# Consumption Heterogeneity: Micro Drivers and Macro Implications

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Federal Reserve Board, August 6, 2018

# Overview

What will this paper do?

1. Create a new method to estimate heterogeneity in consumption responses to permanent and transitory shocks to income
   - Clear negative relation between MPC and liquid wealth
2. Application: Redistribution Channel of Monetary Policy (Auclert (2017))
   - We find a transitory 1% interest rate rise decreases consumption by 0.33% through the interest rate exposure channel
   - This channel is likely far larger than the intertemporal substitution channel (1-6x as large)

# How Are Consumption Responses Typically Measured?

Three methods:

1. (Natural) Experiments - stimulus checks, lotteries etc
   - Few true experiments, especially for permanent shocks
   - Data limitations
2. Ask people
   - Unclear how to interpret
3. Use covariance structure of income and consumption
   - Empirical methods (until now!) have been flawed

We develop a robust method based on 3

# Evidence on Magnitude of Consumption Response

| | Consumption Measure | | | | |
|---|---|---|---|---|---|
| **Permanent Shocks** | Nondurables | Total PCE | Horizon | Method | Event/Sample |
| Blundell, Pistaferri, and Preston (2008)* | 0.65 | | ∼ | 3 | Estimation Sample: 1980–92 |
| Gelman, Gorodnichenko, Kariv, Koustas, Shapiro, Silverman, and Tadelis (2016) | | 1.0 | ∼ | 1 | Gasoline Price Shock |
| **Transitory Shocks** | | | | | |
| Agarwal and Qian (2014) | | 0.90 | 10m | 1 | Growth Dividend Program Singapore 2011 |
| Blundell, Pistaferri, and Preston (2008)* | 0.05 | | | 3 | Estimation Sample: 1980–92 |
| Browning and Collado (2001) | | ∼ 0 | | 1 | Spanish ECPF Data, 1985–95 |
| Coronado, Lupton, and Sheiner (2005) | | 0.36 | 1y | 1 | 2003 Tax Cut |
| Fuster, Kaplan, and Zafar (2018) | | 0.08–0.31 | 3m | 2 | NY Fed Survey Cons. Expectations |
| Gelman (2016) | | 0.13 | 3m | 1 | Tax refunds 2013-2016 |
| Hausman (2012) | | 0.6–0.75 | 1y | 1 | 1936 Veterans' Bonus |
| Hsieh (2003)* | ∼ 0 | 0.6–0.75 | | 1 | CEX, 1980–2001 |
| Jappelli and Pistaferri (2014) | 0.48 | | | 2 | Italy, 2010 |
| Johnson, Parker, and Souleles (2009) | ∼ 0.25 | | 3m | 1 | 2003 Child Tax Credit |
| Lusardi (1996)* | 0.2–0.5 | | | 3 | Estimation Sample: 1980–87 |
| Parker (1999) | 0.2 | | 3m | 1 | Estimation Sample: 1980–93 |
| Parker, Souleles, Johnson, and McClelland (2013) | 0.12–0.30 | 0.50–0.90 | 3m | 1 | 2008 Economic Stimulus |
| Sahm, Shapiro, and Slemrod (2010) | | ∼ 1/3 | 1y | 1 | 2008 Economic Stimulus |
| Shapiro and Slemrod (2009) | | ∼ 1/3 | 1y | 1 | 2008 Economic Stimulus |
| Souleles (1999) | 0.045–0.09 | 0.34–0.64 | 3m | 1 | Estimation Sample: 1980–91 |
| Souleles (2002) | 0.6–0.9 | | 1y | 1 | The Reagan Tax Cuts of the Early 1980s |

* Elasticity

Methods 1) Natural Experiment 2) Survey question 3) Covariance restrictions

Table mostly lifted from Carroll, Slacalek, Tokuoka, and White (2017)

# Evidence on Distribution of Consumption Response

Most studies do not have enough power to say anything about how their MPC estimates vary in the population

Exceptions:

- Jappelli and Pistaferri (2014) Italian Survey Data
- Fagereng, Holm, and Natvik (2016) Norway Lottery Data
- Gelman (2016) Financial App Data
- Fuster, Kaplan, and Zafar (2018) NY Fed Survey

**Liquid assets** and **income** are key predictors of transitory MPC

# Application: Auclert (2017)

Auclert (2017) identifies three ways in which **heterogeneity** affects monetary policy

Each is potentially measurable in panel data

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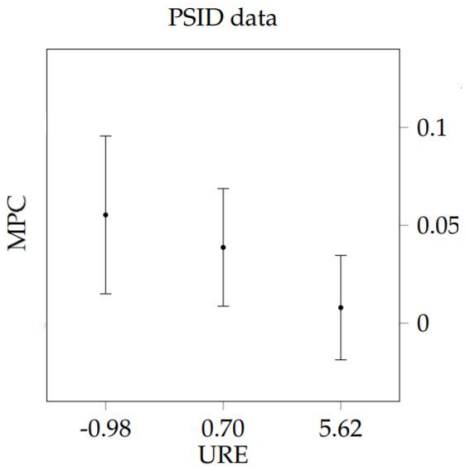


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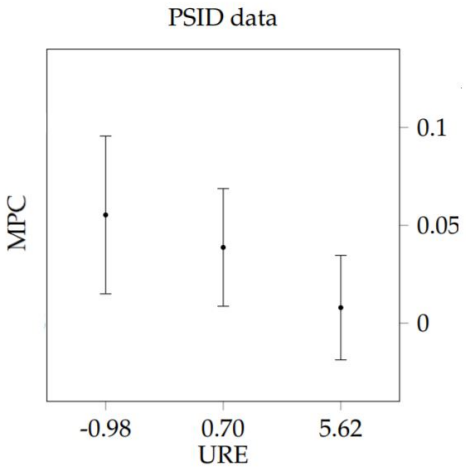


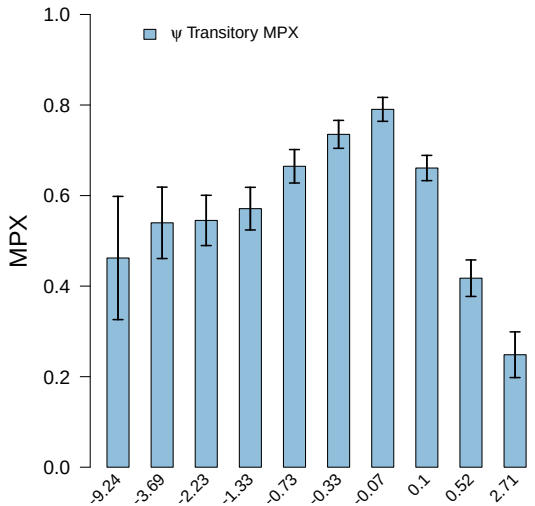


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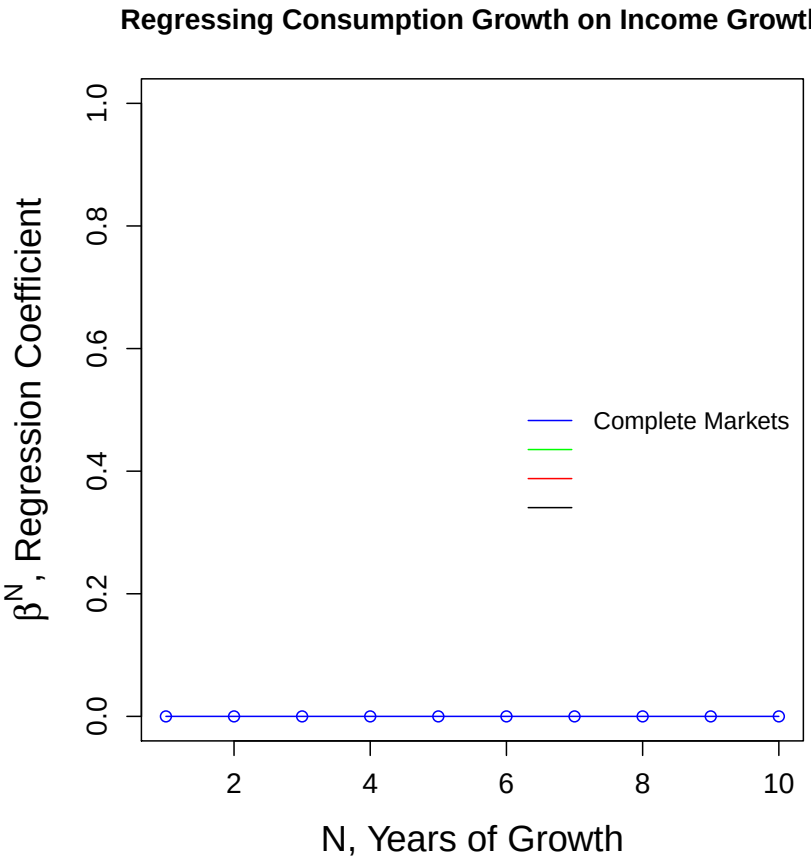
We can do a lot better!

# Methodology Intuition

Exploit increasing importance of permanent shocks as the time over which growth is measured increases

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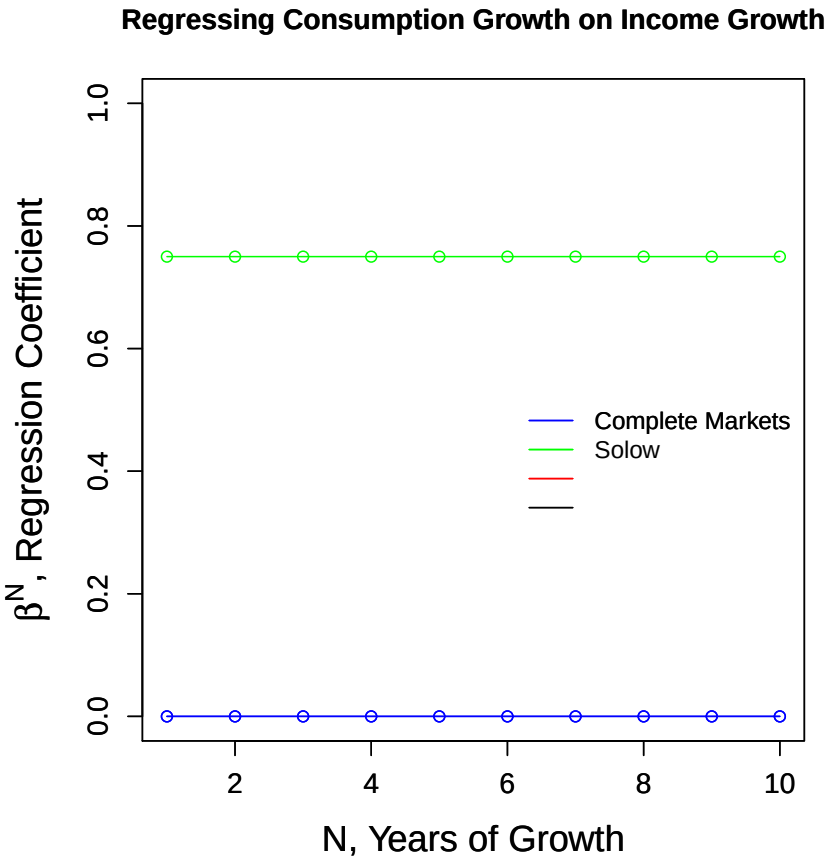


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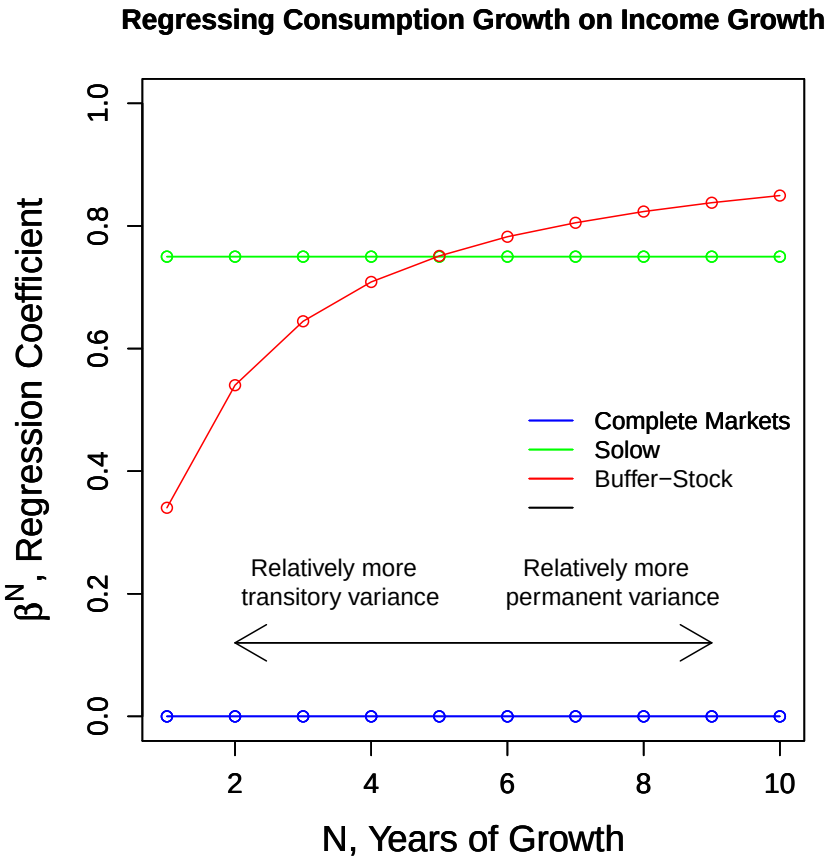


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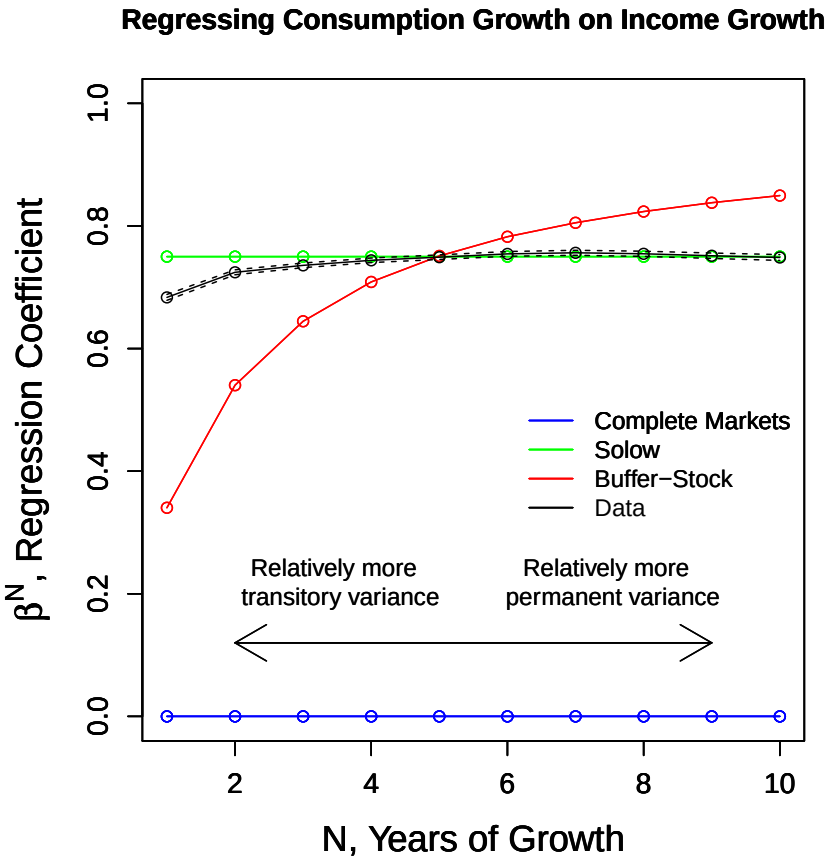


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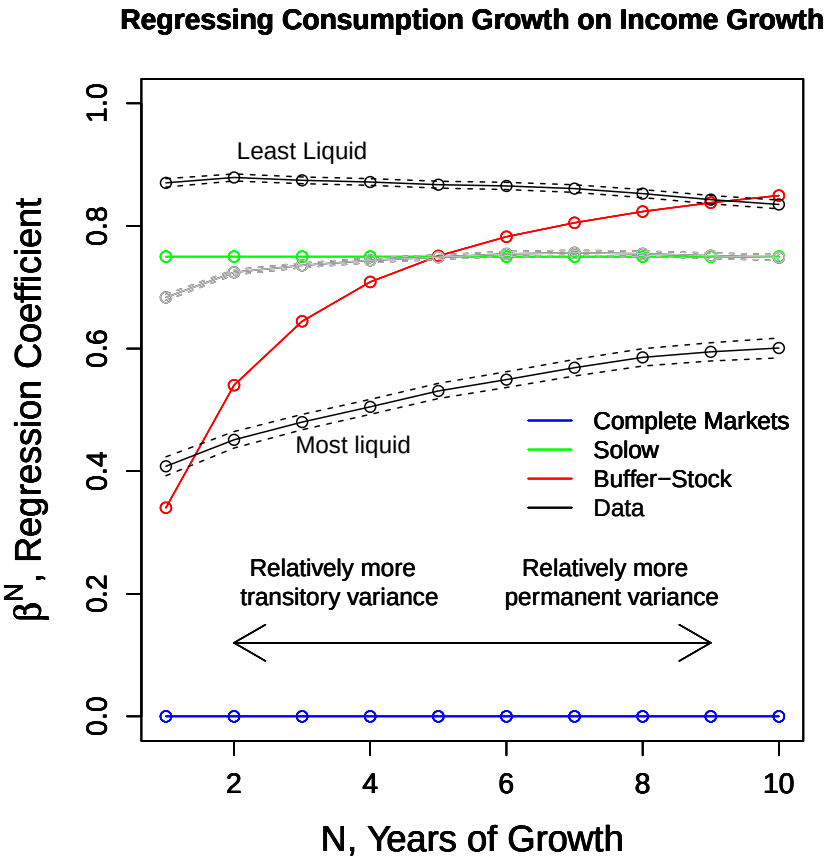


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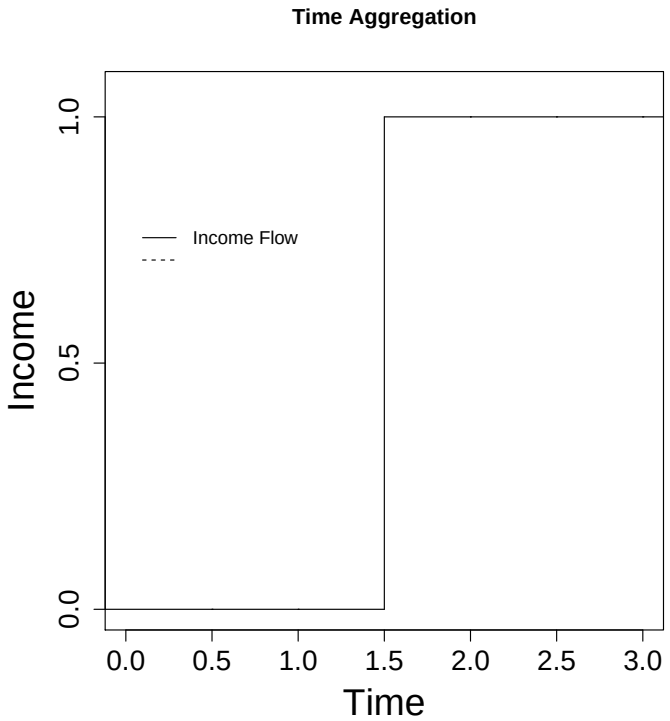
# Aside: Why Not Blundell, Pistaferri and Preston 2008?

1) Time Aggregation Problem (Crawley 2018)



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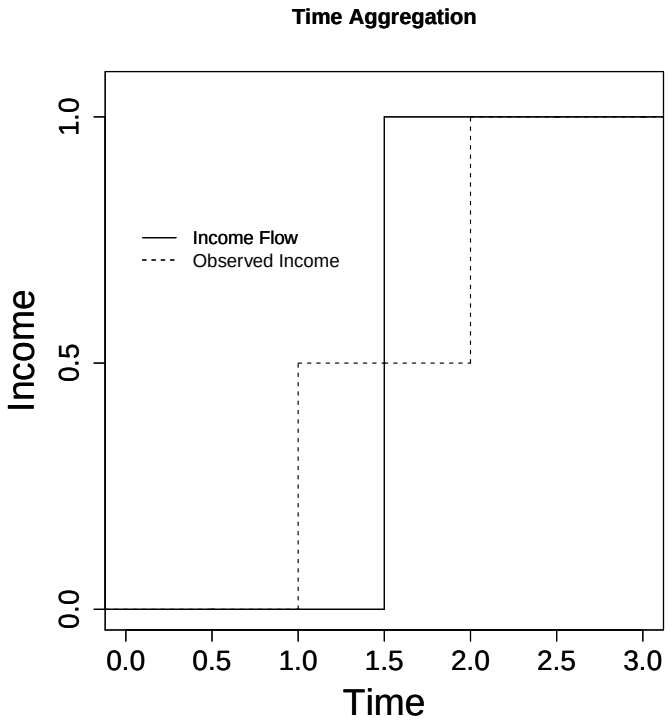

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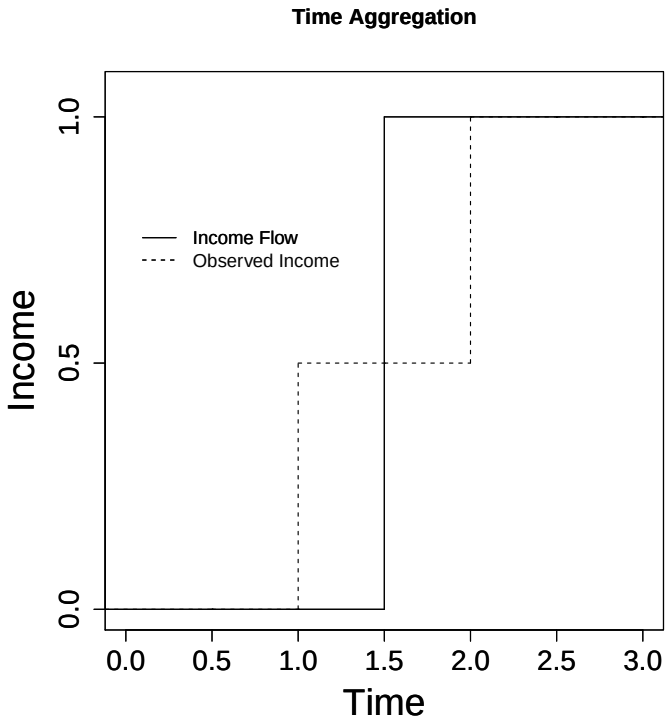


PIH Example:

- MPC out of Permanent Shocks = 1
- MPC out of Transitory Shocks = 0

BPP method estimates MPC out of transitory shocks to be -0.6

# Aside: Why Not Blundell, Pistaferri and Preston 2008?

2) BPP assume consumption is a random walk

- High transitory MPCs are incompatible with consumption following a random walk

# Identification of the Income Process

We follow the spirit of Carroll & Samwick (1997):

- Permanent income follows a random walk

$$p_t = p_{t-1} + \zeta_t$$

- Total income includes a transitory component

$$y_t = p_t + \varepsilon_t$$

Growth over N years is:

$$\Delta^N y_T = (\zeta_{T-N+1} + ... + \zeta_T) + \varepsilon_T - \varepsilon_{T-N}$$
$$\mathrm{Var}(\Delta^N y_T) = N\mathrm{Var}(\zeta) + 2\mathrm{Var}(\varepsilon)$$

# Identification of the Income Process

We follow the spirit of Carroll & Samwick (1997):

- If transitory income follows an MA(2) process:

$$y_t = p_t + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2}$$

$$\implies \mathrm{Var}(\Delta^N y_T) = N \underbrace{\mathrm{Var}(\zeta)}_{\text{Perm var}} + 2 \underbrace{(1 + \theta_1^2 + \theta_2^2)\mathrm{Var}(\varepsilon)}_{\text{“Total” trans var}} \text{ if } N \geq 3$$

Carroll & Samwick use $N = 3, 4, 5$ to identify permanent shock variance and “total” transitory shock variance

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1. How does time aggregation affect this identification?
2. What might the equivalent of “robust to MA(2) transitory shocks” be in continuous time?

# Identification of the Income Process

Carroll & Samwick in Continuous Time with Aggregation

- To begin assume no persistence in the transitory shock
- $p_t$ and $q_t$ are independent martingale processes with independent increments

$$\mathrm{Var}(p_t - p_{t-1}) = \sigma_p^2$$
$$\mathrm{Var}(q_t - q_{t-1}) = \sigma_q^2$$

- Instantaneous income is equal to the flow of permanent income plus the transitory income component

$$dy_t = p_t dt + dq_t$$

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We observe $\bar{y}_T$, total income over year $T$:

$$\bar{y}_T = \int_{T-1}^{T} p_t dt + q_T - q_{T-1}$$

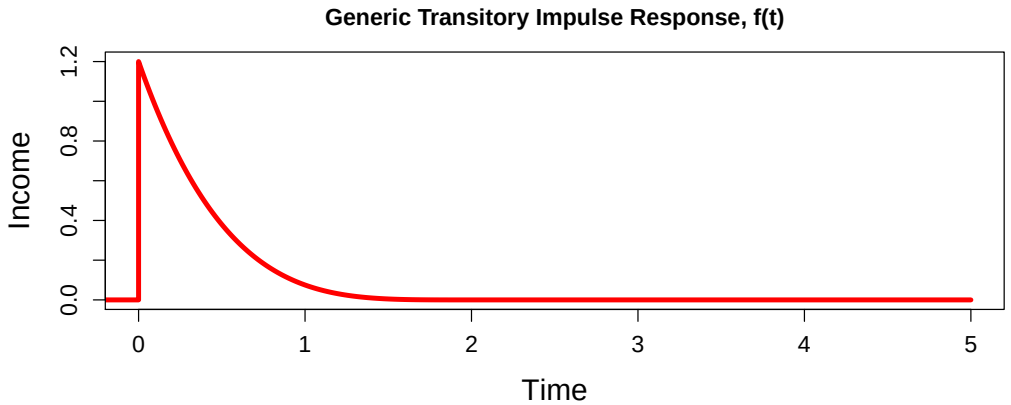
$$\implies \text{Var}(\Delta^N \bar{y}_T) = (N - \frac{1}{3})\sigma_p + 2\sigma_q$$

# Identification of the Income Process

Allow a generic persistence in transitory shock

- Following shock, transitory income flow decays as:

$$f(t) \text{ where } f(t) = 0 \text{ if } t > 2$$




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

$$\implies \text{Var}(\Delta^N \bar{y}_T) = (N - \frac{1}{3})\sigma_p^2 + 2\sigma_{\tilde{q}}^2 \text{ for } N \geq 3$$

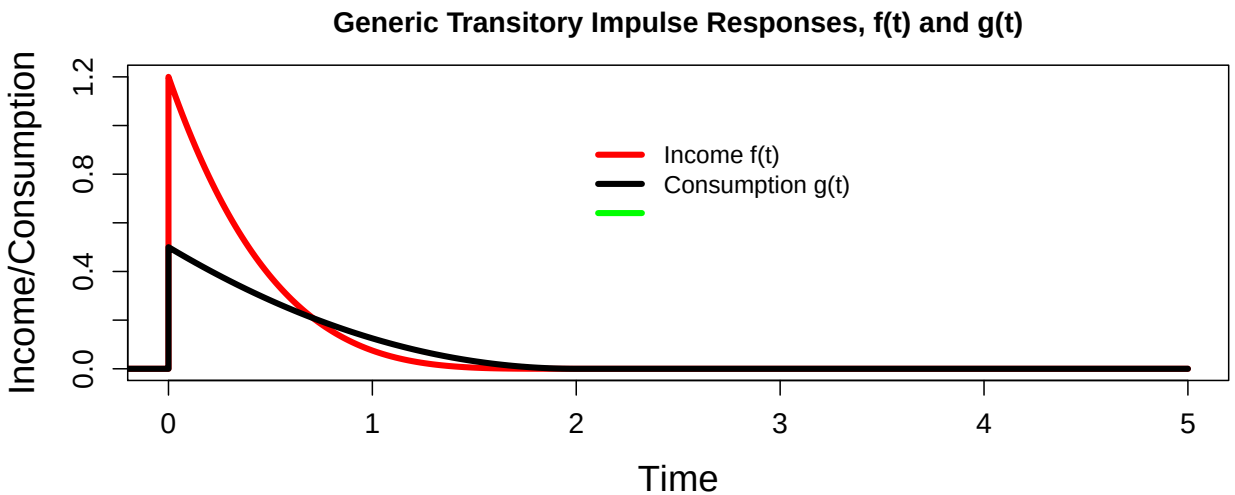
where $\tilde{q_T} = \int_{T-1}^{T} \int_{t-2}^{t} f(t-s)dq_s dt$ is the time aggregated transitory component of income

# Identification of the Consumption Response

Assumptions on Consumption

- Permanent: Consumption permanently moves by fraction $\phi$ of the income shock
- Transitory: Allow for generic impulse response $g(t)$ where $g(t) = 0$ for $t > 2$

Evidence

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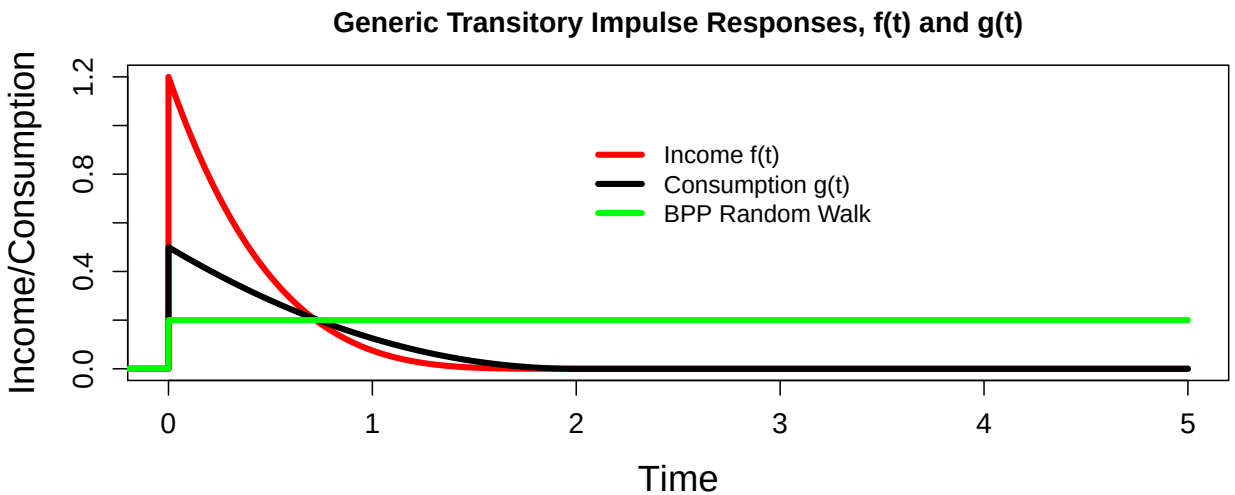


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# Identification of the Consumption Response

Consumption flow is given by:

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

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

where $\psi = \frac{\text{Cov}(\tilde{c},\tilde{q})}{\text{Var}(\tilde{q})}$, the regression coefficient of 'transitory' consumption on transitory income

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- $\phi$: MPX out of permanent income shocks
- $\psi$: MPX out of transitory income shocks

# 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 $N = 3, 4, 5$ (total of six equations) to identify the four unknowns:

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

# Threats to Identification

| | **Direction of Bias** | |
|---|---|---|
| | Perm MPX | Tran MPX |
| Persistent Consumption Response | +ve | -ve |
| Endogenous Income Shocks | Neutral | +ve |
| Income Measurement Error | Neutral | +ve |
| Permanent Shocks are AR(1) | Neutral | +ve |
| Non-linear MPX | ? | ? |
| Time-varying risk | ? | ? |

# Data: Income

- Starting point: Register based micro data for all Danish households made available by Statistics Denmark
- Really good income data
  - We use after-tax income for the household head, based on third-party reported tax data
  - Restrict sample to heads aged 30-55
- We divide through by permanent income (mean income over all observed years) and take the residual after controlling for age, education, marital status etc. (along with interactions of these)

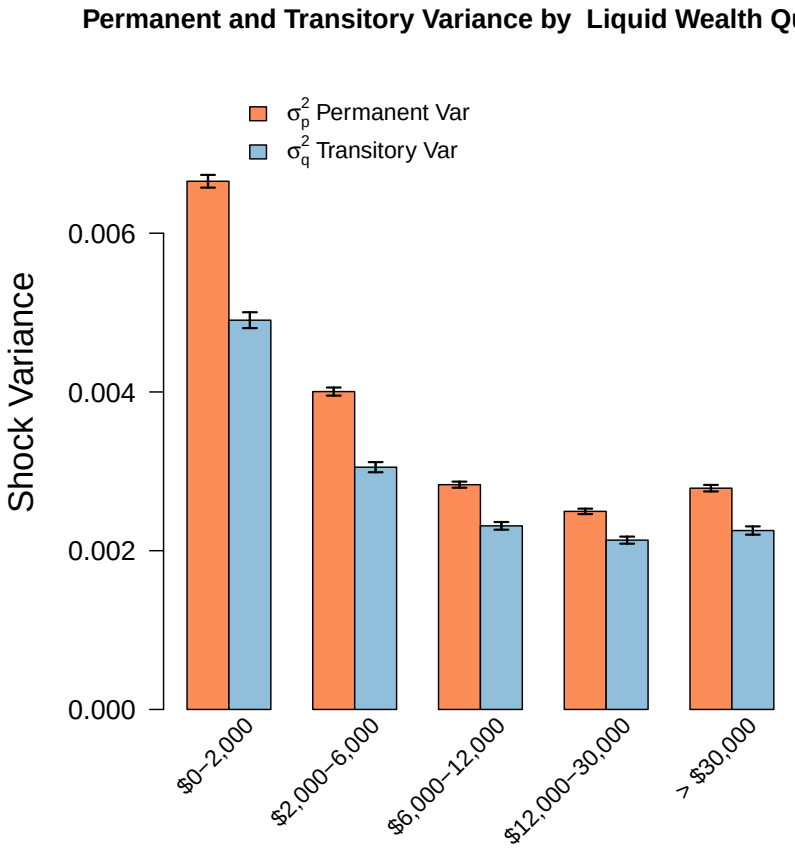
# Data: Expenditure

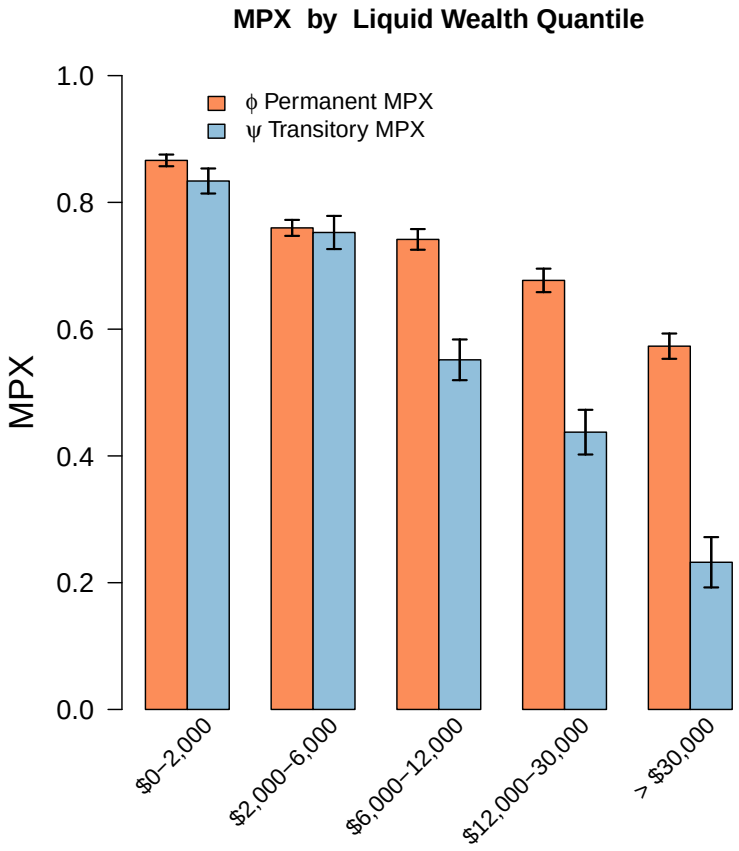
We use the identity

$$C_t \equiv Y_t - S_t = Y_t - P_t - \Delta NW$$

- Deposit and brokerage accounts all third party reported
- Works well for households with simple financial lives
- Main issue: Capital gains and losses
  - Exclude households where methodology will not work well (eg business owners)
  - Exclude housing wealth and years with housing transactions
  - Capital gains for stocks 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

# MPX by Liquid Wealth

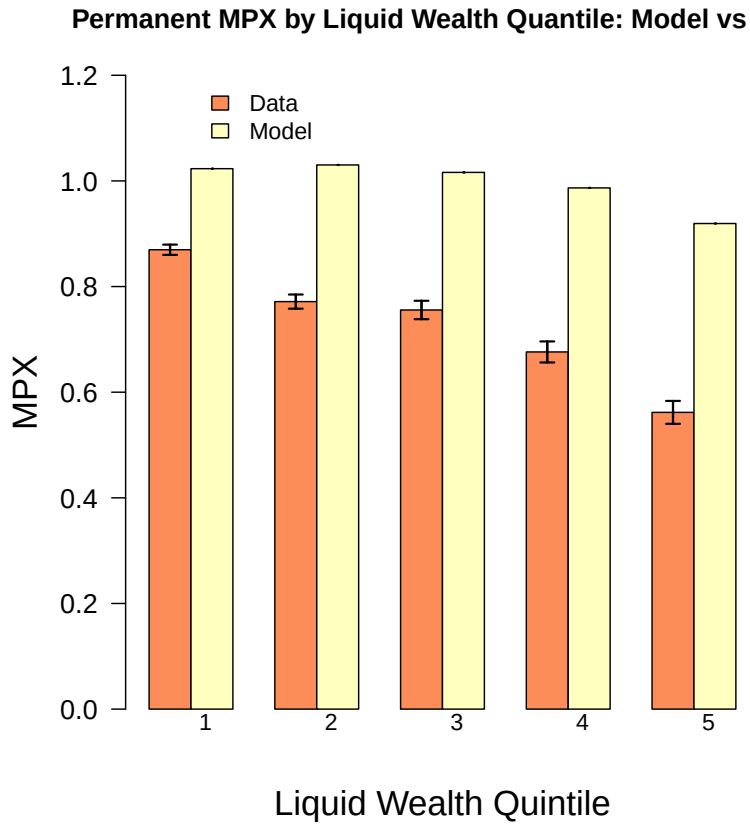


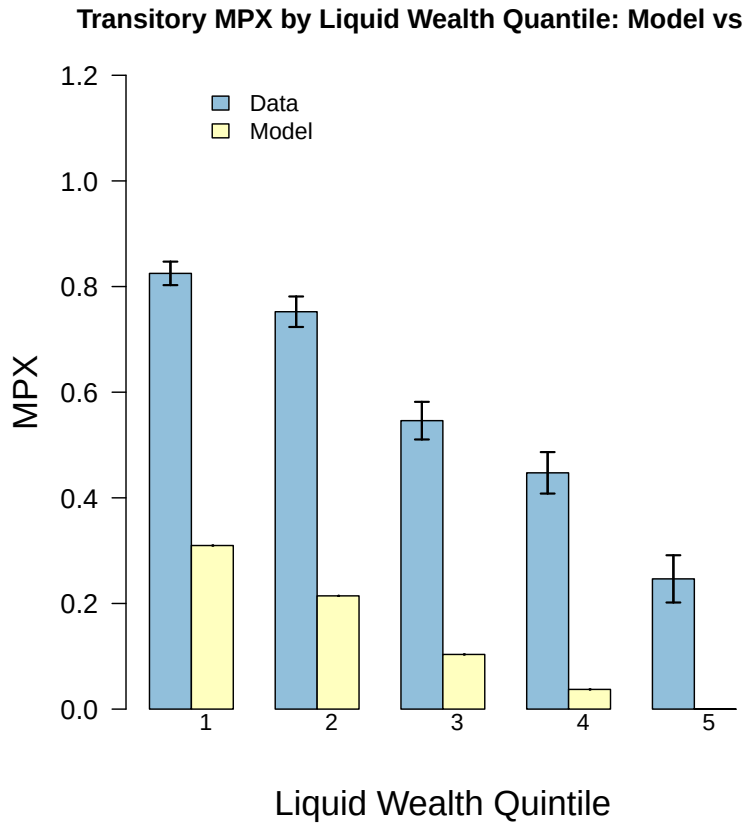




MPX by Net Wealth

# Model vs Data

How does a standard model compare with the data?



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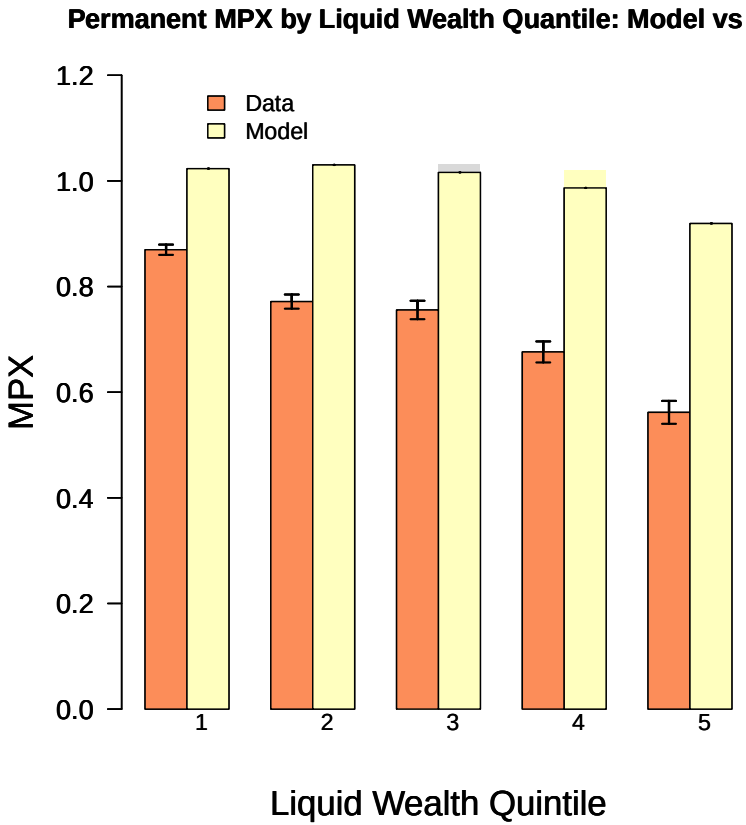


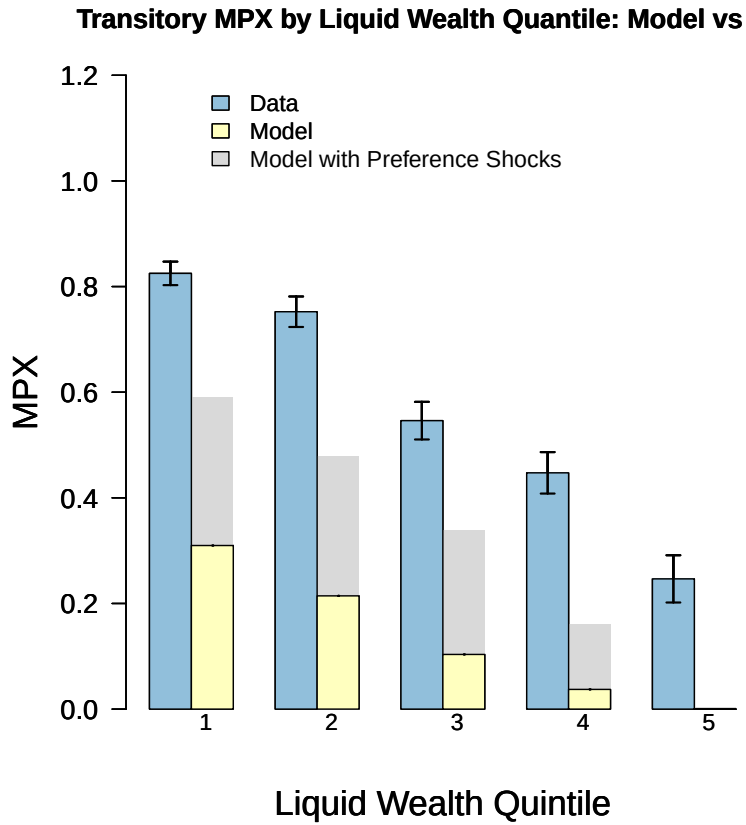

# Monetary Policy: Measuring Redistribution

We calculate the sufficient statistics from Auclert (2017)

Here we will focus on the *Interest Rate Exposure* channel:

If

1. Households that *owe* a lot of floating rate debt have *high* MPCs
2. Households that *own* a lot of floating rate debt have *low* MPCs

Then lowering interest rates will on average *increase* consumption through redistribution

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Do we know if 1 and 2 hold? How can we measure the size of this effect?

# Monetary Policy: Measuring 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:

$$dc_i = MPC_i URE_i \frac{dR}{R} \tag{1}$$

# Monetary Policy: Measuring Redistribution

In aggregate, the size of this channel is given by:

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

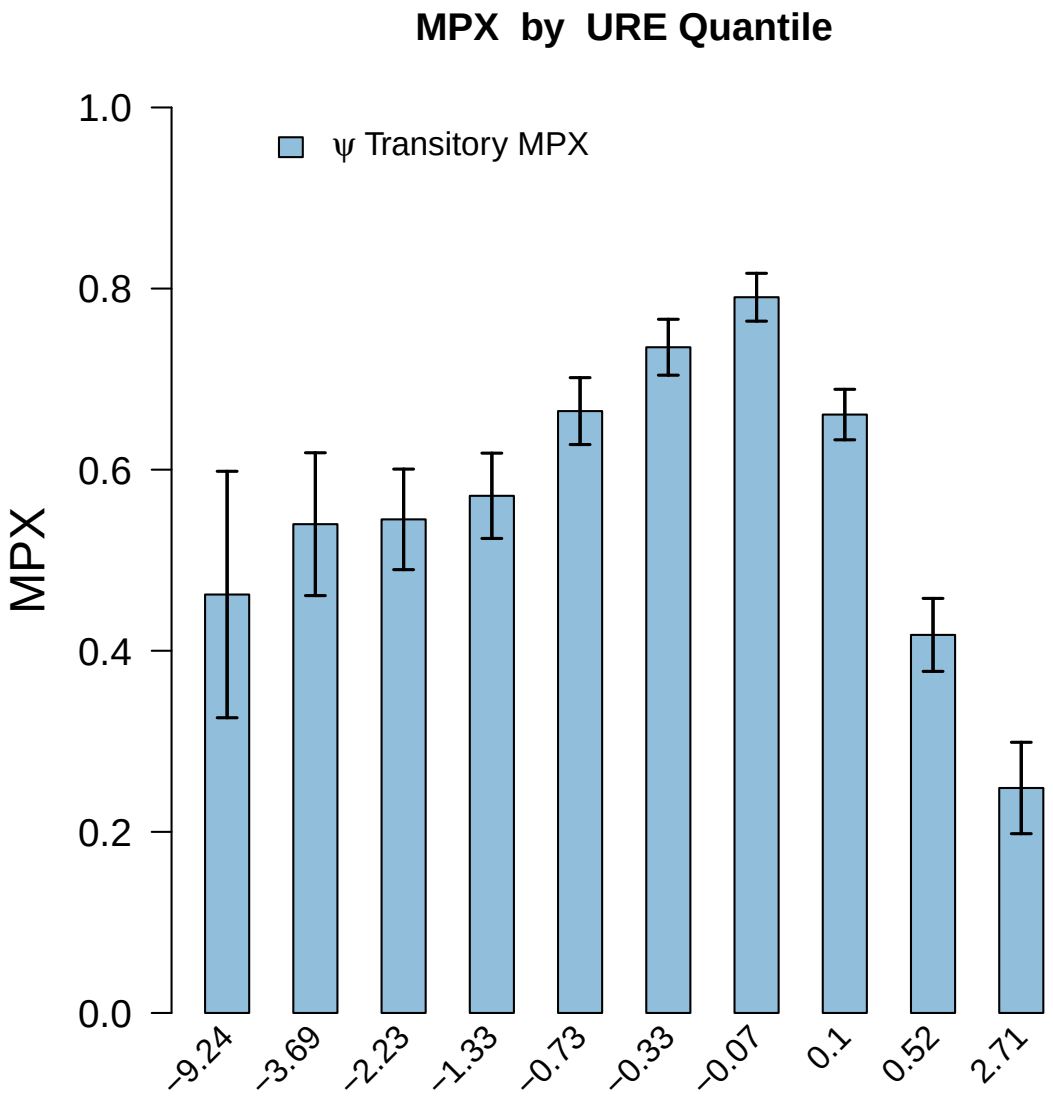
Define sufficient statistic:

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

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

We can do that!

# Monetary Policy: Measuring Redistribution



# Monetary Policy: Measuring Redistribution

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

- -338bn Kr

| | MPX | URE | $\mathcal{E}_R$ component |
|---|---|---|---|
| **Estimation Sample** | **See Distribution** | **-338** | **-0.35** |
| Young | 0.5 | -38 | -0.02 |
| Old | 0.2 | -6 | -0.00 |
| Pension Funds | 0.1 | 143 | 0.02 |
| Government | 0.0 | -120 | 0.00 |
| Non-financial Corp. | 0.1 | -67 | -0.01 |
| Financial Sector | 0.1 | 380 | 0.04 |
| Rest of World | 0.0 | 45 | 0.00 |
| **Total** | | **0** | **-0.33** |

**Notes**: URE numbers are in billions of 2015 Kr.

# Monetary Policy: Measuring Redistribution

The Five Transmission Channels:

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

# Monetary Policy: Measuring Redistribution

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| | |
|---|---|
| $\mathcal{M}$ | 0.46 |
| $\mathcal{E}_Y$ | -0.00 |
| $\mathcal{E}_P$ | -0.66 |
| $\mathcal{E}_R$ | -0.33 |
| $\mathcal{S}$ | 0.56 |

# Monetary Policy: Measuring Redistribution

The Five Transmission Channels:

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| $\mathcal{E}_Y$ | -0.00 |
| $\mathcal{E}_P$ | -0.66 |
| $\mathcal{E}_R$ | -0.33 |
| $\mathcal{S}$ | 0.56 |

Compare $\mathcal{E}_R$ to $\sigma S$:

$\sigma$ in the range of 0.1 to 0.5 (maybe)

$\sigma S \approx 0.06 - 0.28$

# Durables

We have data on value of household cars

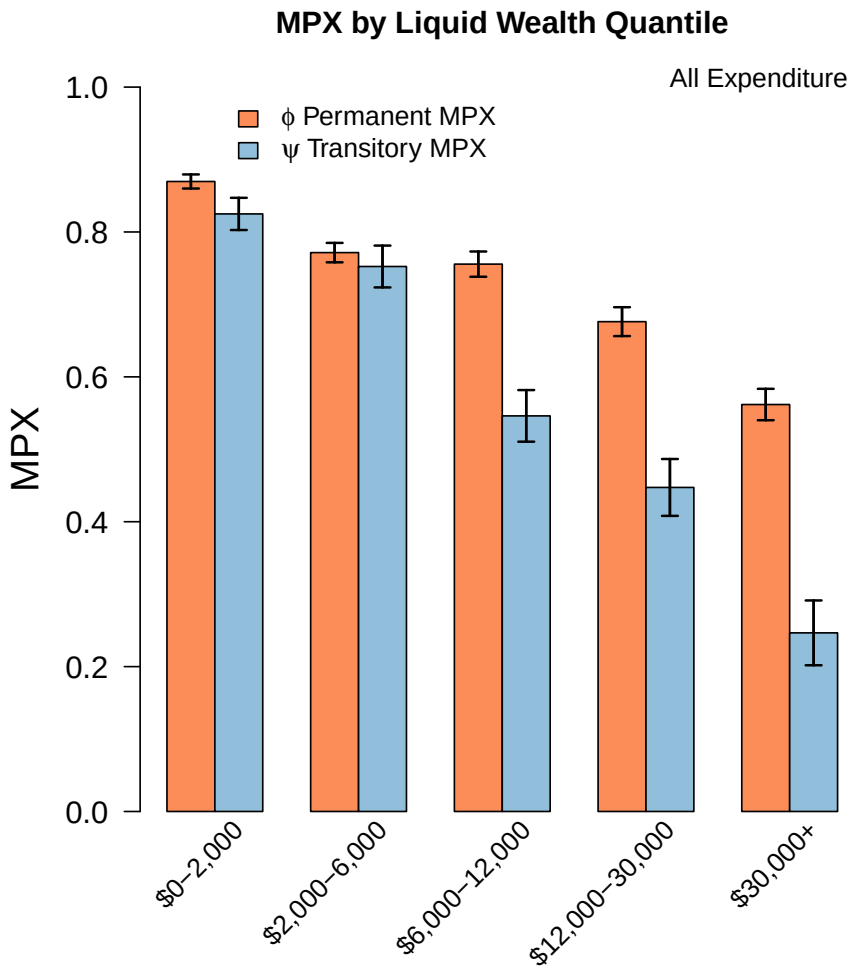
- Construct expenditure excluding car purchases and sales

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

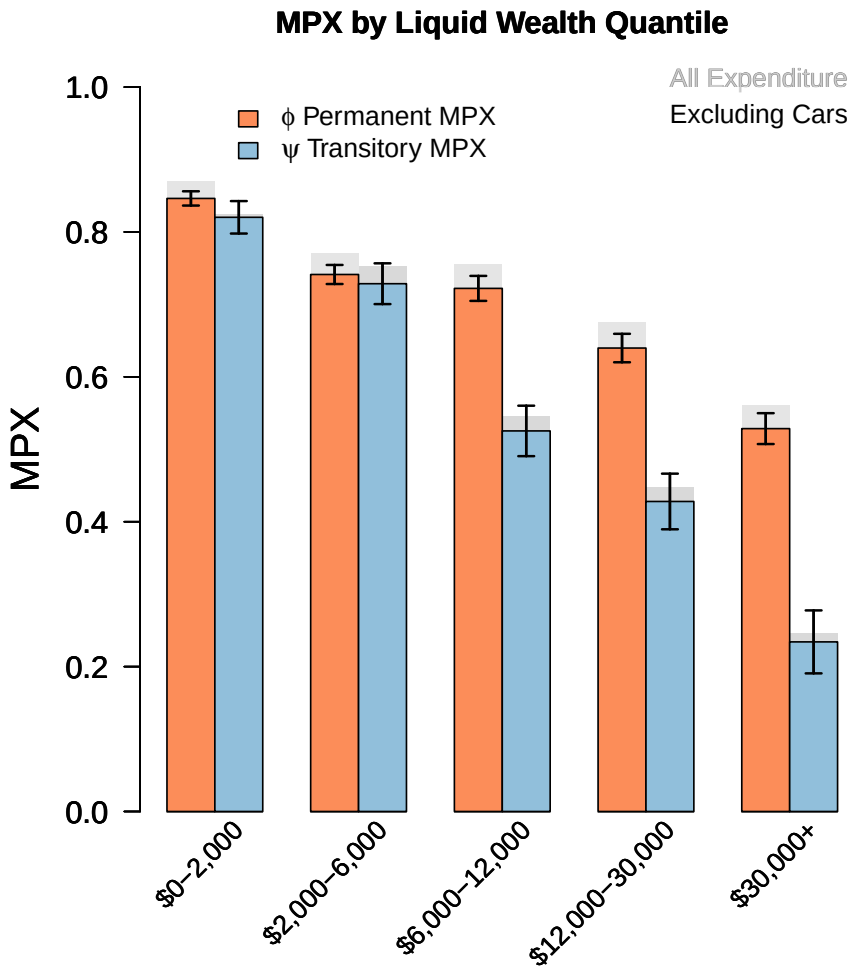
- Construct proxy for non durable consumption (Cars $\approx 42.1\%$ durable expenditure)

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

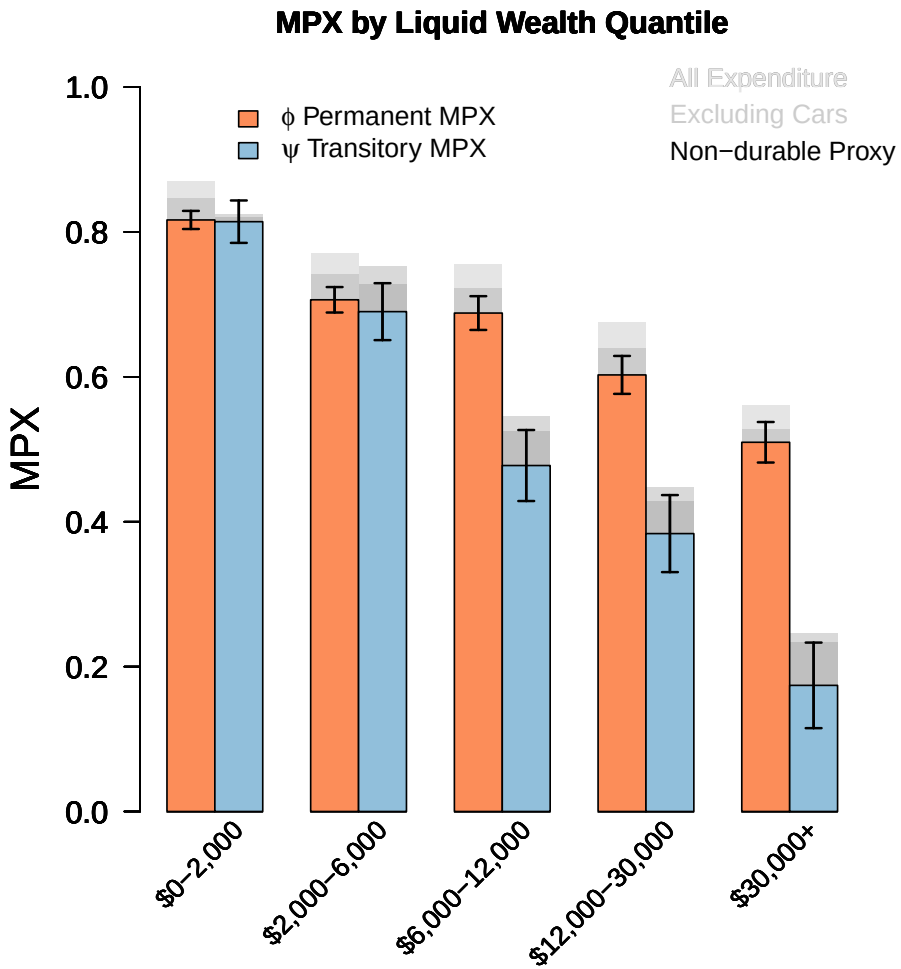
# Durables


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+

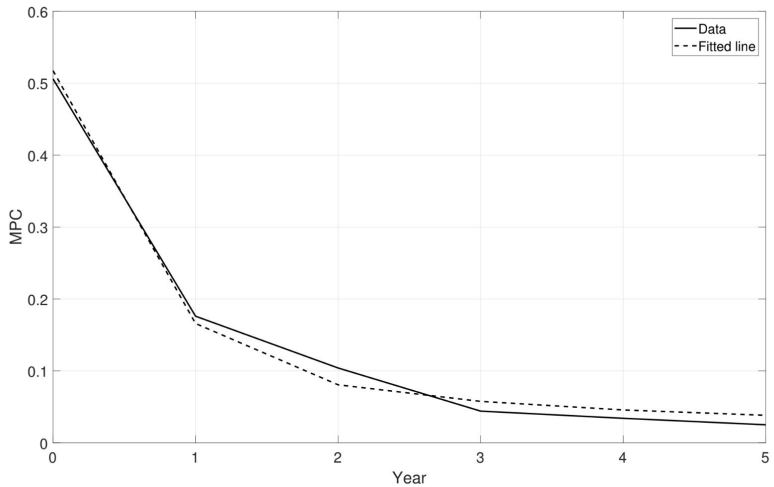
# Conclusion

- 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!

# Evidence of Consumption Decay Within 2 Years

## From Fagereng, Holm, and Natvik (2016)

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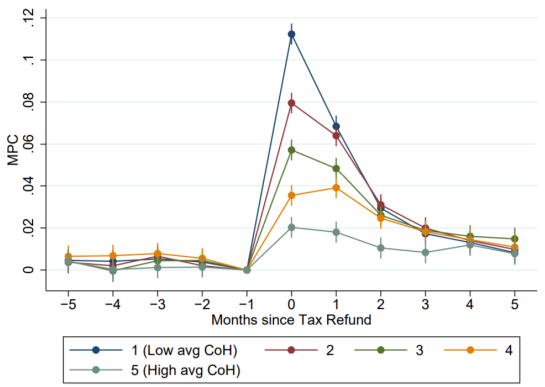
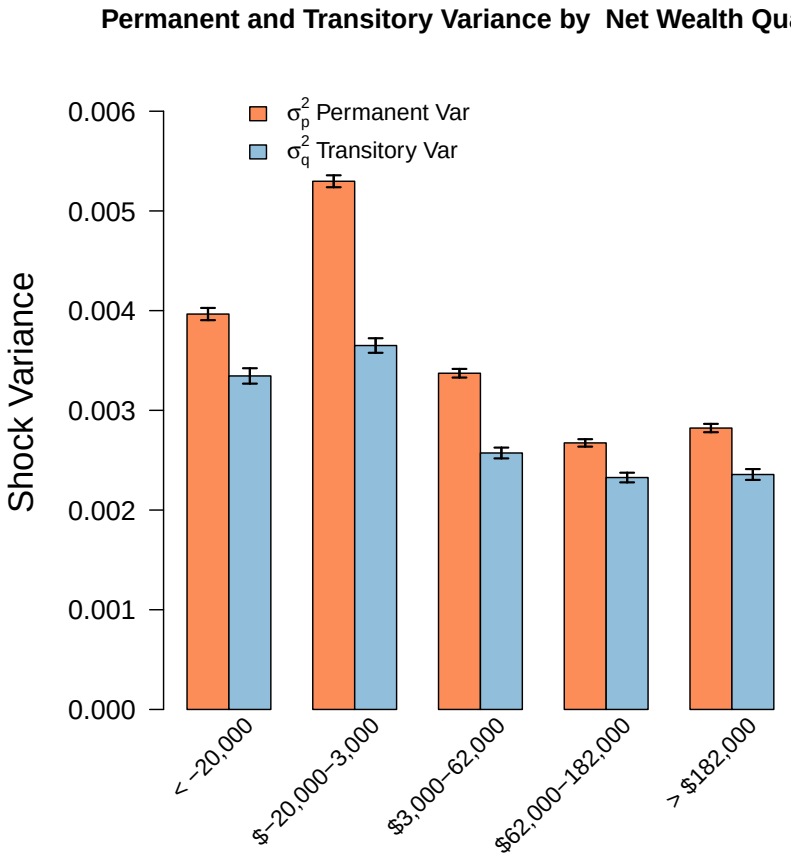
## From Gelman (2016)

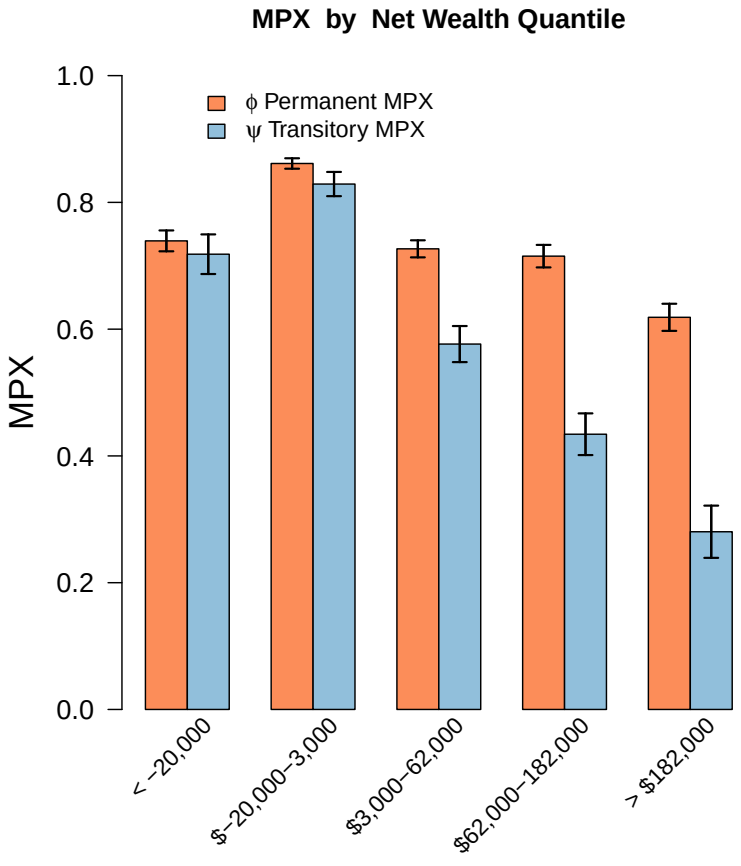
Figure 10: Tax refund impulse response function




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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