Consumption Heterogeneity: Micro Drivers and Macro Implications

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GRIPS-UT

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What Do We Do?

We estimate the **consumption response**

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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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

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e.g. Consumption smoothing requires liquid wealth

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2) Quantify Macro Implications

e.g. Redistribution in Monetary Policy

What do we find? (Liquid Wealth)

Low Liquid Wealth Households:

- Hand-to-Mouth
- Spend 85 cents out of every marginal dollar, both transitory and permanent

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High Liquid Wealth Households:

- Large Response to Transitory Shocks (25 cents per dollar)
- Small Response to Permanent Shocks (60 cents per dollar)

relative to Permanent Income Hypothesis or Buffer-Stock models

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
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Low MPX
≈ 0.25

↙

Decrease spending
a *lot*

↘

Increase spending
a *little*

What do we find? (Redistribution in Monetary Policy)

Medium MPX
≈ 0.5

High MPX
≈ 0.8

Low MPX
≈ 0.25

1yr rate ↑ 1%

Aggregate Spending ↓ 26 basis points

Through this redistribution channel *alone*

How Do We Do This? Reduced Form Approach

Identifying Restrictions on

Income

and

Consumption

In **Continuous** Time

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Identifying Restrictions on

Income → Permanent (random walk) shocks
Income → Transitory (<2 years) shocks

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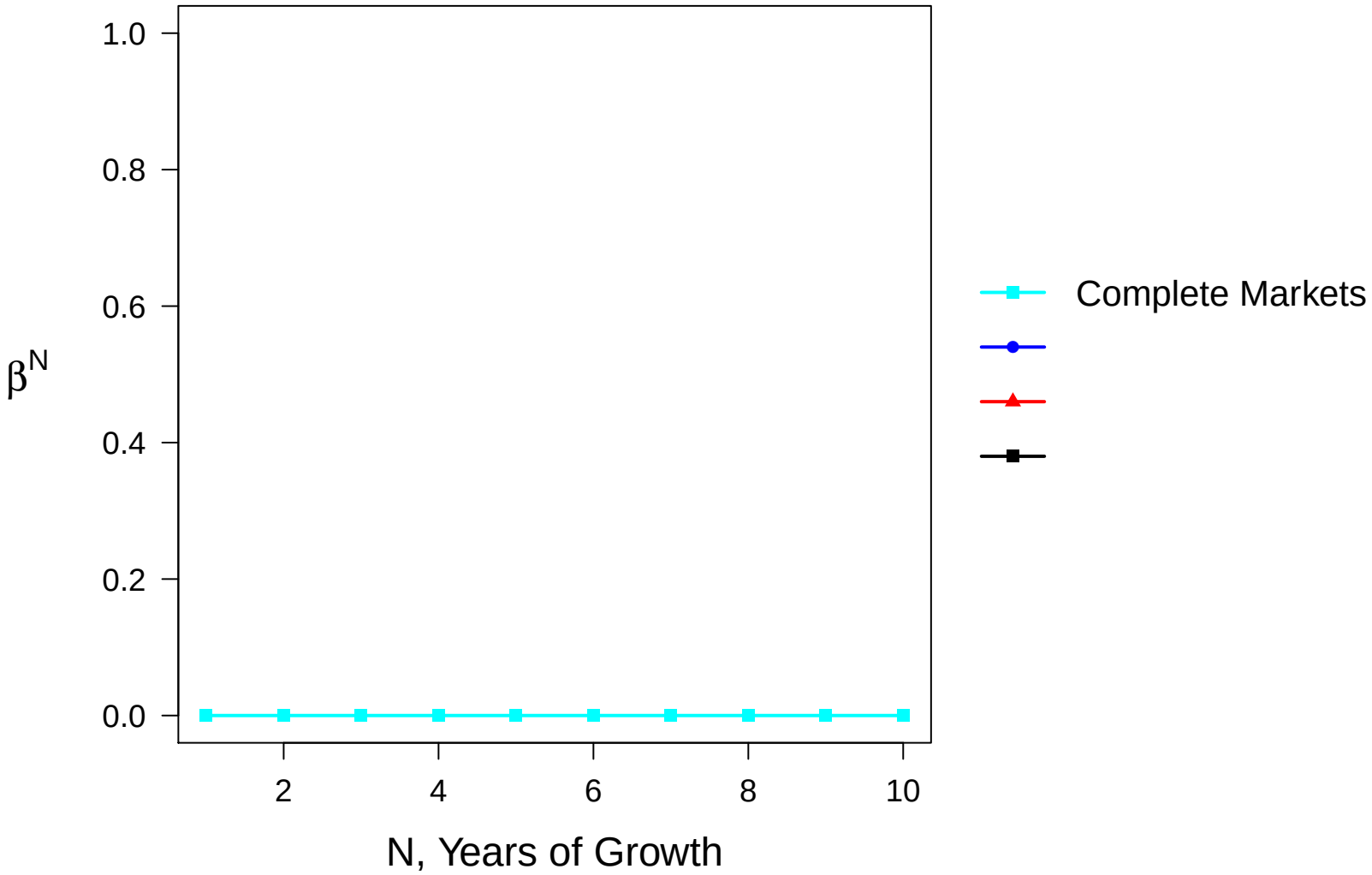
But first some intuition: Naïvely Regress

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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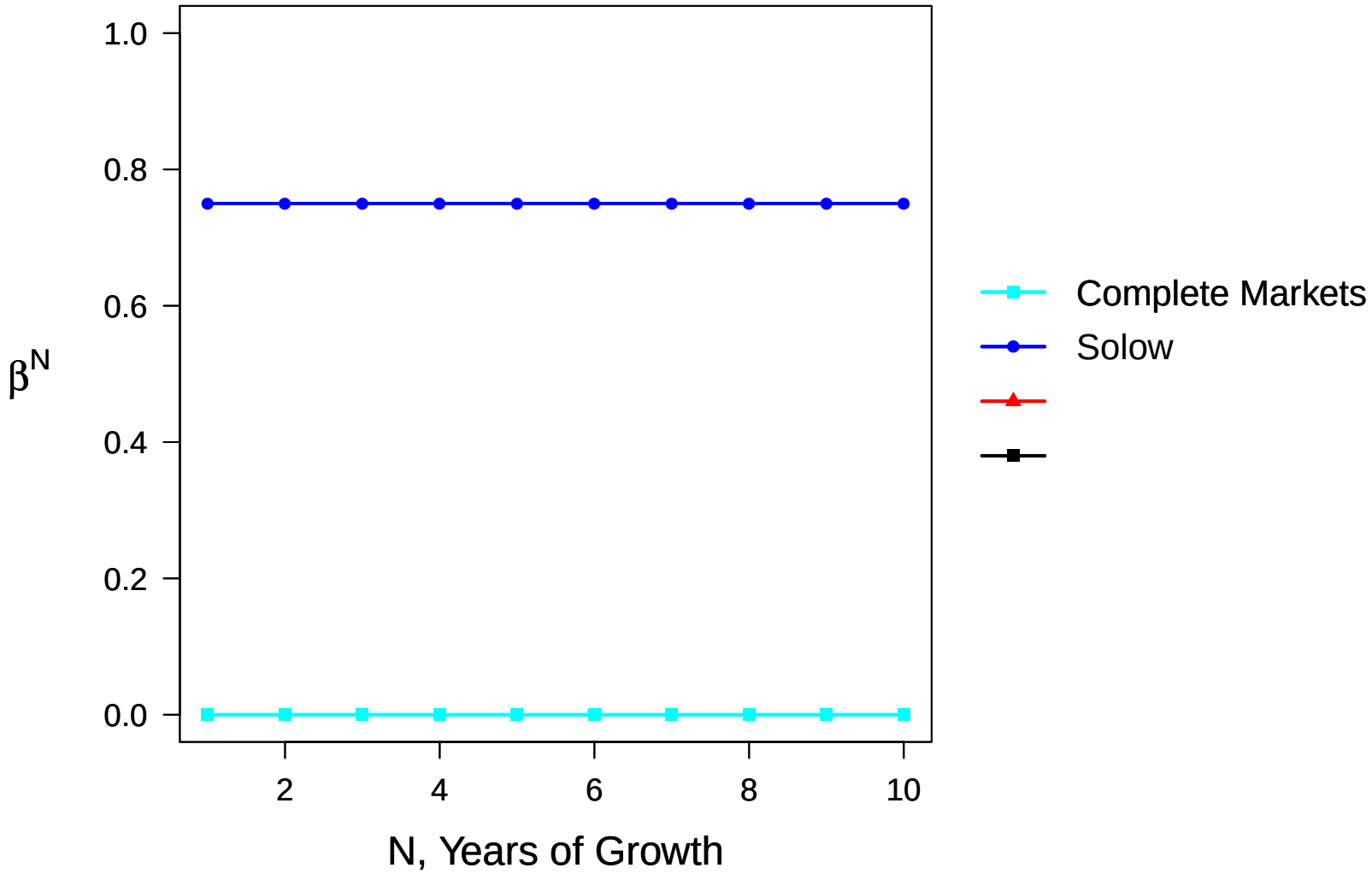

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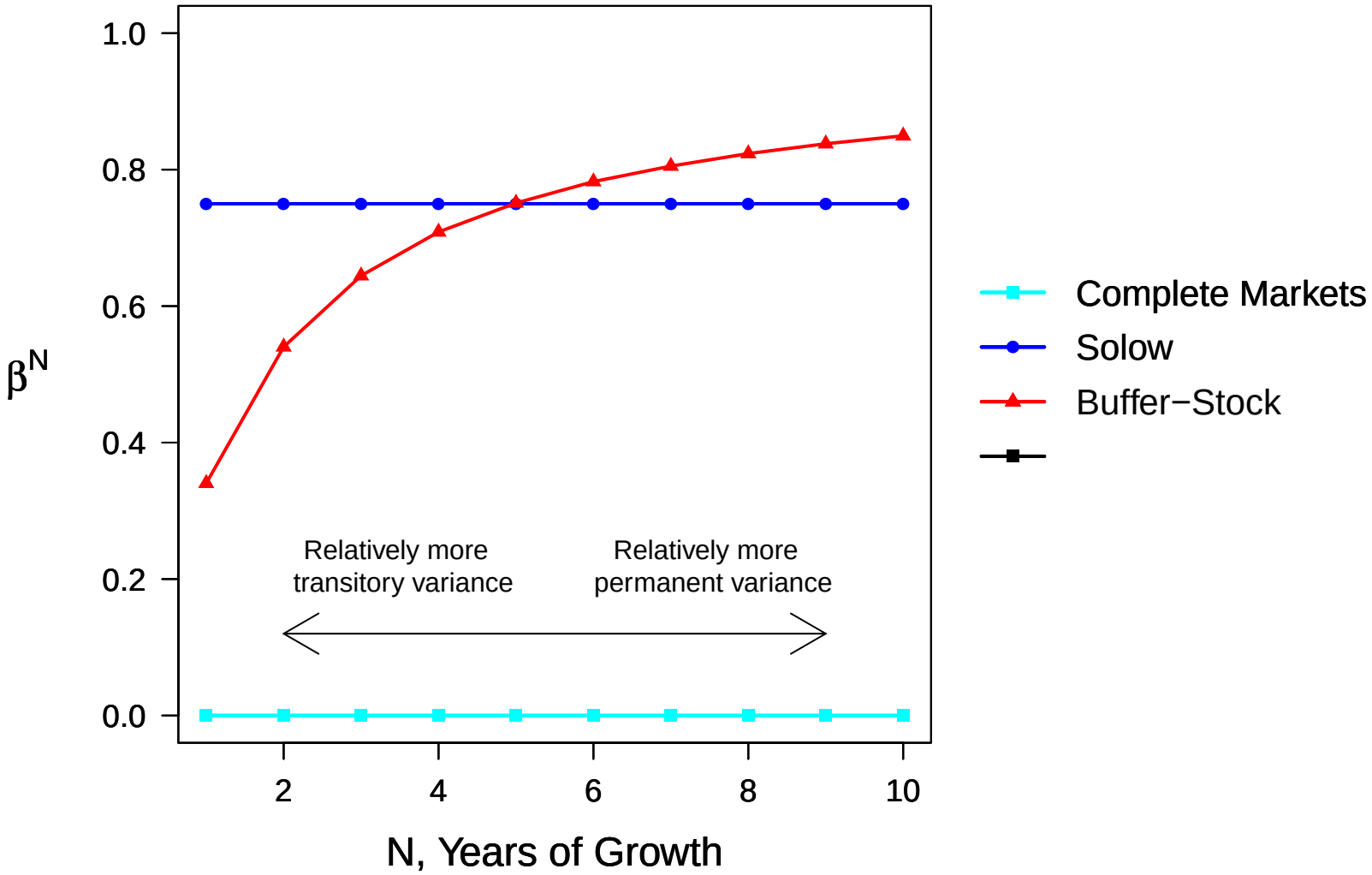

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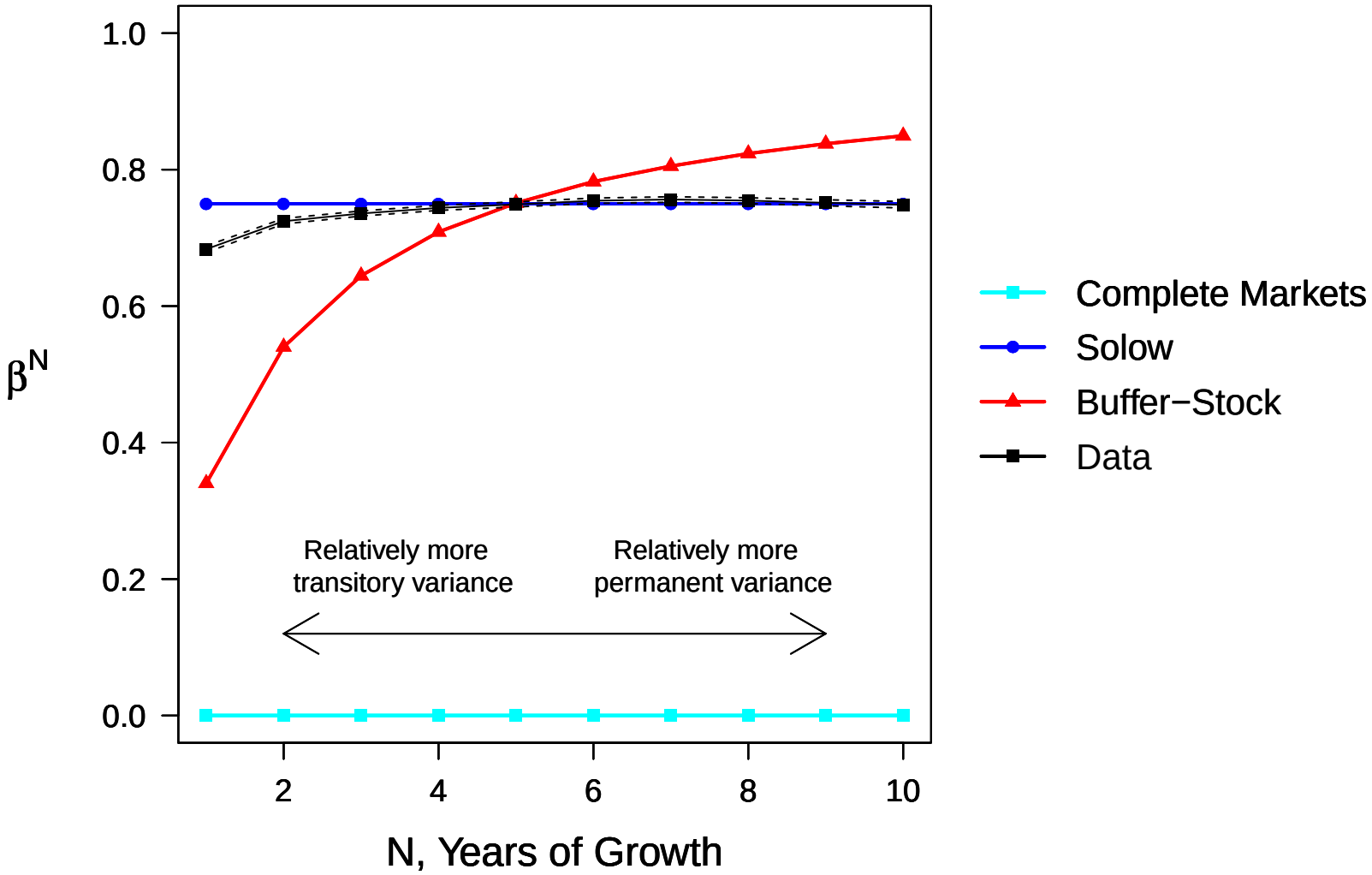

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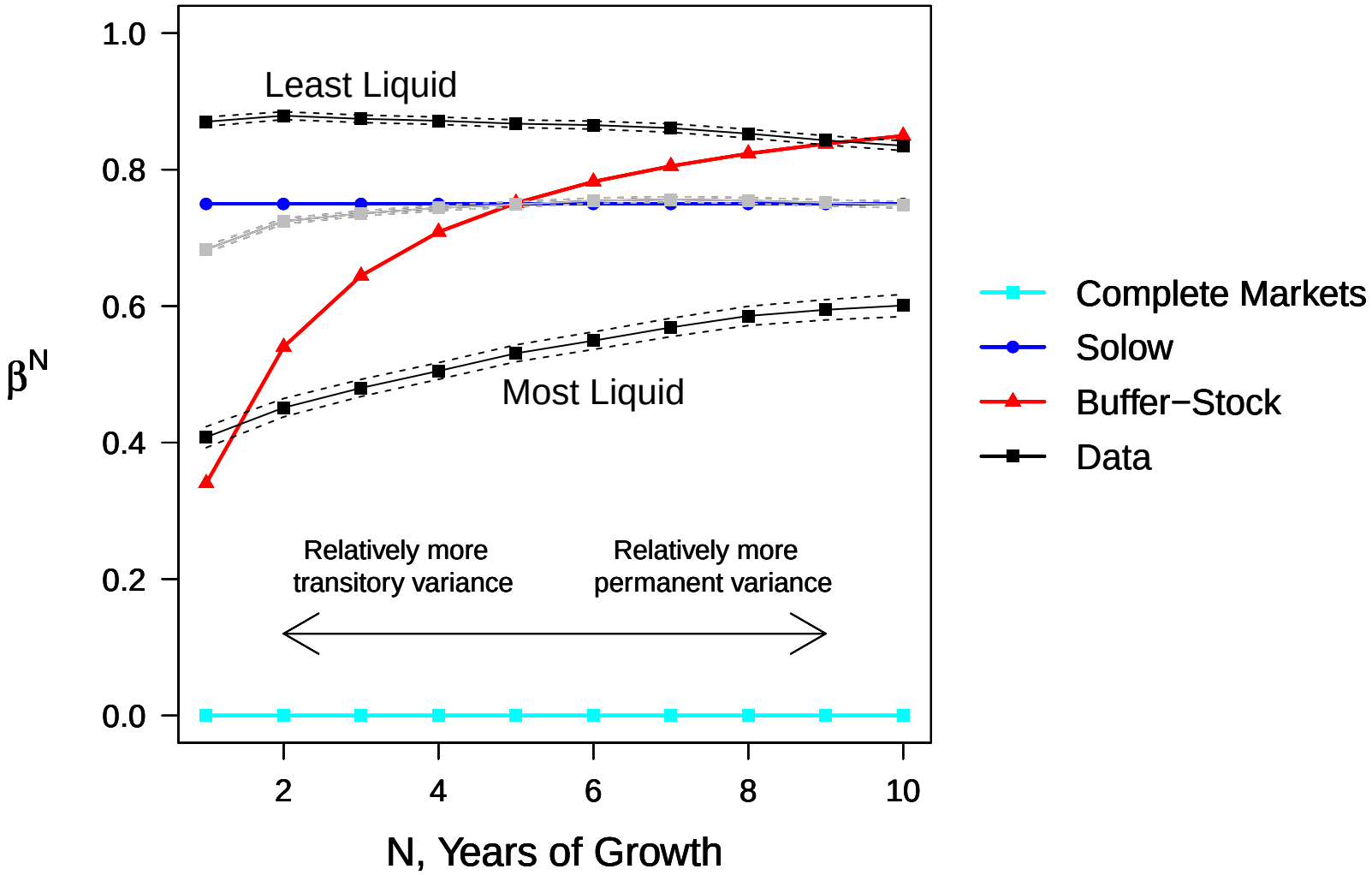
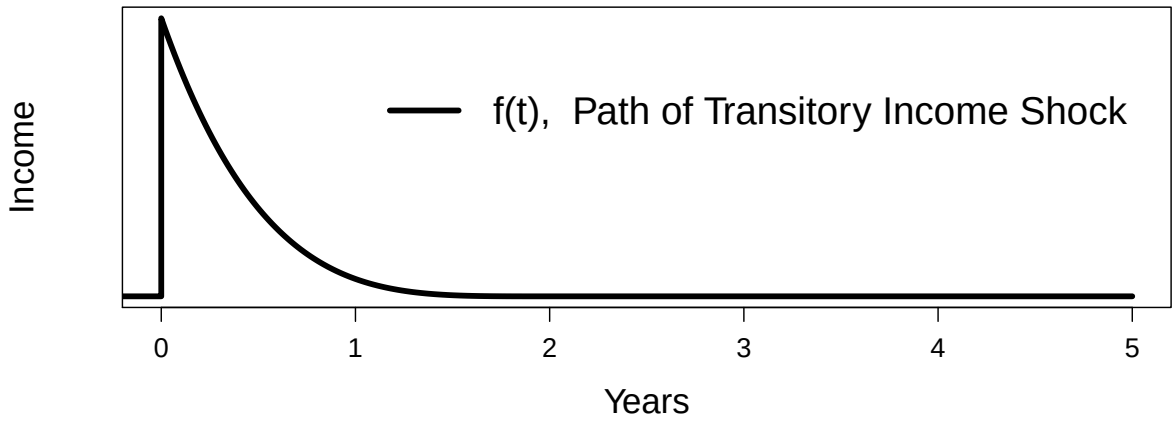


Identification Restrictions: Income Process

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



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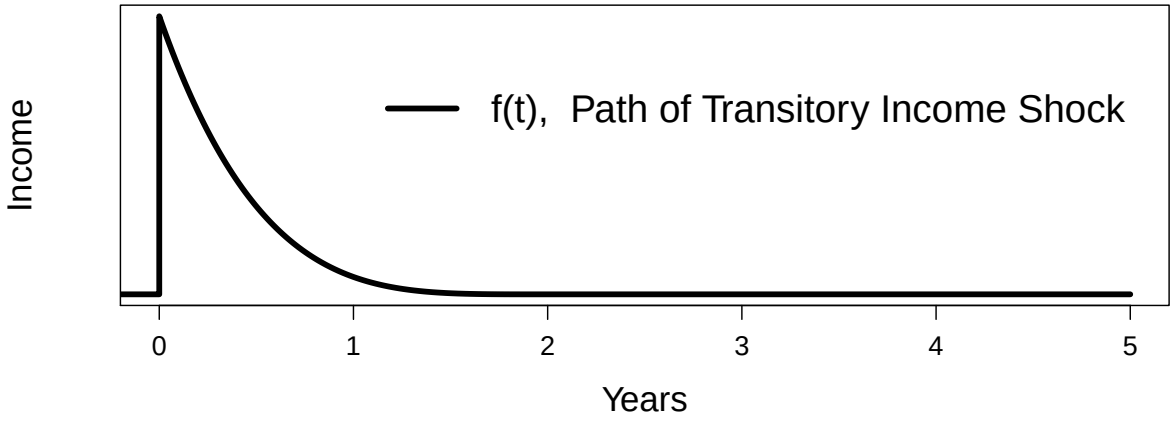

$$y_t = p_t + \int_{t-2}^{t} f(t-s)dq_s$$

Permanent income flow

Transitory income flow

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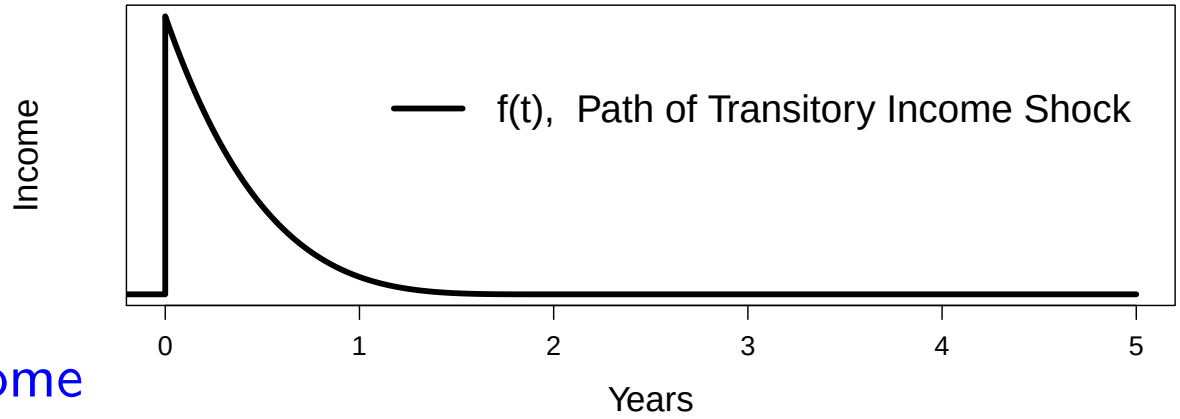


Observed Income

$$\uparrow$$

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

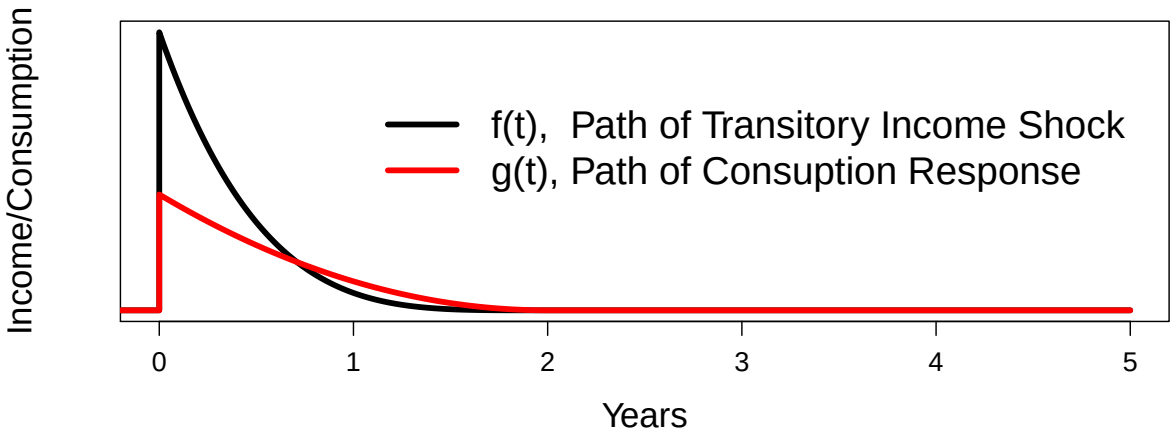
$$\downarrow$$

Time Aggregation

Identification Restrictions: Consumption Response

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

Evidence



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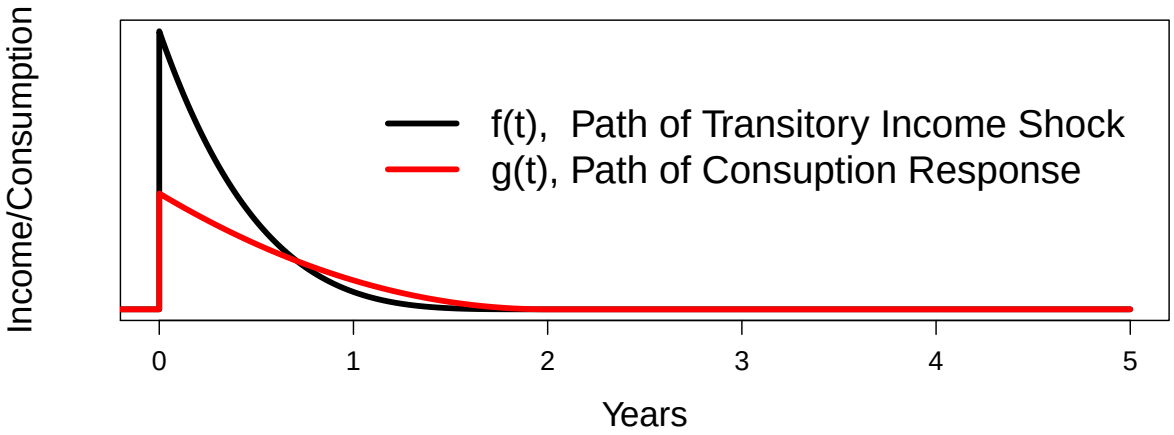

$$c_t = \phi p_t + \int_{t-2}^{t} g(t-s)dq_s$$

Permanent consumption flow

Transitory consumption flow

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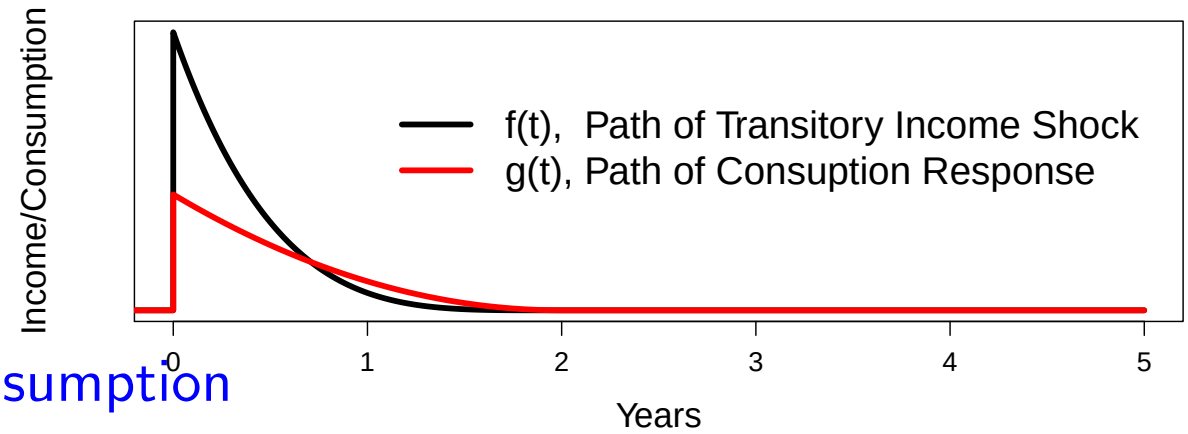

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$$\bar{c}_T = \int_{T-1}^{T} c_t dt = \int_{T-1}^{T} \phi p_t dt + \int_{T-1}^{T} \int_{t-2}^{t} g(t-s) dq_s dt$$

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Time Aggregation

Full Identification

We use GMM on the equations:

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

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

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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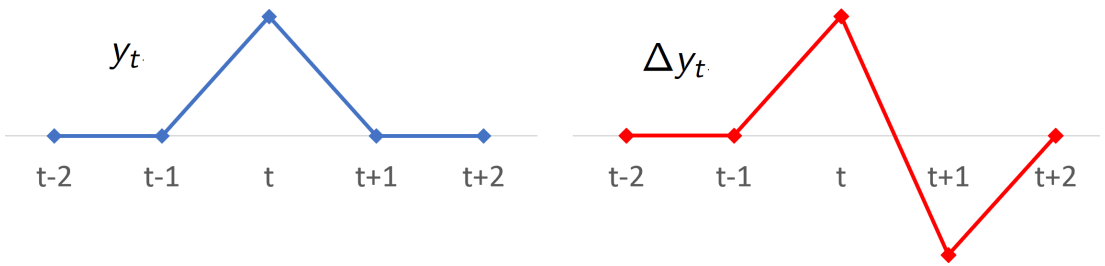

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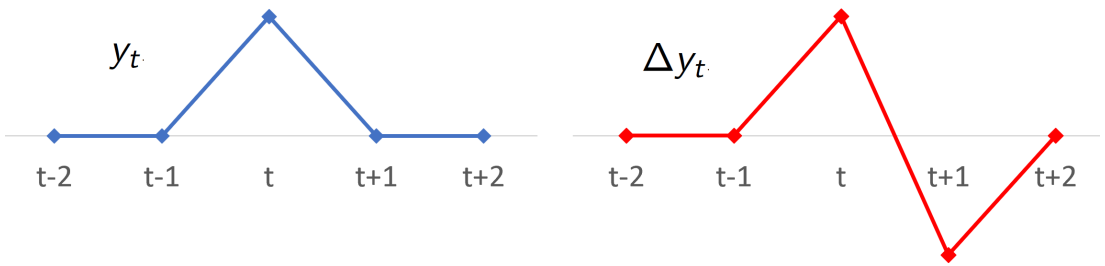

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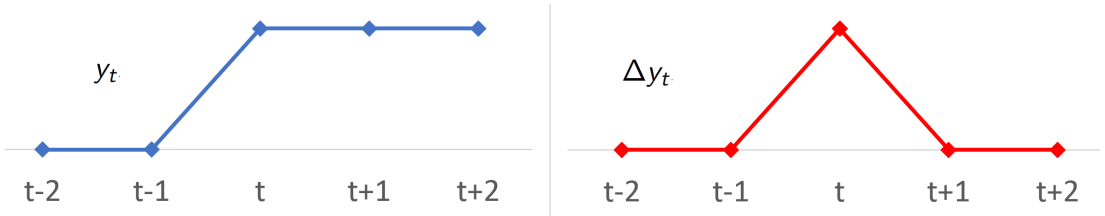

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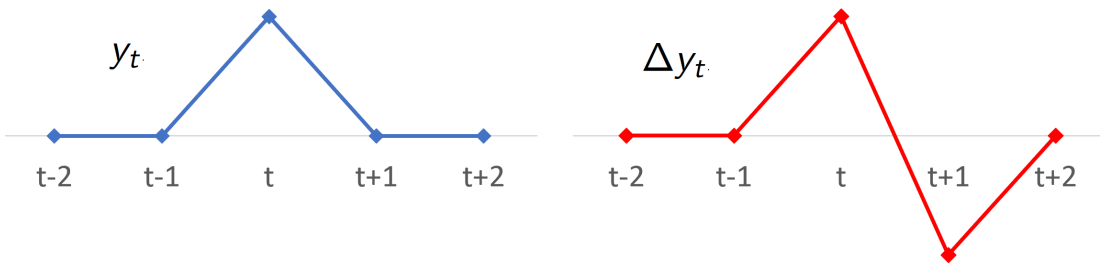

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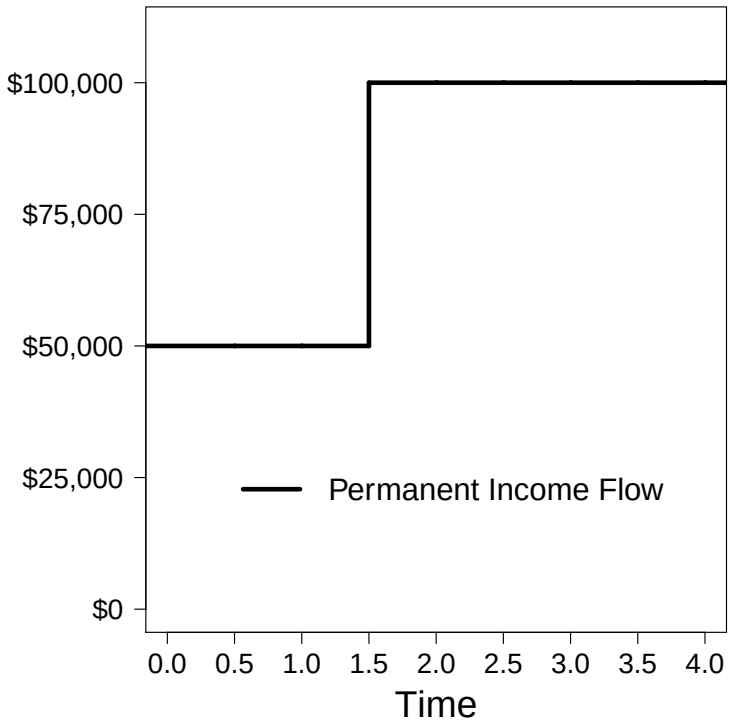
Fails due to the **Time Aggregation Problem**

Time Aggregation Problem in BPP (Crawley 2018)



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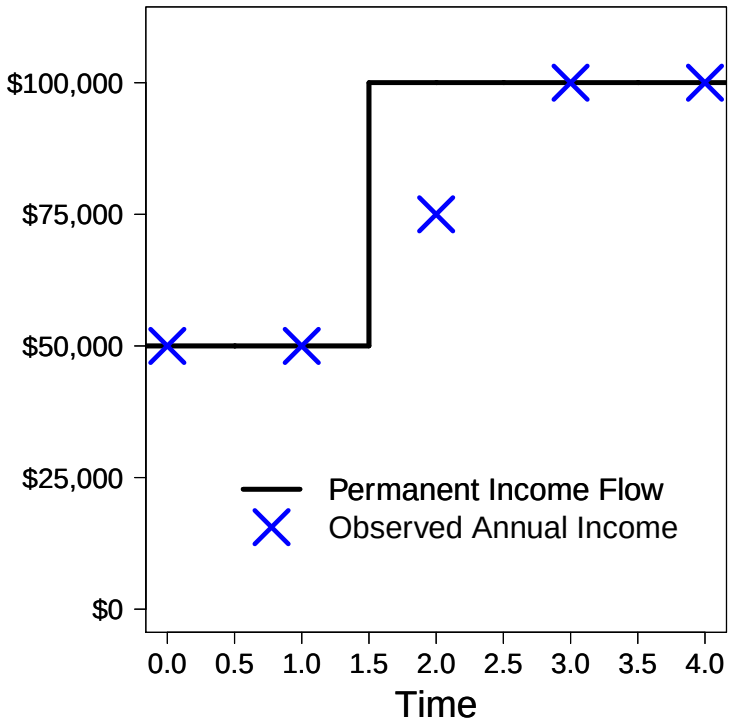

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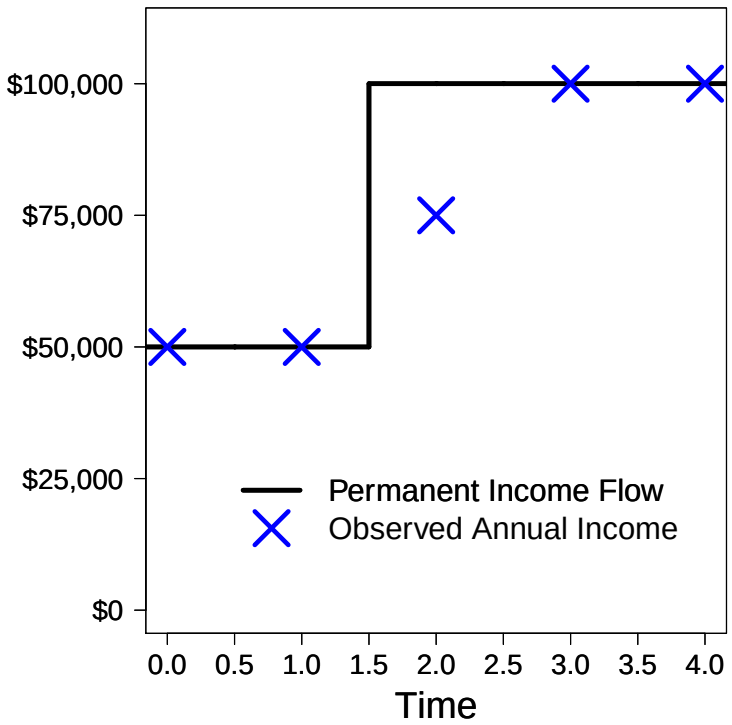

Observed permanent income growth is *positively* autocorrelated

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

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

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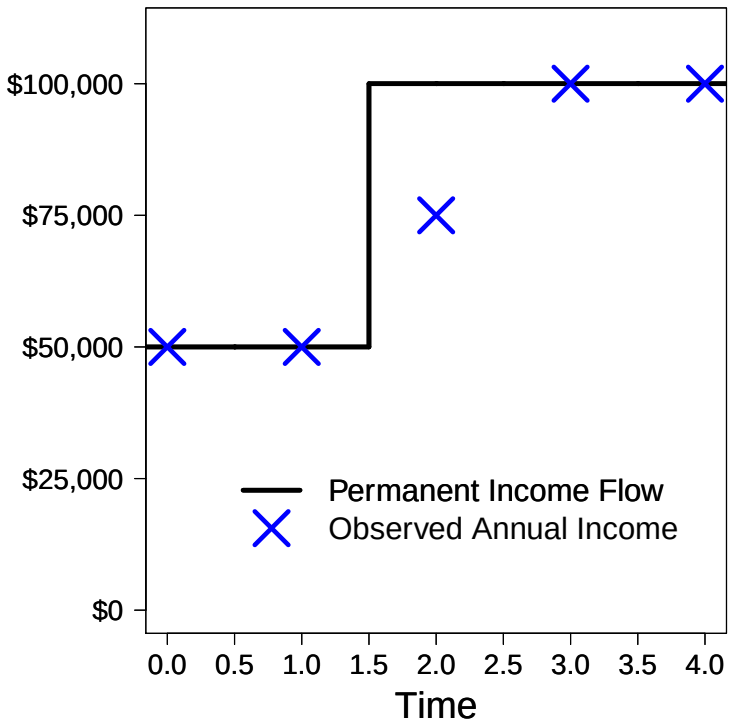

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If the Permanent Income Hypothesis holds, BPP will estimate the MPC to be -0.6

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

  Danish Mortgage Market

- **Expenditure**

  No *direct* measure of spending

Data: Expenditure

Intertemporal budget constraint

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

Data: Expenditure

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

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

Data: Expenditure

Intertemporal budget constraint

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

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

- 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

Summary Statistics

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
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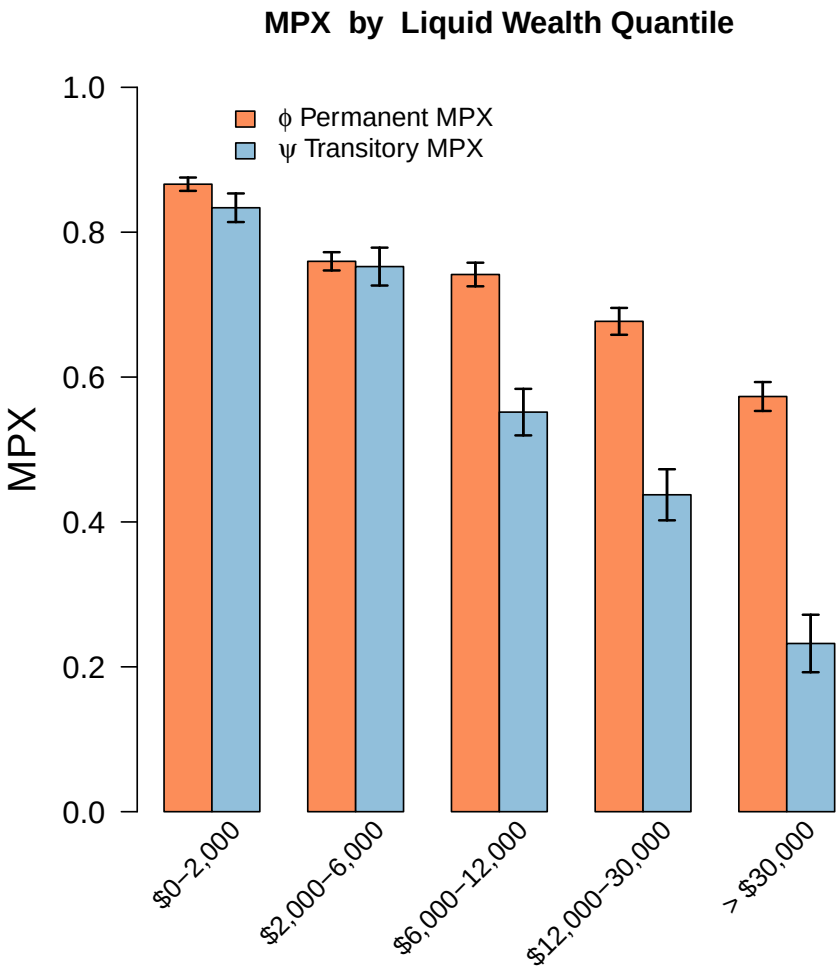
When might this fail?

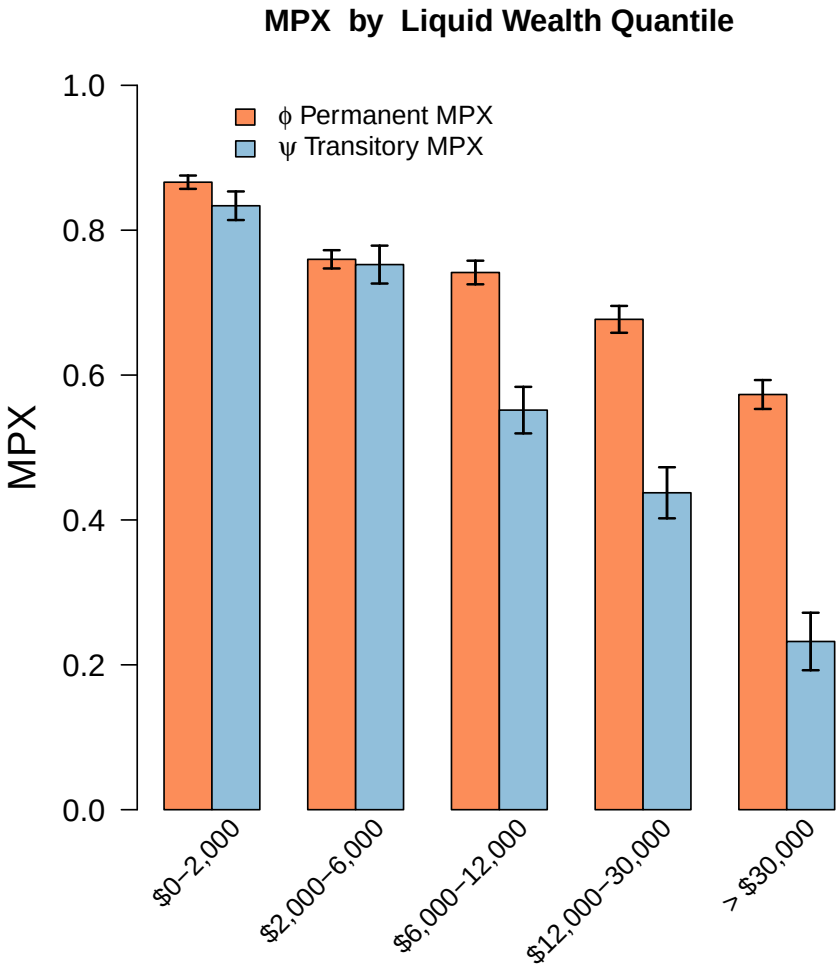
- Off balance sheet saving
- Returns correlated with *changes* in income (e.g. stock compensation)
- When insurance is provided by friends and family

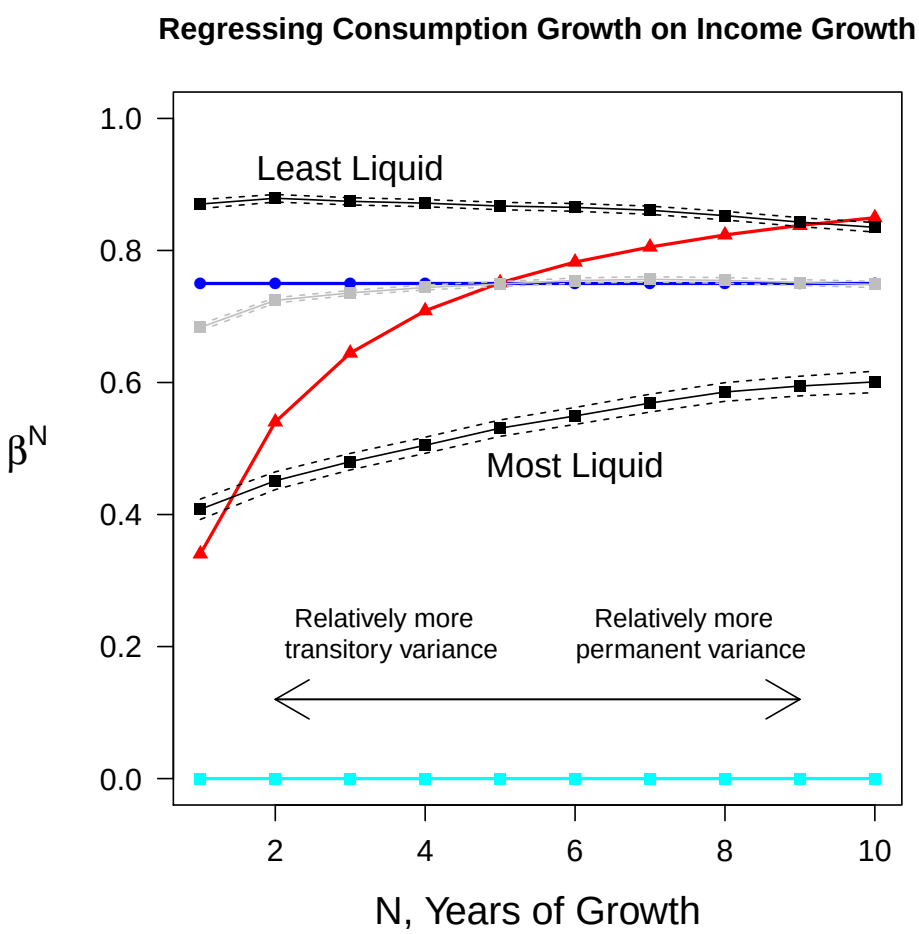
Results by Liquid Wealth



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

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→ Large in Spender-Saver, or TANK models

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

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} Redistribution Channels

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 Channel

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**

Unhedged Interest Rate Exposure

URE Definition: Net savings made 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

Unhedged Interest Rate Exposure

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Interest rate change $dR \implies$ Household i's spending changes by:

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

through the Interest Rate Exposure Channel *alone*.

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:

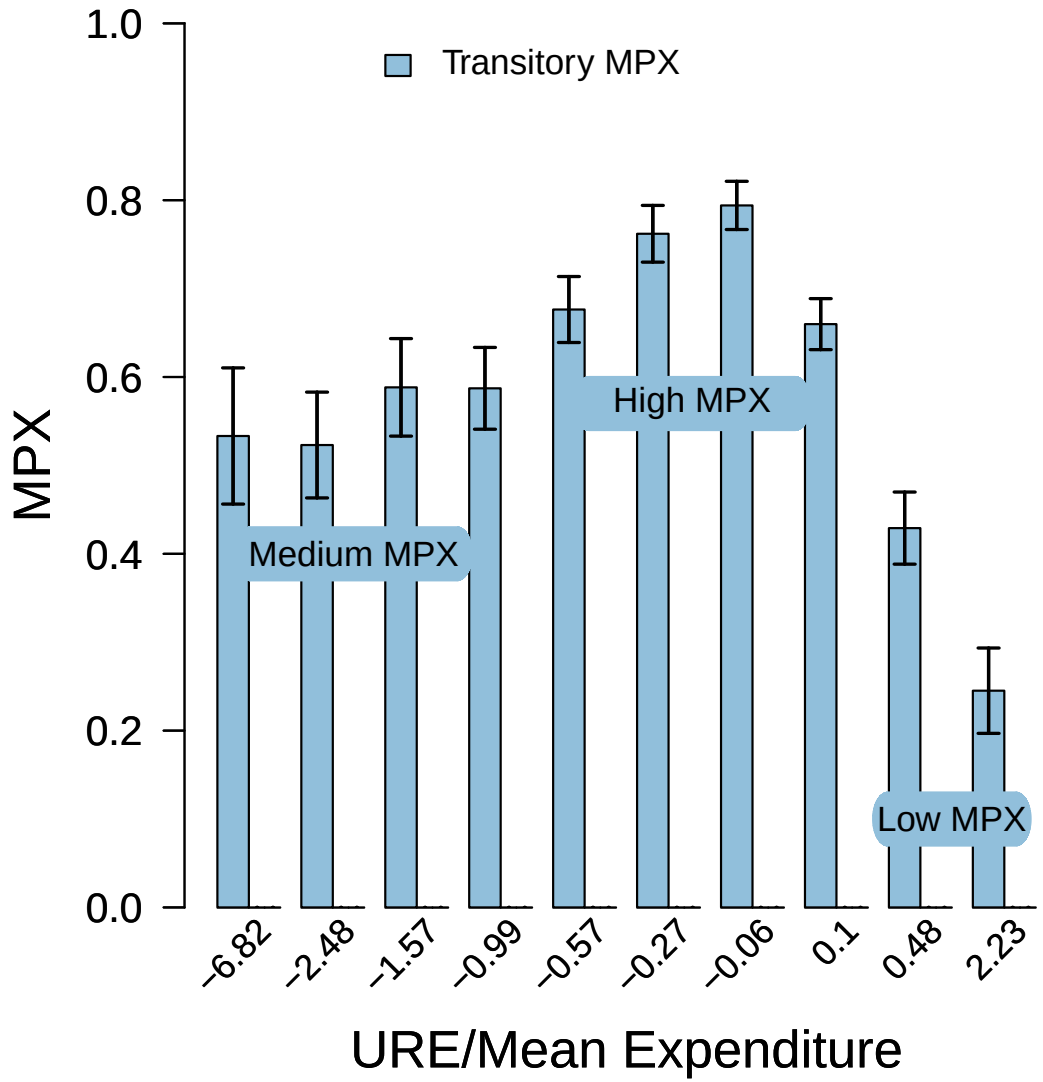
$$\mathcal{E}_R = \mathbb{E}_I\left(MPC_i \frac{URE_i}{\mathbb{E}_I(c_i)}\right)$$

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

We can do that!

Out of Sample Assumptions

MPX by Unhedged Interest Rate Exposure



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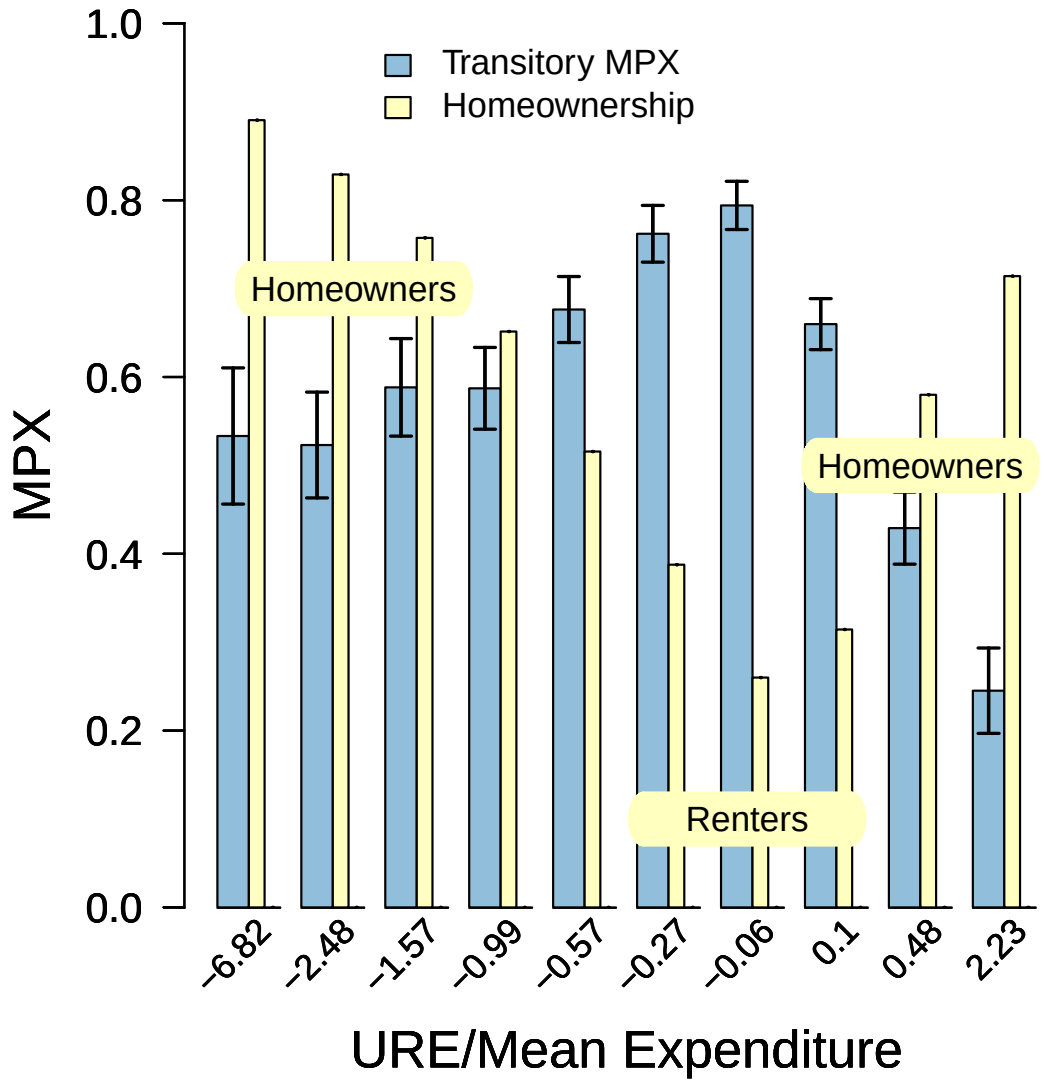

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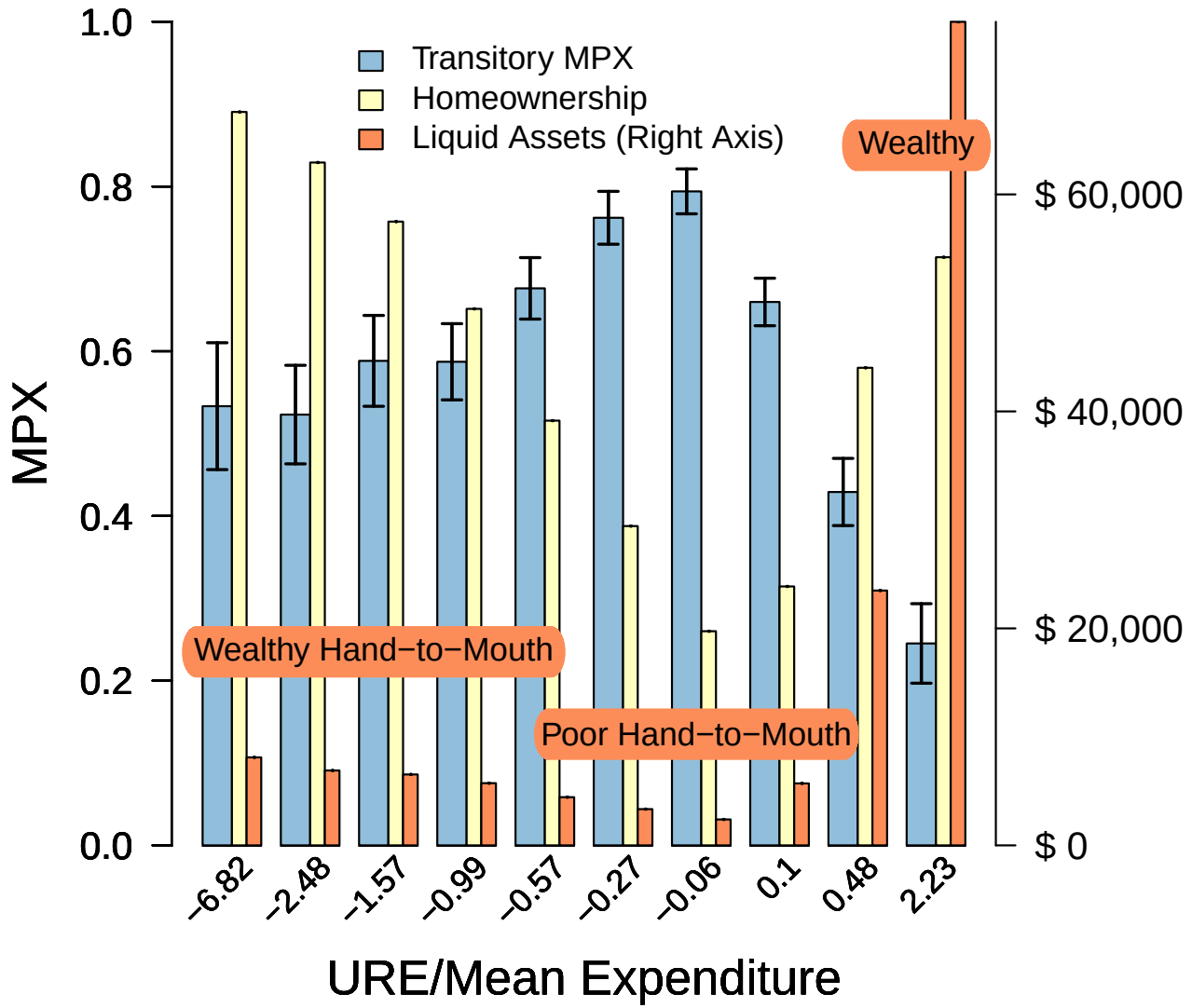

All Five Transmission Channels

$$\frac{dC}{C} = \overbrace{\mathcal{M}\frac{dY}{Y}}^{\text{Aggregate Income Channel}} \overbrace{+\gamma\mathcal{E}_Y\frac{dY}{Y}}^{\text{Earnings Heterogeity Channel}} \overbrace{-\mathcal{E}_P\frac{dP}{P}}^{\text{Fisher Channel}}$$

$$\underbrace{+\mathcal{E}_R\frac{dR}{R}}_{\text{Interest Rate Exposure Channel}} \qquad \underbrace{-\sigma\mathcal{S}\frac{dR}{R}}_{\text{Intertemporal Substitution Channel}}$$

$\mathcal{M}$	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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$\mathcal{S}$	0.49

Compare $\mathcal{E}_R$ to σS:

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

$\sigma S \approx 0.05$

Durables

We have data on value of household cars

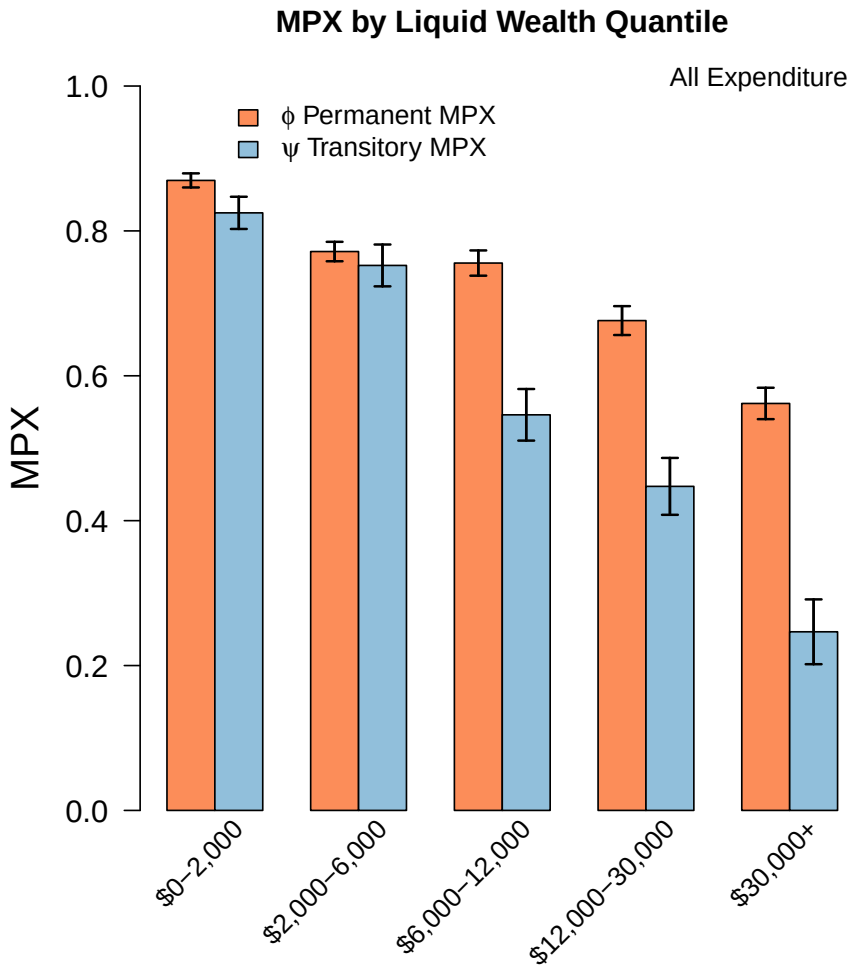
- Construct expenditure excluding car purchases and sales

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

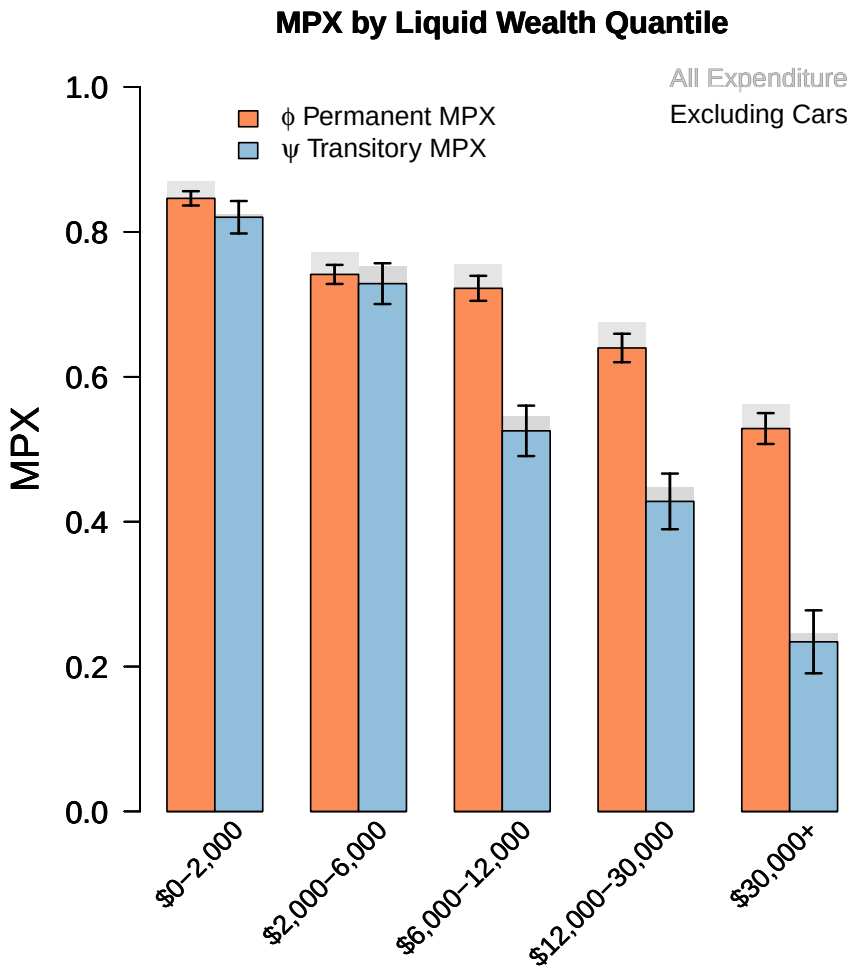
- Construct proxy for non durable consumption (Cars $\approx 42.1\%$ durable expenditure)

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

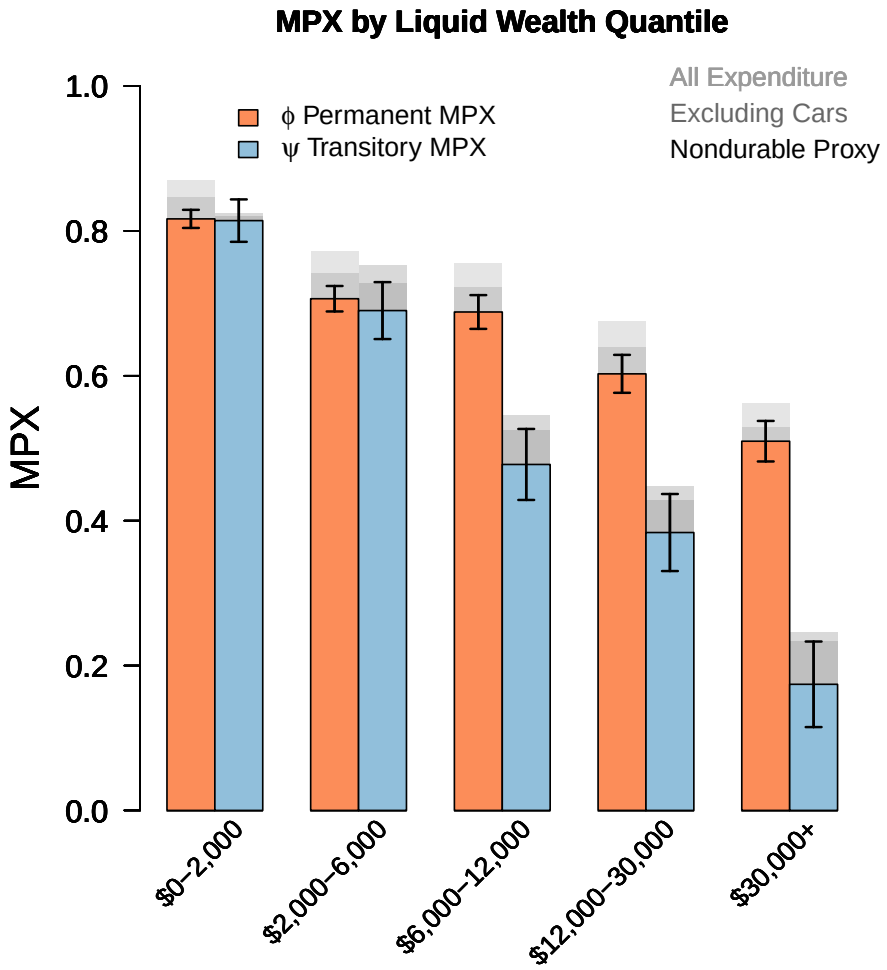
Durables


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
Nondurable 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+

Conclusion

New Method to Estimate Consumption Behavior

- Corrects for Bias in BPP
- Estimates align with natural experiment literature
- Potential to use on a wide variety of datasets and applications

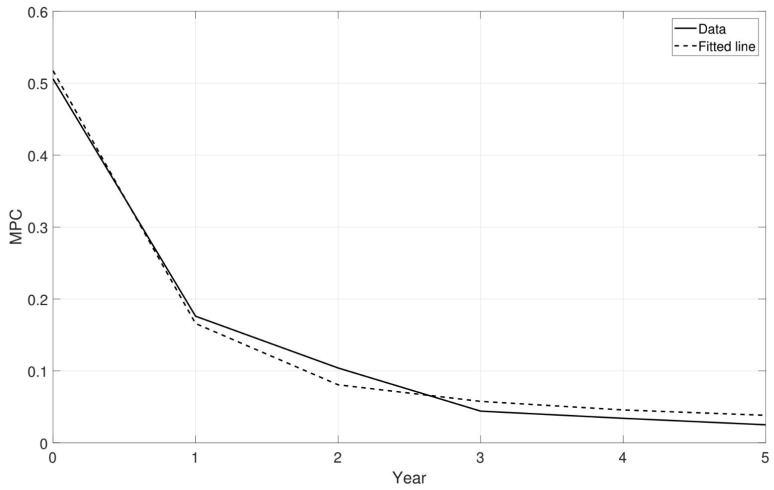
Applied to Danish Registry Data

- Sample Size $\Longrightarrow$ Sharp Focus on Heterogeneity
- High MPC from transitory shocks, Low MPC from Permanent shocks
- Quantify Monetary Policy Transmission Channels

Thank you!

Evidence of Consumption Decay Within 2 Years

From Fagereng, Holm, and Natvik (2016)



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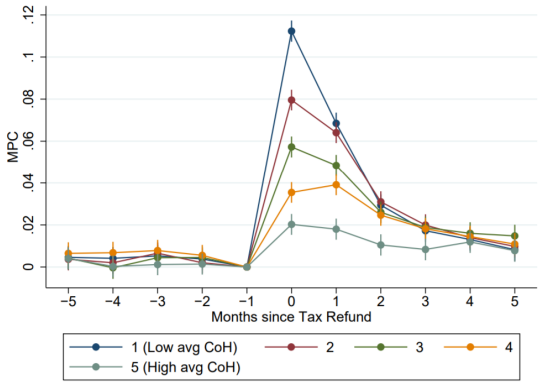
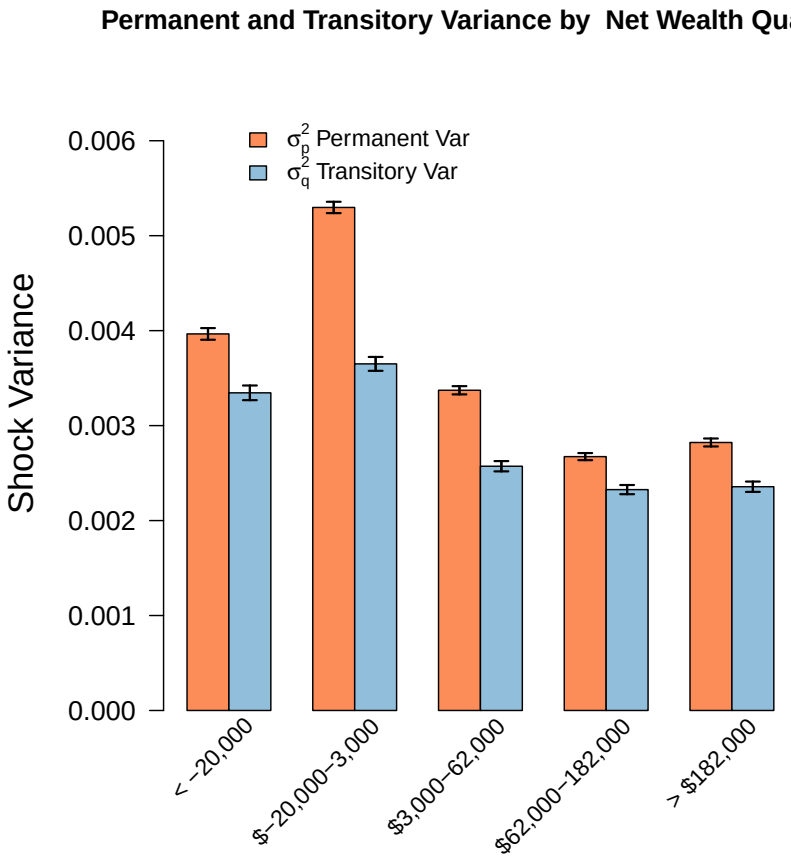
From Gelman (2016)

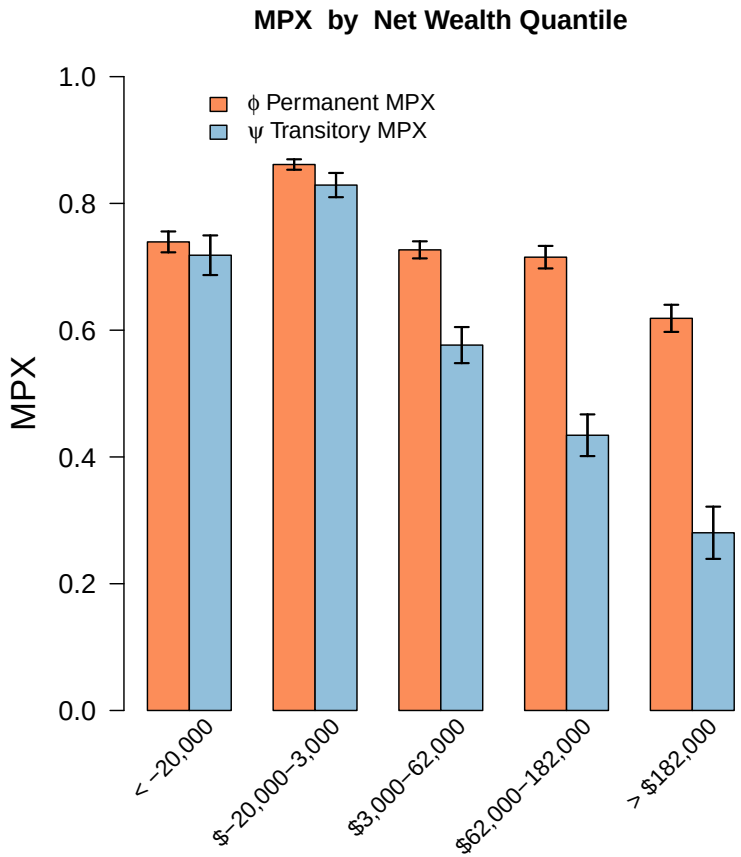
Figure 10: Tax refund impulse response function



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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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.

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Summary Statistics

	Estimation Sample			Population (Age 30-55)		
	Mean	Median	Std Dev	Mean	Median	Std Dev
After Tax Income	59,261	57,804	28,819	58,312	53,304	68,799
Consumption	52,680	48,344	28,581	54,022	46,373	38,126
Liquid Assets	18,438	6,856	33,016	23,331	6,578	81,473
Net Worth	74,937	19,115	157,295	85,799	12,952	564,404
Homeowner	0.57	1.00	0.50	0.50	1.00	0.50
Car Owner	0.66	1.00	0.47	0.55	1.00	0.50
Higher Education	0.31	0.00	0.46	0.33	0.00	0.47
Age	43.5	44.0	7.1	42.5	42.0	7.3
URE	-28,052	-12,627	108,382	-47,589	-19,374	243,604
NNP	-109,685	-65,810	156,523	-158,321	-85,207	542,498
No. Household-year obs		7,664,360			18,050,340	

Notes: Values are 2015 USD. Age refers to the age in 2008 of the main income earner in the household. For the purposes of calculation of consumption in the population, top and bottom 1% in terms of consumption have been excluded. URE and NNP can only be calculated in the period 2009-2015 due to mortgage information being insufficiently detailed in the previous years.

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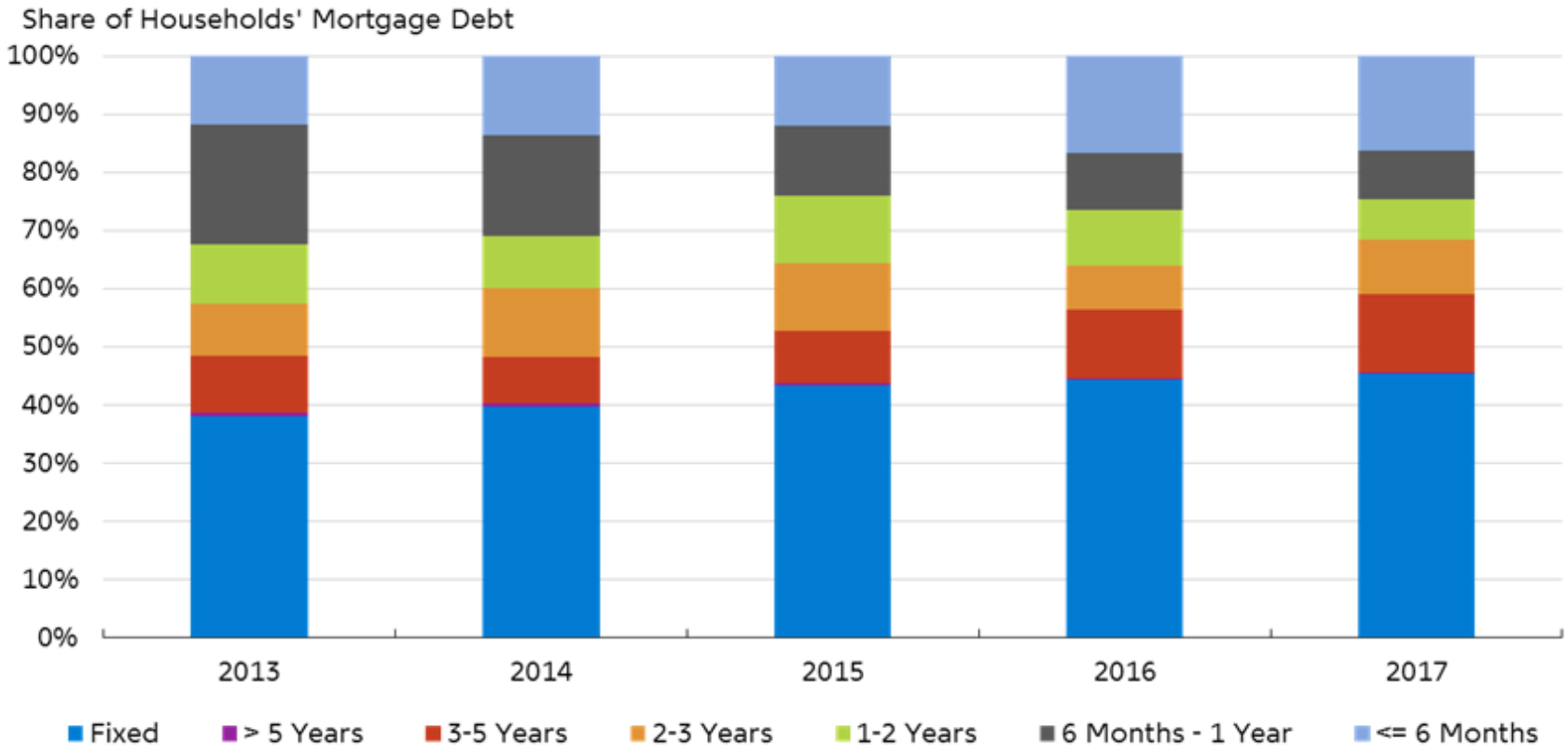
Danish Mortgage Market



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