Consumption Heterogeneity: Micro Drivers and Macro Implications

Edmund Crawley & Andreas Kuchler

Johns Hopkins University, September 18, 2018

Is Heterogeneity Important for Macroeconomics?

Theory: Consumption heterogeneity *potentially* very important for macroeconomic dynamics

- Recent HANK models

Empirics: Ability to measure heterogeneity limited by

- Methods to measure MPCs
- Consumption data
- Household balance sheet data

What does this paper do?

Two Empirical Contributions

1. **Method:** New methodology to measure MPCs out of transitory and permanent income shocks
   - Builds on Blundell, Pistaferri, and Preston (2008)
   - Correctly accounts for the Time Aggregation Problem

2. **Data:** Panel data covering all Danish households 2004-2015
   - Large sample size reveals clear, systemic heterogeneity
   - Detailed household balance sheets allow us to infer implications for monetary policy transmission

What does this paper find?

Wealthy Hand-to-Mouth

Poor Hand-to-Mouth

Wealthy

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Wealthy Hand-to-Mouth

MPC ≈ 0.5

Poor Hand-to-Mouth

MPC ≈ 0.8

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Interest Rate Hike

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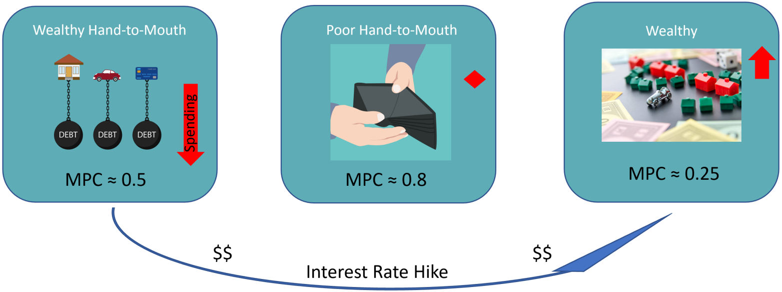

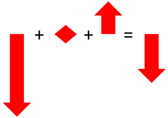

A **one percentage point** interest rate hike reduces aggregate expenditure by **35 basis points** through this ***interest rate exposure channel*** alone

Redistribution >> Intertemporal Substitution

What has the Empirical MPC literature Found?

General consensus: **MPCs are large** (≈ 0.5 including durables)

- For both expected and unexpected transitory shocks

Few studies have enough power to say much about the distribution of MPCs in the population

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

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

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

Our method and data can uncover detailed heterogeneity - Many potential applications

How Are Consumption Responses Typically Measured?

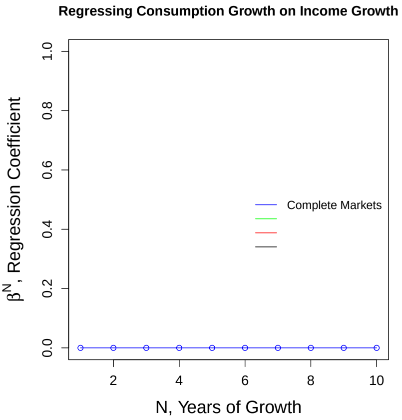
Three methods:

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

Methodology Intuition and Suggestive Findings

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



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

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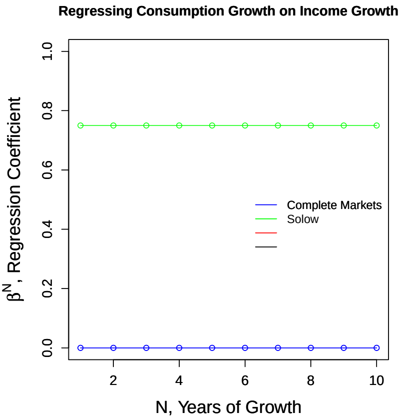

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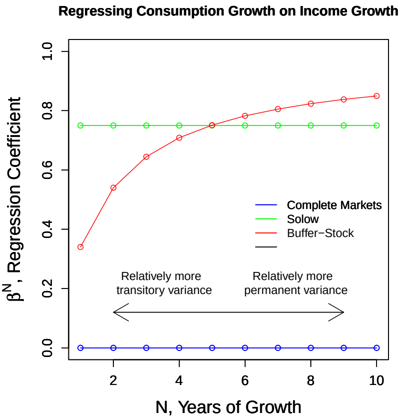

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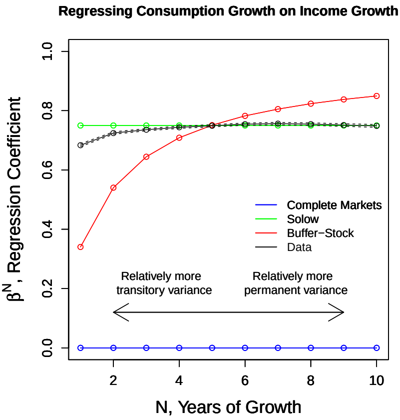

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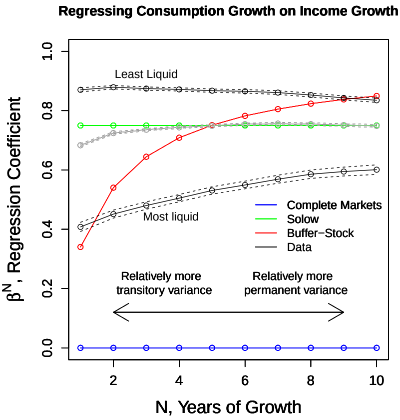

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Aside: Why Not Blundell, Pistaferri and Preston 2008?

Common Assumptions

Income y_t is made up of:

- Permanent Income (random walk)
- Transitory Income (uncorrelated over time)

Key to BPP Identification

Δy_{t+1} is a *valid instrument* for transitory shocks in year t

- Negatively correlated with transitory shocks in year t
- Uncorrelated with permanent shocks in year t

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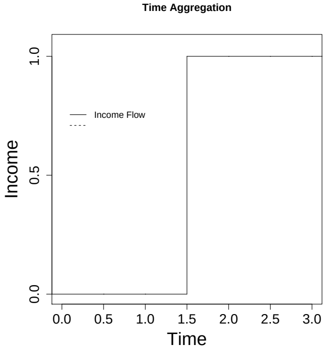
Fails due to the **Time Aggregation Problem**

Time Aggregation Problem (Crawley 2018)



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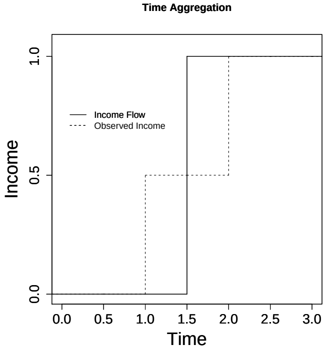

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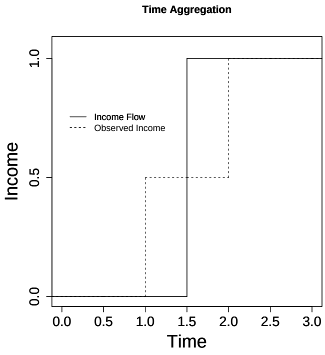

Permanent income growth is *positively* autocorrelated

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

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

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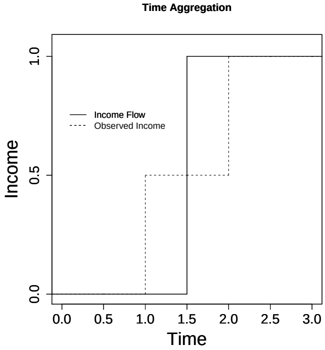

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If the Permanent Income Hypothesis holds, BPP will estimate the MPC to be -0.6

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:

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

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:

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

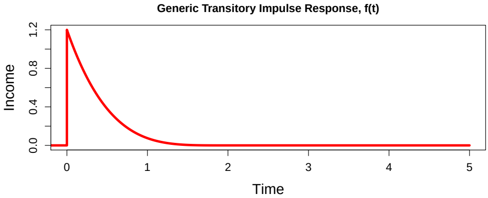
$$\implies \mathrm{Var}(\Delta^N \bar{y}_T) = (N - \frac{1}{3})\sigma_p + 2\sigma_q$$

Identification of the Income Process

Allow a generic persistence in transitory shock

- Following shock, transitory income flow decays as:

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



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

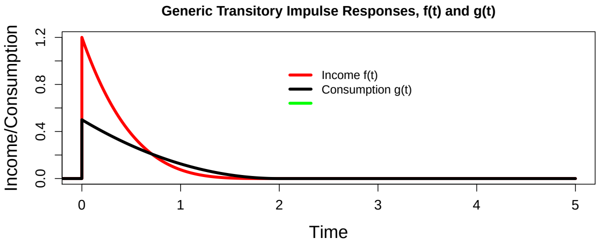
$$\implies \mathrm{Var}(\Delta^N \bar{y}_T) = (N - \frac{1}{3})\sigma_p^2 + 2\sigma_{\tilde{q}}^2 \text{ for } N \geq 3$$

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 ϕ of the income shock
- Transitory: Allow for generic impulse response $g(t)$ where $g(t) = 0$ for $t > 2$ Evidence



This is a key difference between what we assume and BPP

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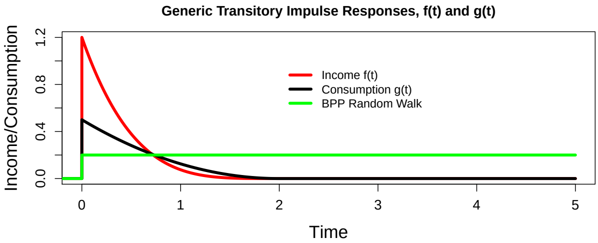

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Identification of the Consumption Response

Consumption flow is given by:

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

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

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

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- ϕ: MPX out of permanent income shocks
- ψ: 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:

- 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

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)

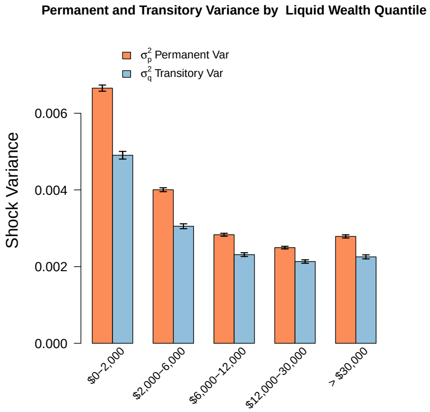
Data: Expenditure

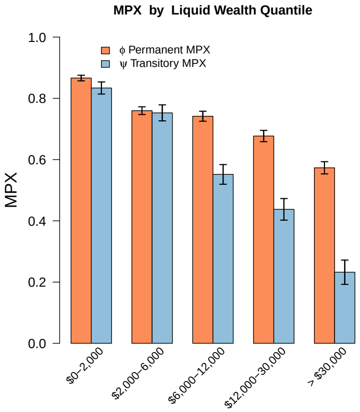
We use the identity

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

- 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

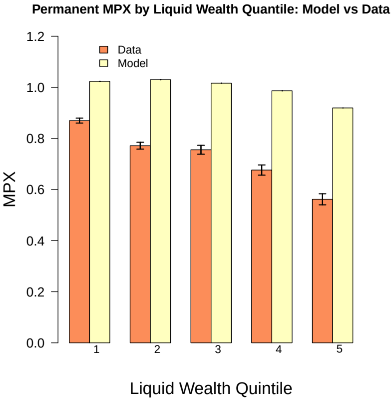


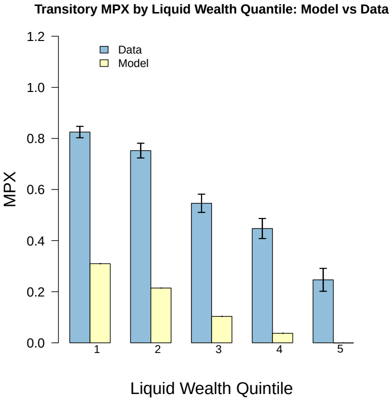


MPX by Net Wealth

Model vs Data

How does a standard model compare with the data?





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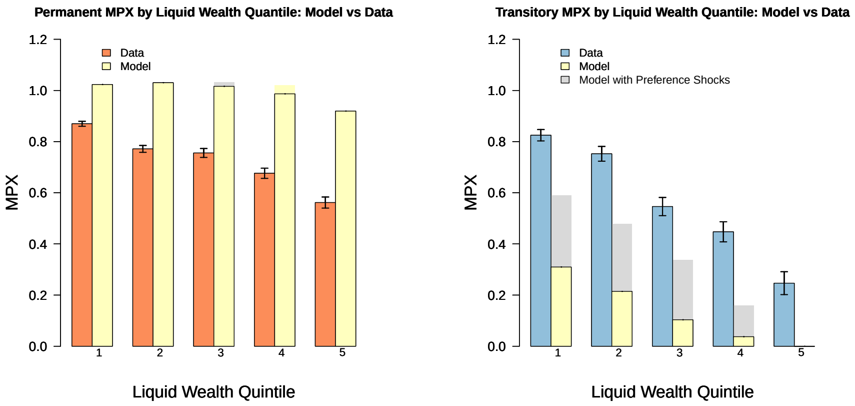

Monetary Policy: Measuring Redistribution

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:

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

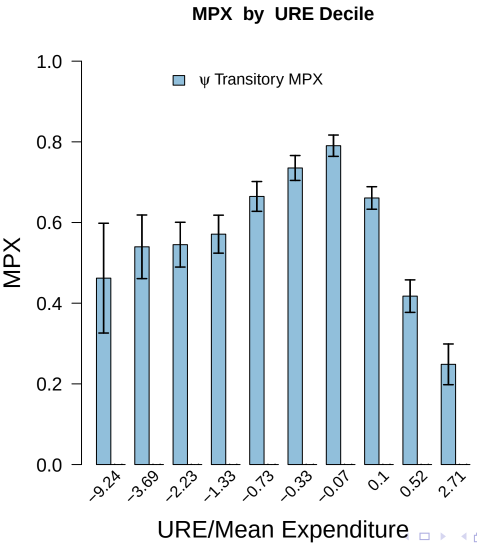
Define sufficient statistic:

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

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

We can do that!

Monetary Policy: Measuring Redistribution



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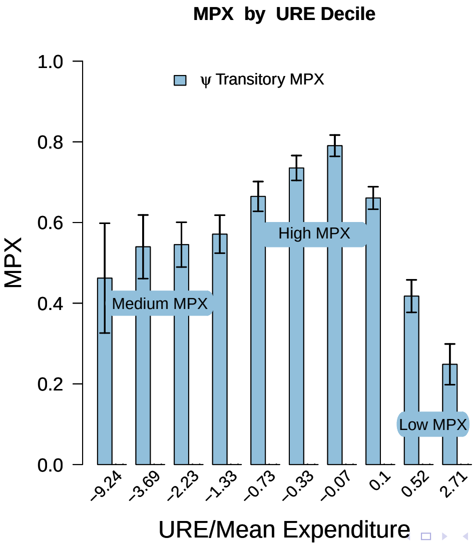

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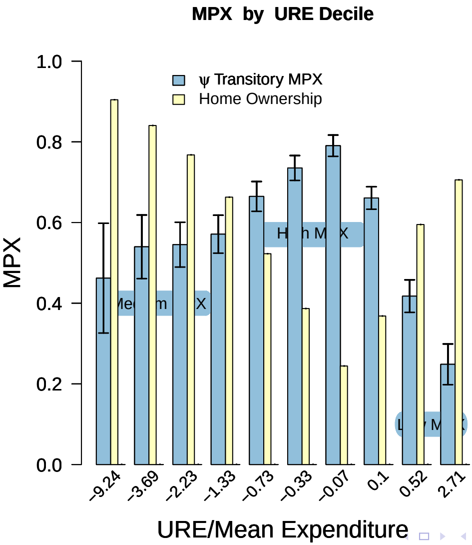

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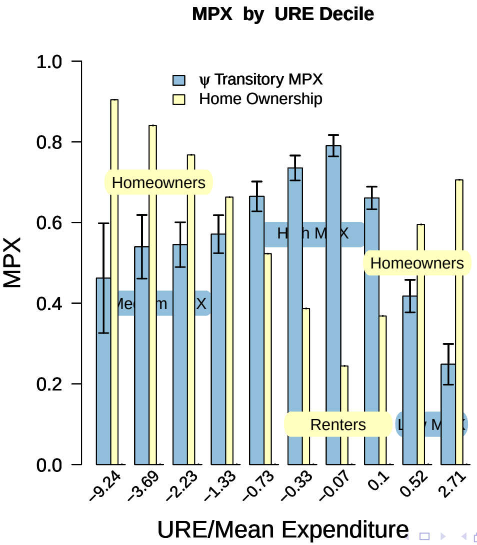

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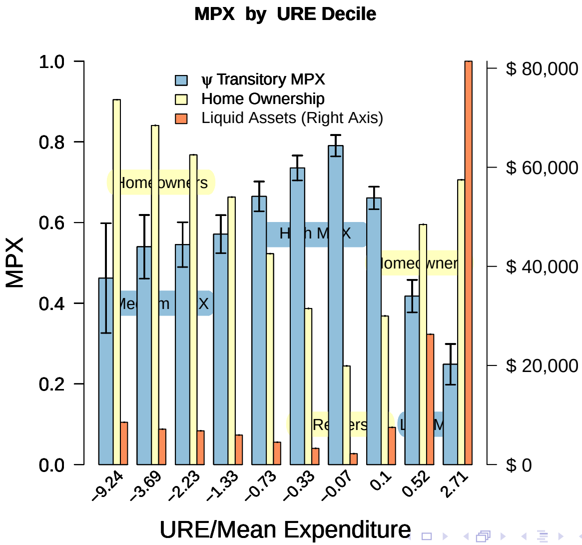

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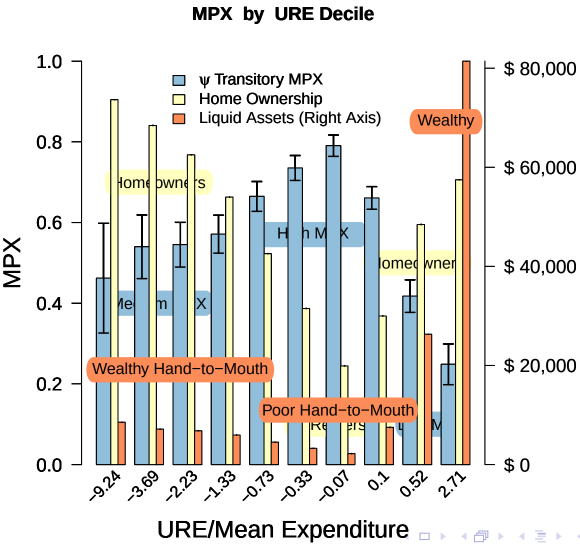

Monetary Policy: Measuring Redistribution

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**	**-57**	**-0.40**
Young	0.5	-16	-0.07
Old	0.5	14	0.06
Pension Funds	0.1	31	0.03
Government	0.0	-19	0.00
Non-financial Corp.	0.1	-11	-0.01
Financial Sector	0.1	51	0.04
Rest of World	0.0	7	0.00
Total		**-0**	**-0.35**

Notes: URE numbers are in billions of 2015 USD.

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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$\mathcal{M}$	0.56
$\mathcal{E}_Y$	-0.03
$\mathcal{E}_P$	-0.81
$\mathcal{E}_R$	-0.35
$\mathcal{S}$	0.47

Monetary Policy: Measuring Redistribution

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$\mathcal{M}$	0.56
$\mathcal{E}_Y$	-0.03
$\mathcal{E}_P$	-0.81
$\mathcal{E}_R$	-0.35
$\mathcal{S}$	0.47

Compare $\mathcal{E}_R$ to σS:

σ 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

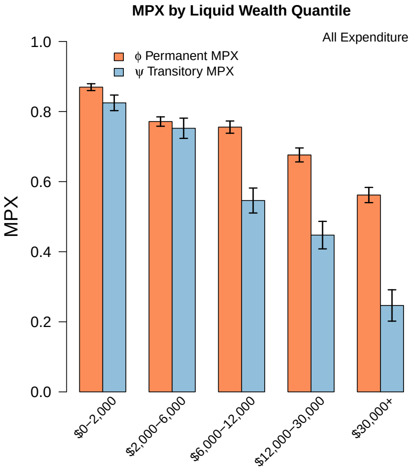
- Construct expenditure excluding car purchases and sales

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

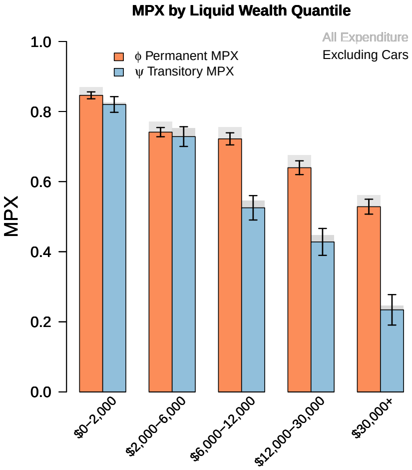
- Construct proxy for non durable consumption (Cars $\approx$ 42.1% durable expenditure)

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

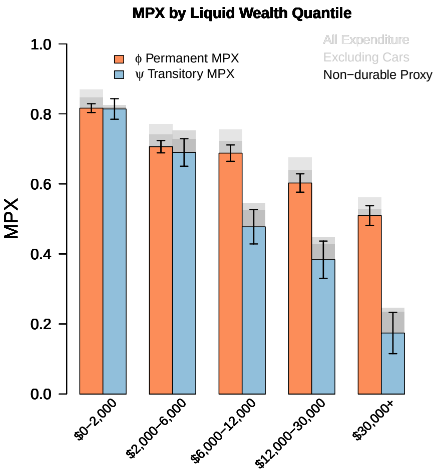
Durables


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

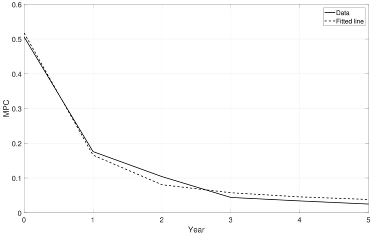
Conclusion

- 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!

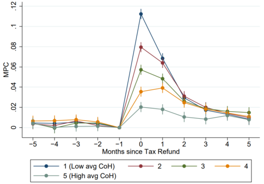
Evidence of Consumption Decay Within 2 Years

From Fagereng, Holm, and Natvik (2016)



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.

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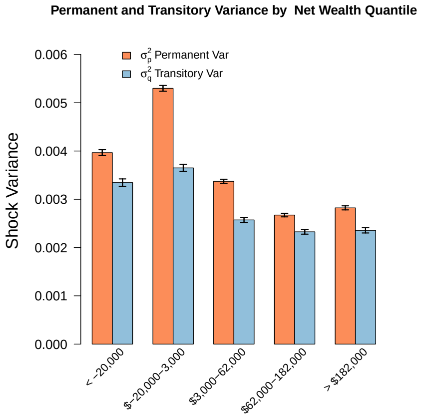
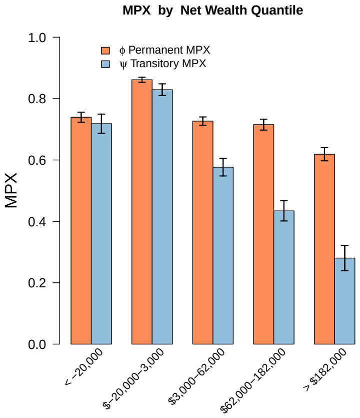
MPX by Net Wealth





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