

# 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

Permanent Shocks	Consumption Measure		Horizon	Method	Event/Sample
	Nondurables	Total PCE			
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
<b>Transitory Shocks</b>					
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, Tokunaka, 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** affect monetary policy

Each is potentially measurable in panel data

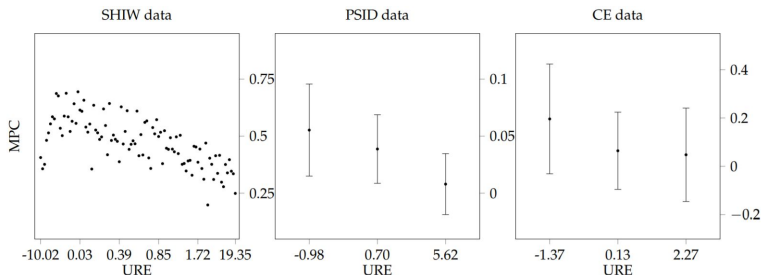
But...

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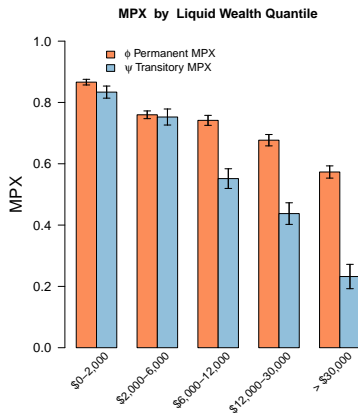
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But...



He doesn't have the right data or methods to be able to do this

# Results Preview



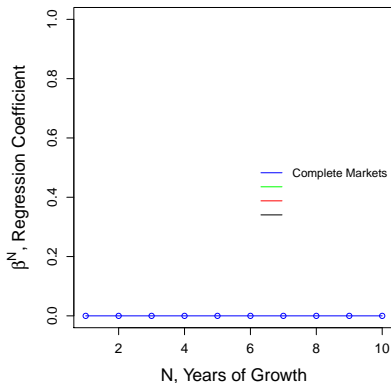




# Methodology Intuition

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

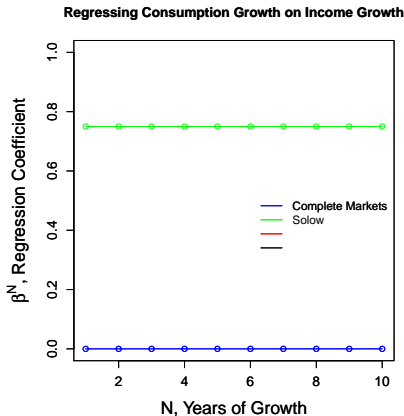
Regressing Consumption Growth on Income Growth



$$\Delta^N c = \beta^N \Delta^N y + \varepsilon$$

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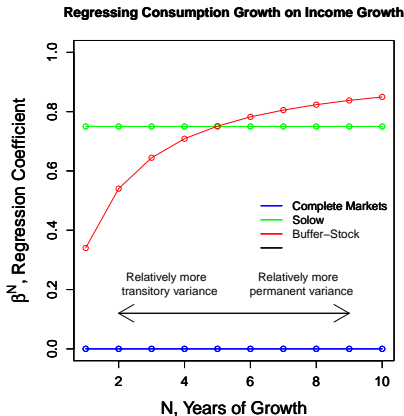
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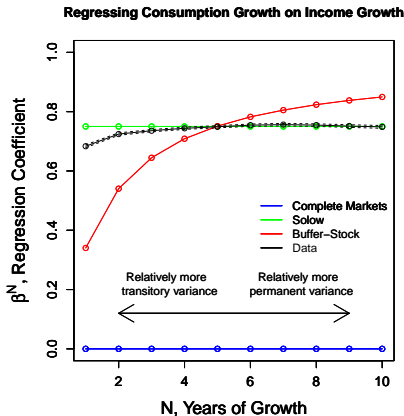
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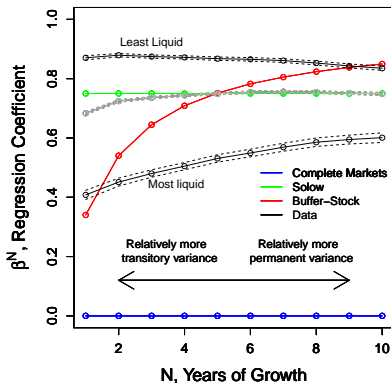


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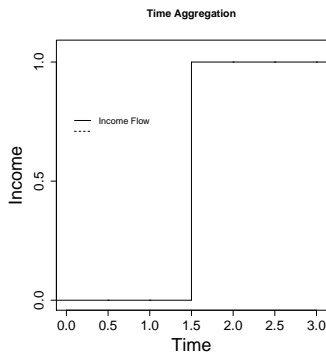
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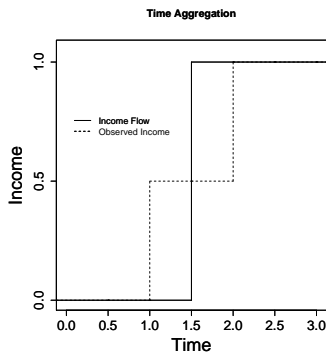
# Aside: Why Not Blundell, Pistaferri and Preston 2008?

## 1) Time Aggregation Problem (Crawley 2018)



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

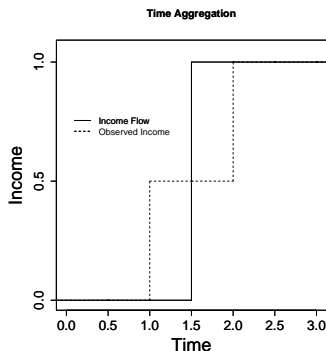
## 1) Time Aggregation Problem (Crawley 2018)





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

## 1) Time Aggregation Problem (Crawley 2018)



### PIH Example:

- MPC out of Permanent Shocks = 1
- MPC out of Transitory Shocks = 0
- Variances approx. equal

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:

$$\Delta^N y_T = (\zeta_{T-N+1} + \dots + \zeta_T) + \varepsilon_T - \varepsilon_{T-N}$$

$$\text{Var}(\Delta^N y_T) = N\text{Var}(\zeta) + 2\text{Var}(\varepsilon)$$

# Identification of the Income Process

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

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

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

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

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

$$\text{Var}(p_t - p_{t-1}) = \sigma_p^2$$

$$\text{Var}(q_t - q_{t-1}) = \sigma_q^2$$

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

$$dy_t = p_t dt + dq_t$$

# Identification of the Income Process

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$$dy_t = p_t dt + dq_t$$

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

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

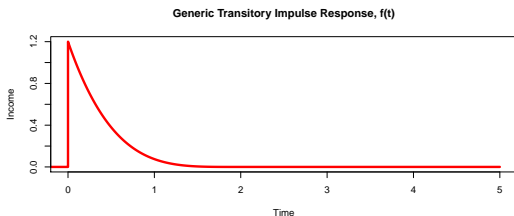
$$\implies \text{Var}(\Delta^N \bar{y}_T) = (N - \frac{1}{3})\sigma_p + 2\sigma_q$$

# 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



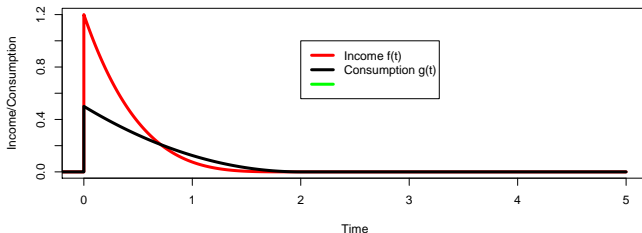
# Identification of the Consumption Response

## 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

Generic Transitory Impulse Responses,  $f(t)$  and  $g(t)$



This is a key difference between what we assume and BPP

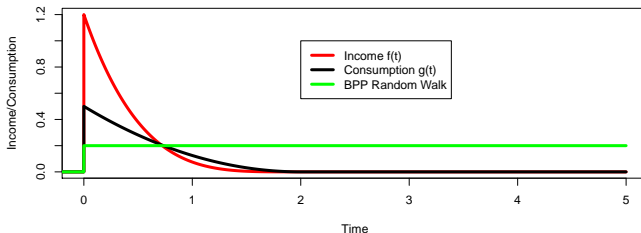
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# Identification of the Consumption Response

Consumption flow is given by:

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

$$\implies \text{Cov}(\Delta^N \bar{c}_T, \Delta^N \bar{y}_T) = \phi \left(N - \frac{1}{3}\right) \sigma_p^2 + 2\psi \sigma_{\tilde{q}}^2$$

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:

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

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

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

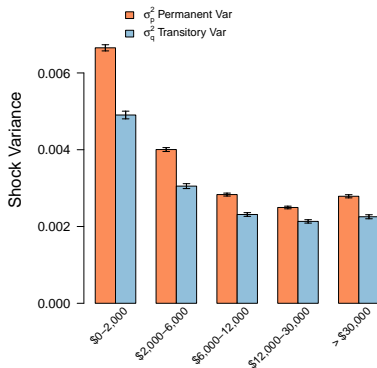
$$C_t \equiv Y_t - S_t = Y_t - P_t - \Delta NW$$

- 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

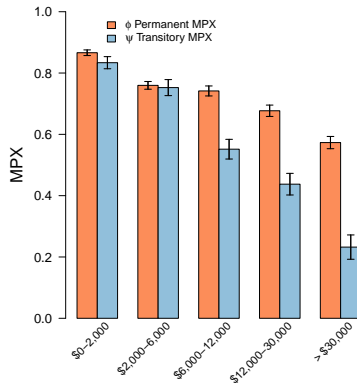


# MPX by Liquid Wealth

Permanent and Transitory Variance by Liquid Wealth Quantile

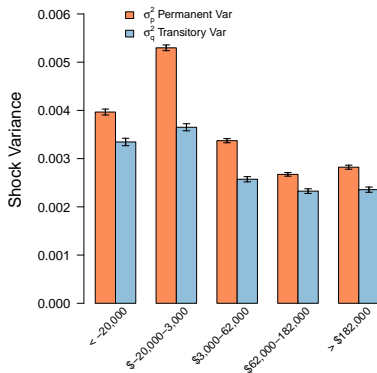


MPX by Liquid Wealth Quantile

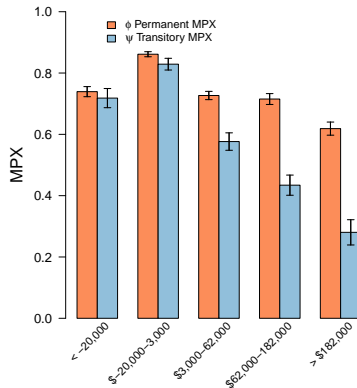


# MPX by Net Wealth

Permanent and Transitory Variance by Net Wealth Quantile



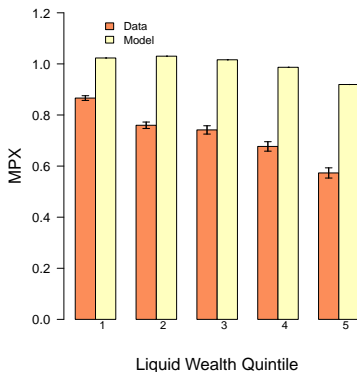
MPX by Net Wealth Quantile



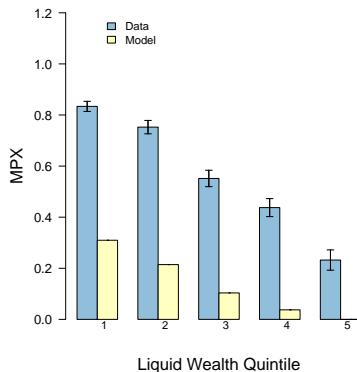
# Model vs Data

How does a standard model compare with the data?

Permanent MPX by Liquid Wealth Quintile: Model vs Data



Transitory MPX by Liquid Wealth Quintile: Model vs Data



# 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:

$$dc_i = MPC_i URE_i \frac{dR}{R} \quad (1)$$

# Monetary Policy: Measuring Redistribution

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

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

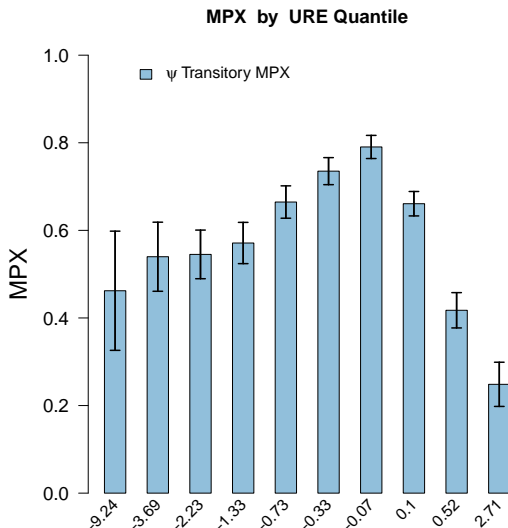
Define sufficient statistic:

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

$\implies$  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
<b>Estimation Sample</b>	<b>See Distribution</b>	<b>-338</b>	<b>-0.35</b>
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
<b>Total</b>		<b>0</b>	<b>-0.33</b>

Notes: URE numbers are in billions of 2015 Kr.

# Monetary Policy: Measuring Redistribution

The Five Transmission Channels:

$$\frac{dC}{C} = \left( \mathcal{M} + \gamma \varepsilon_Y \right) \frac{dY}{Y} - \varepsilon_P \frac{dP}{P} + \left( \varepsilon_R - \sigma S \right) \frac{dR}{R}$$

We calculate

- $\varepsilon_R \approx -0.33$
- $\varepsilon_P \approx -0.66$
- $S \approx 0.56$ , 1-consumption-weighted MPC
- $\sigma$  in the range of 0.1 to 0.5 (maybe)

$\implies$  the intertemporal substitution channel,  $\sigma S \approx 0.05 - 0.28$ , is potentially much smaller than the interest rate exposure channel

# Durables

We have data on value of household cars

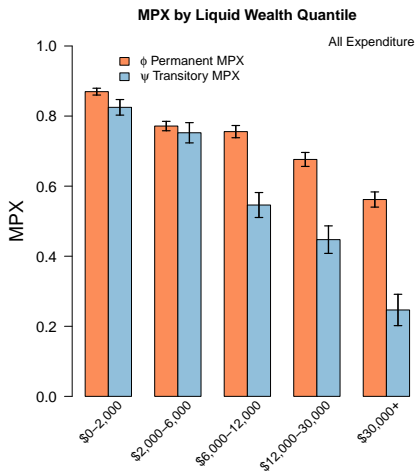
- Construct expenditure excluding car purchases and sales

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

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

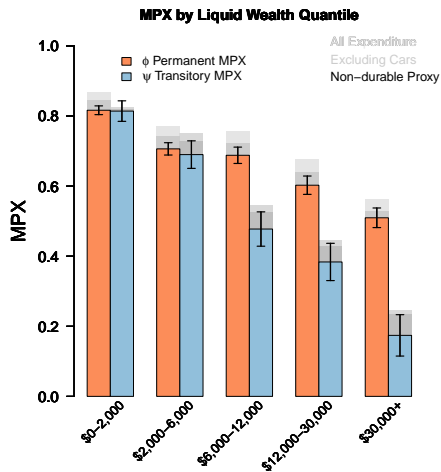
$$C_T^{\text{nondurable}} = C_T - \frac{1}{0.421} \Delta \text{CarValue}$$

# Durables





# Durables



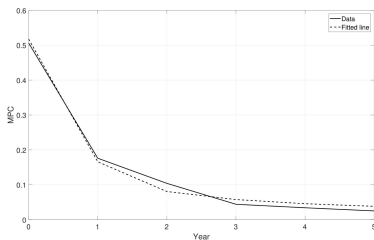
# Conclusion

- 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

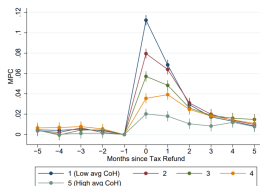
From Fagereng, Holm,  
and Natvik (2016)



Back

From Gelman (2016)

Figure 10: Tax refund impulse response function



Notes: 1,445,560 observations from 48,050 individuals. The vertical bars on each coefficient represent 95% confidence intervals using heteroskedasticity robust errors clustered at the individual level.