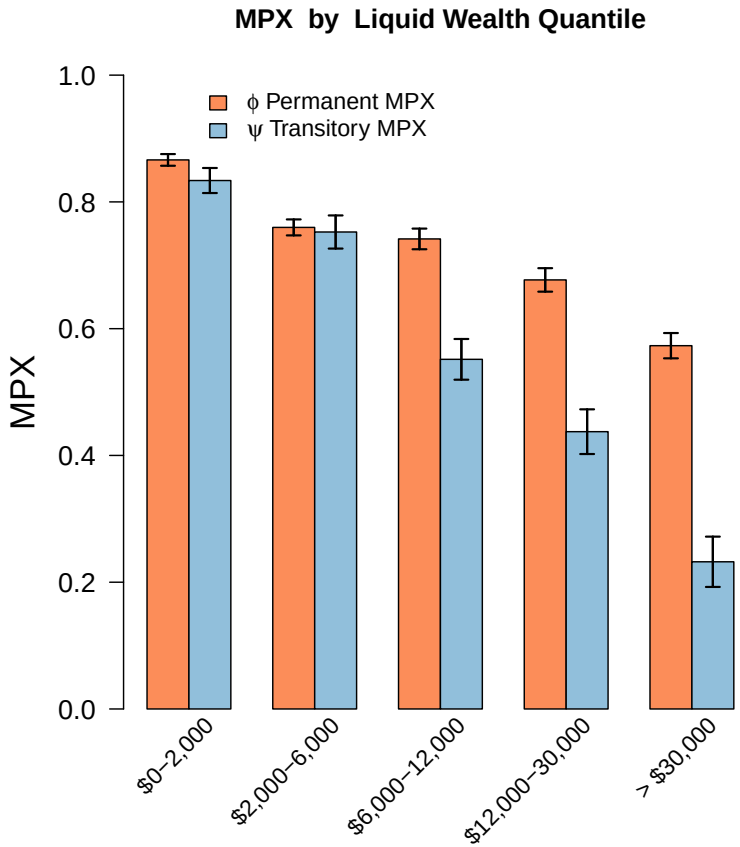
Compare $\mathcal{E}_R$ to σS:

$\sigma \approx 0.1$ Best, Cloyne, Ilzetzki, and Kleven (2018)

$\sigma S \approx 0.05$

Aim of Modeling Exercise

Can we calibrate a standard Buffer-Stock saving model to fit the distribution of MPC with liquid wealth?



Key features:

- High overall Transitory MPC
- Decreasing with liquid wealth

Benchmark Model

Households maximize expected utility

$$\mathbb{E}_t \sum_{i=t}^{\infty} \beta^i u(\mathbf{c}_i)$$

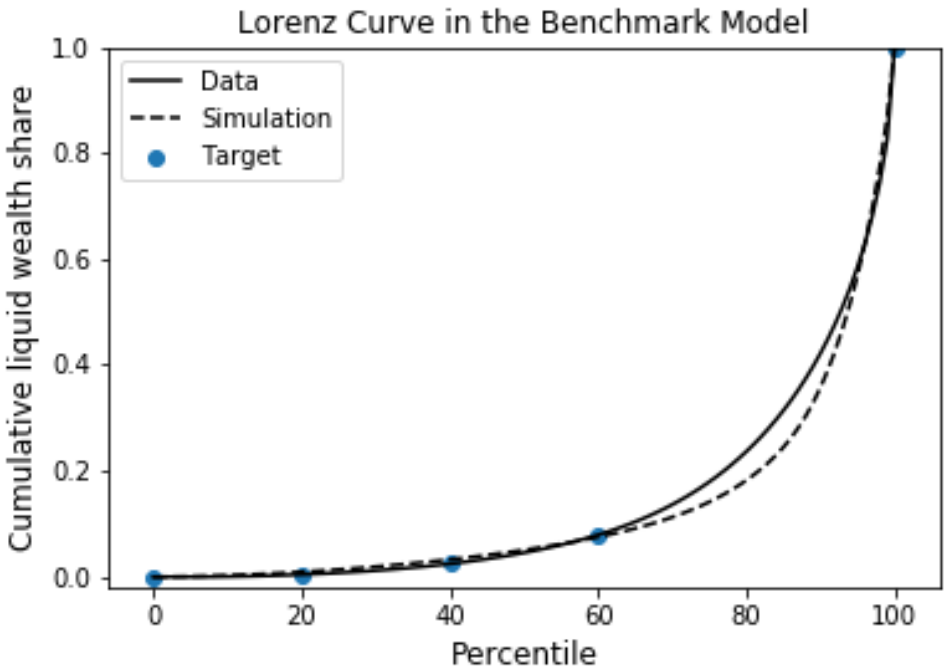
with:

- Permanent and Transitory shocks to income (calibrated to Danish data)
- Saving in one (liquid) asset
- No borrowing
- CRRA utility, $\rho = 2$

Benchmark Model: Fitting the Liquid Wealth Distribution

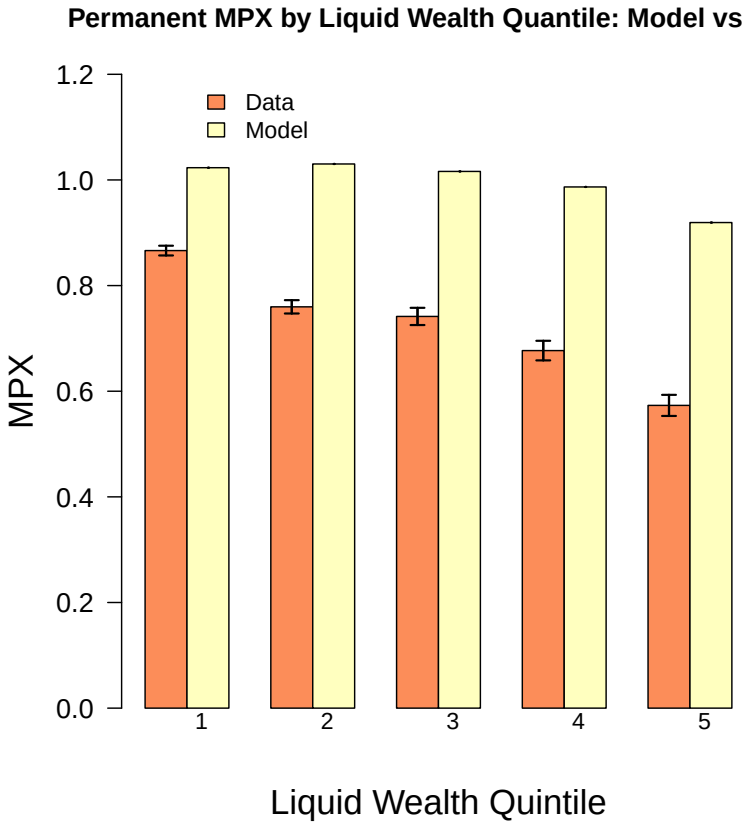
Ex-ante heterogeneity in the discount rate

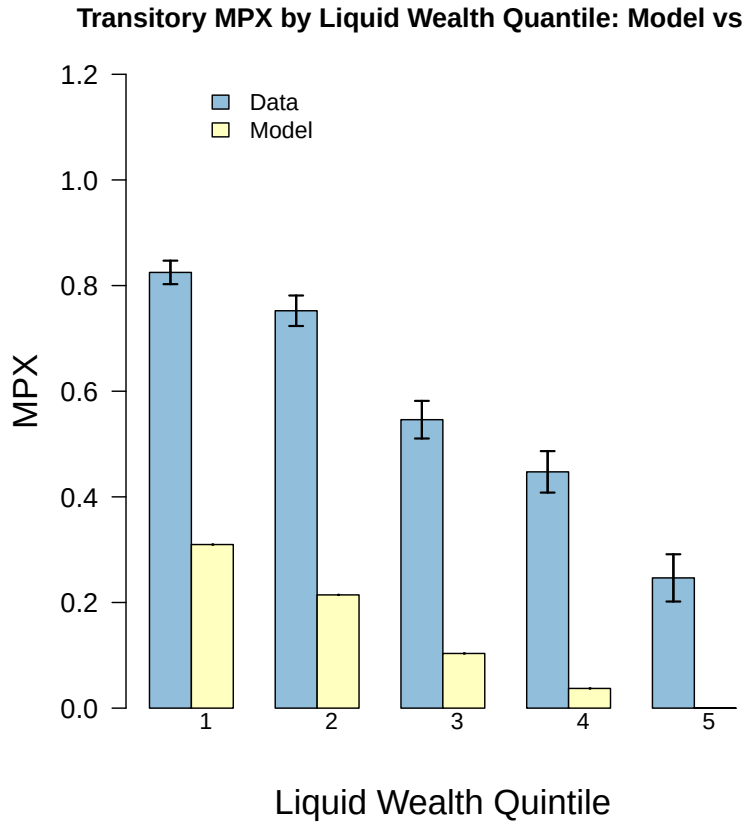
$\beta^i \sim \text{Unif}[\beta_{\text{low}}, \beta_{\text{high}}]$ Chosen to fit level and distribution of liquid wealth (especially at the low end)



Benchmark Model: Results

Simulate panel of data and estimate ϕ and ψ





Taste Shock Model

First order problem: Transitory MPCs are too low

Need to lower β's without reducing savings

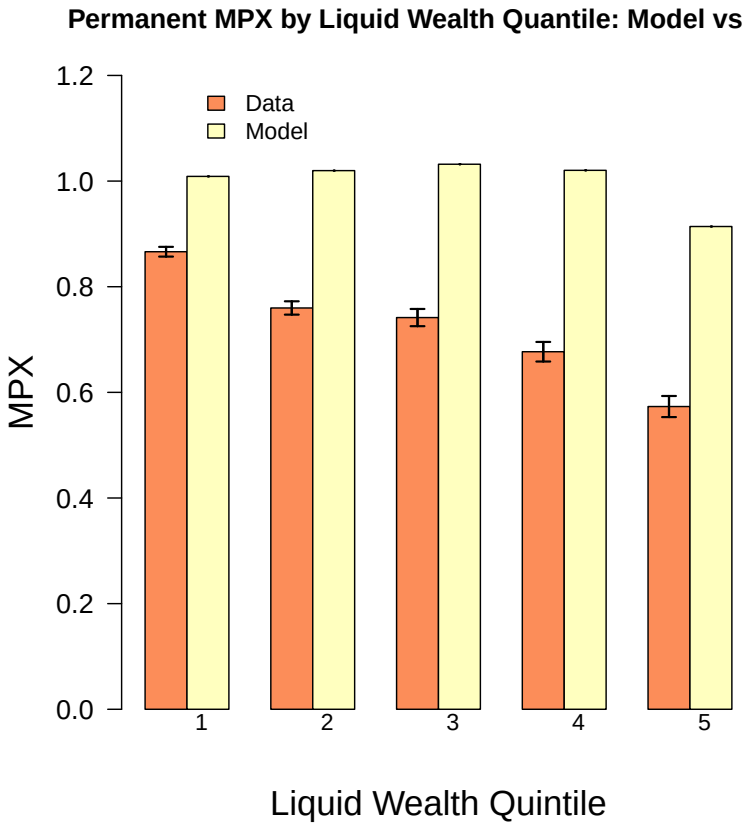
Is income risk the only source of precautionary saving?

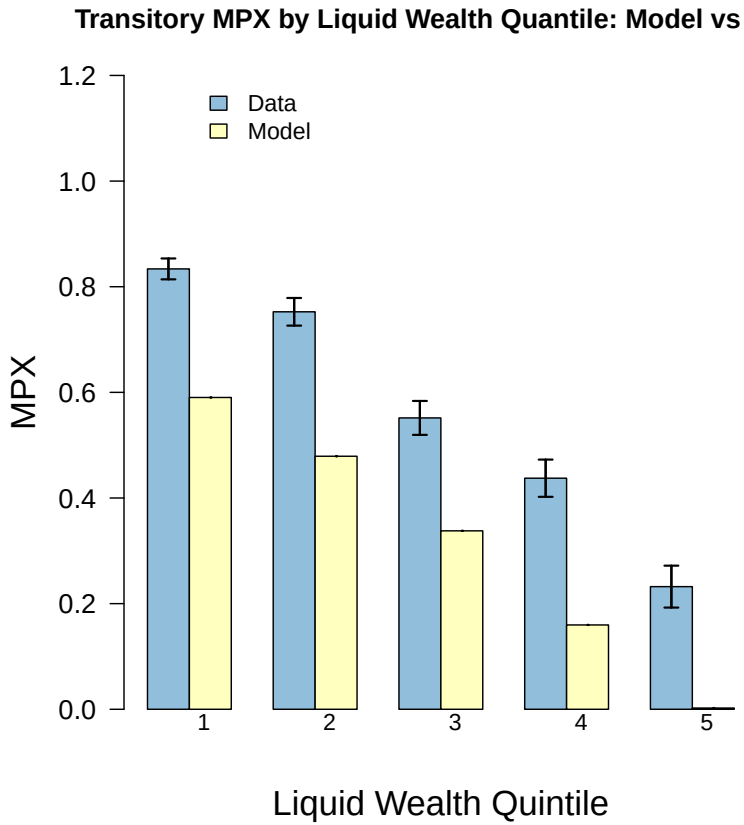
- In the data, expenditure FAR for volatile than income
- Surprise expenses can be large

Simple extension - add large taste shocks

$$\mathbb{E}_t \sum_{i=t}^{\infty} \beta^i \mathcal{X}_i u(\mathbf{c}_i)$$

Taste Shock Model: Results





Conclusion

- We have designed a new method to estimate consumption responses to income shocks
- It appears to work well, both in theory and practice
- We can use it to show that heterogeneity plays a key role in monetary policy transmission

Thank you!

Durables

We have data on value of household cars

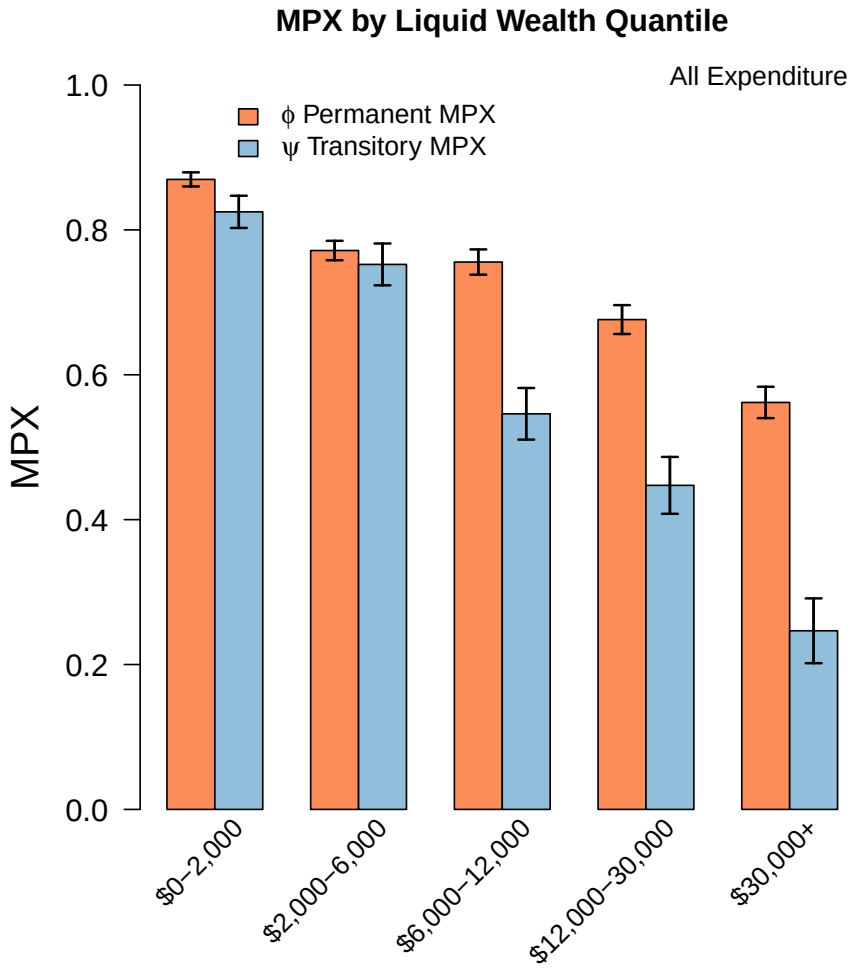
- Construct expenditure excluding car purchases and sales

$$C_T^{\text{nocar}} = C_T - \Delta\text{CarValue}$$

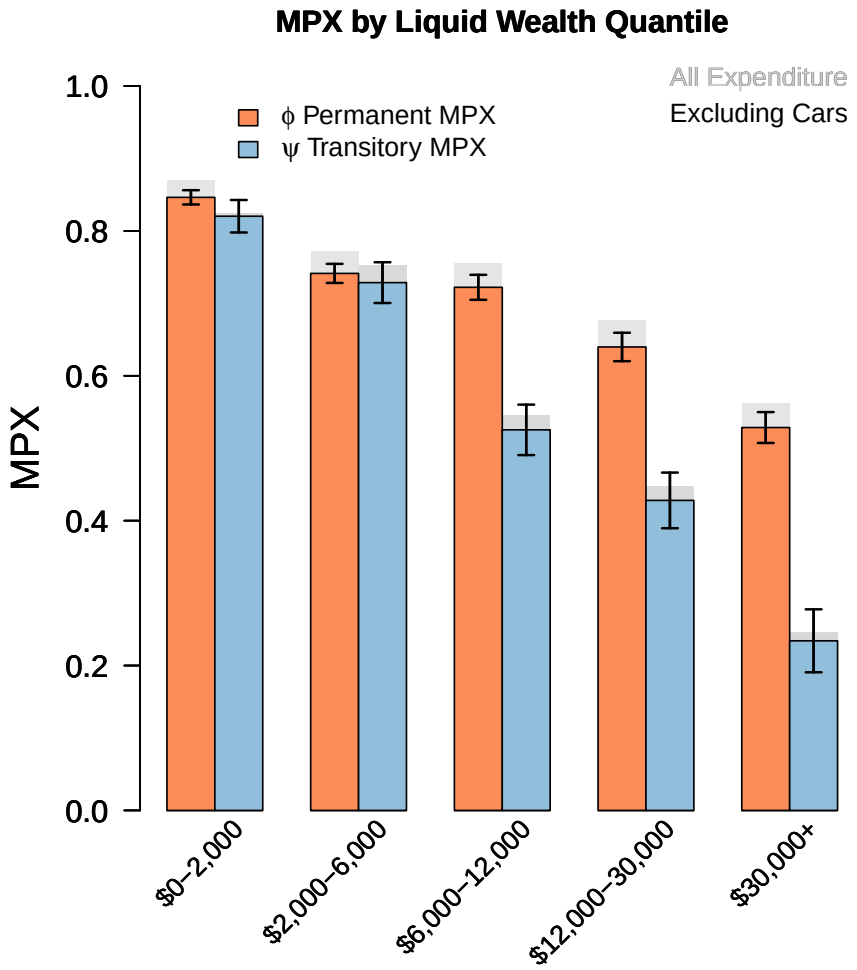
- Construct proxy for non durable consumption (Cars $\approx 42.1\%$ durable expenditure)

$$C_T^{\text{nondurable}} = C_T - \frac{1}{0.421}\Delta\text{CarValue}$$

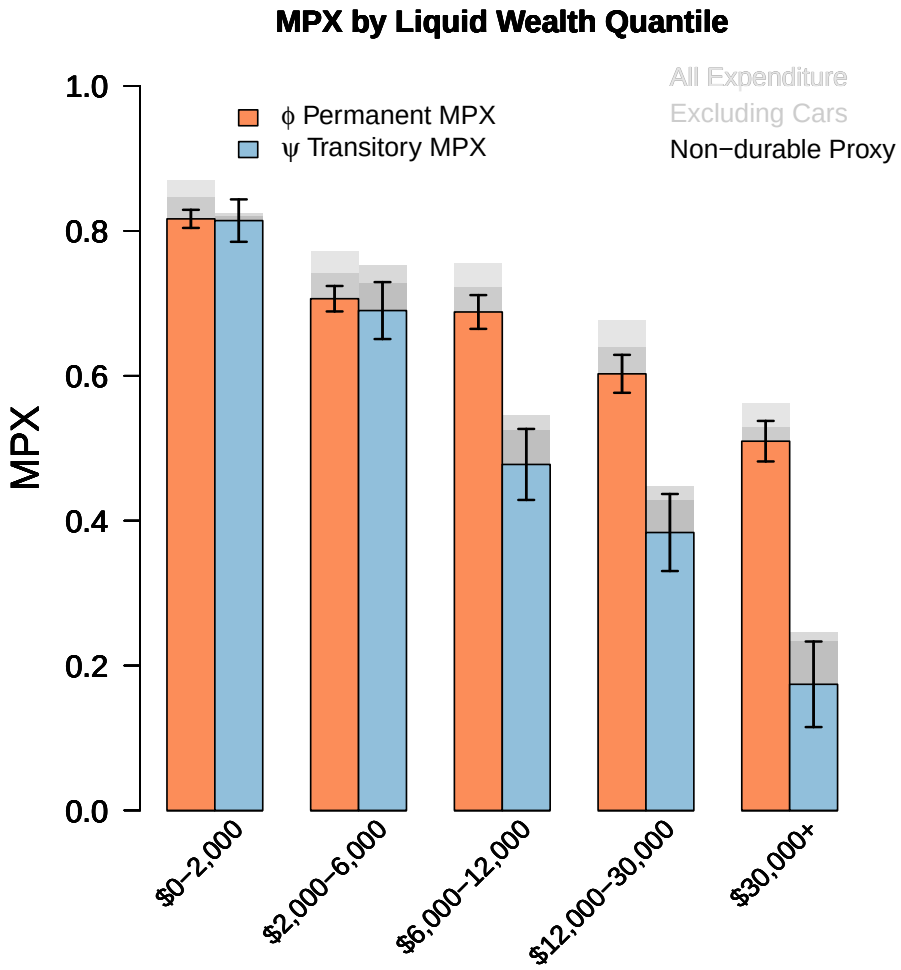
Durables


MPX by Liquid Wealth Quantile
All Expenditure
ϕ Permanent MPX
ψ Transitory MPX
MPX
1.0
0.8
0.6
0.4
0.2
0.0
$0–2,000
$2,000–6,000
$6,000–12,000
$12,000–30,000
$30,000+

Durables

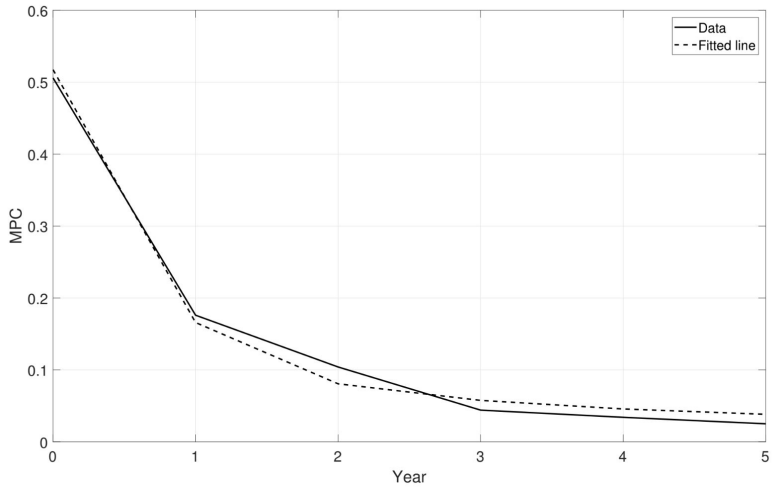

MPX by Liquid Wealth Quantile
All Expenditure
Excluding Cars
ϕ Permanent MPX
ψ Transitory MPX
MPX
1.0
0.8
0.6
0.4
0.2
0.0
$0–2,000
$2,000–6,000
$6,000–12,000
$12,000–30,000
$30,000+

Durables


MPX by Liquid Wealth Quantile
All Expenditure
Excluding Cars
Non−durable Proxy
ϕ Permanent MPX
ψ Transitory MPX
MPX
1.0
0.8
0.6
0.4
0.2
0.0
$0−2,000
$2,000−6,000
$6,000−12,000
$12,000−30,000
$30,000+

Evidence of Consumption Decay Within 2 Years

From Fagereng, Holm, and Natvik (2016)



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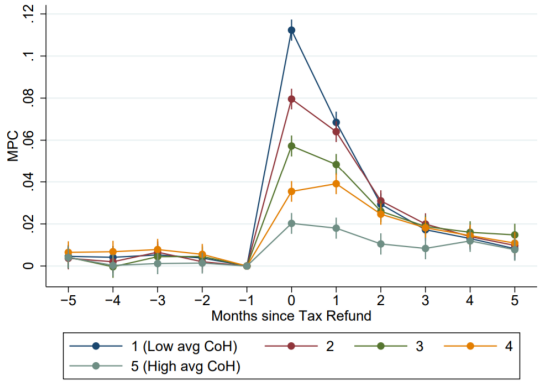
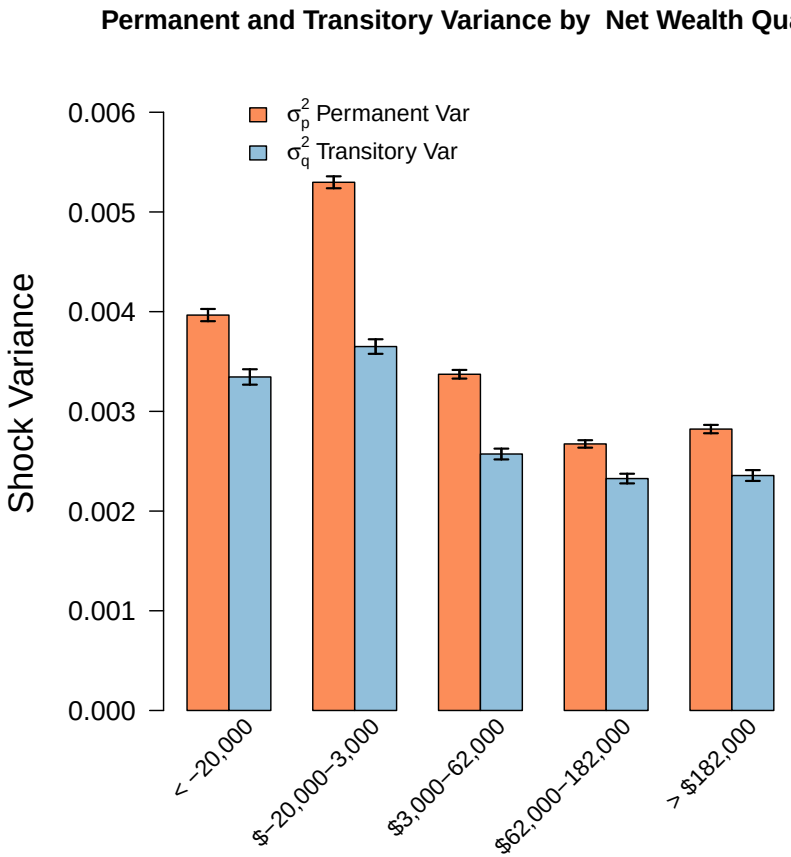
From Gelman (2016)

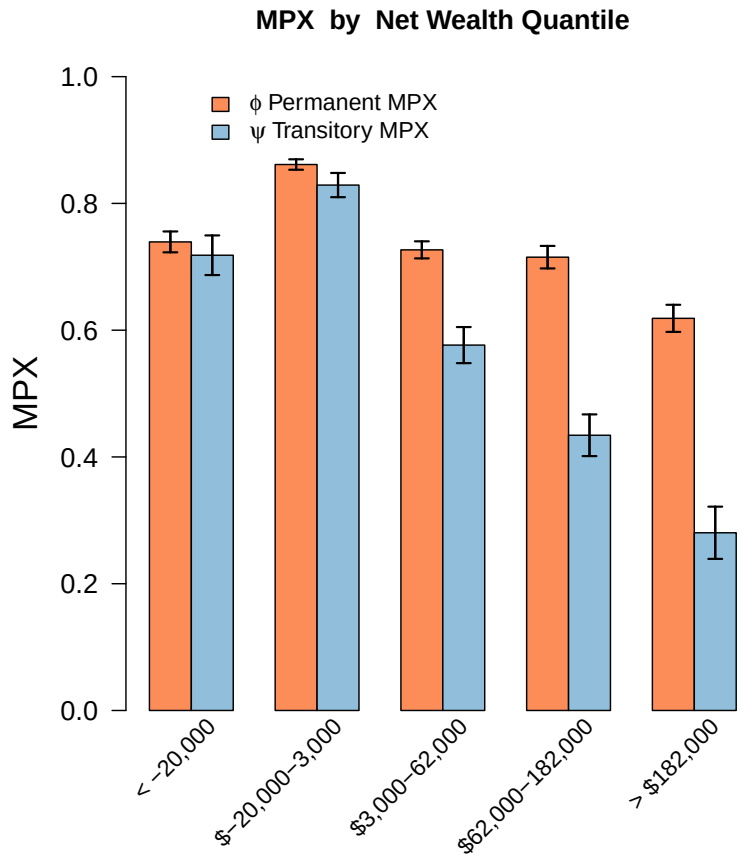
Figure 10: Tax refund impulse response function



Notes: 1,445,560 observations from 48,059 individuals. The vertical bars on each coefficient represent 95% confidence intervals using heteroskedasticity robust errors clustered at the individual level.

MPX by Net Wealth





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