Consumption Heterogeneity: Micro Drivers and Macro Implications

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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 0.24% through the interest rate exposure channel
   - This channel is likely far larger than the intertemporal substitution channel (1-4x 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		$\sim$	1	Estimation Sample: 1980–92
Gelman, Gorodnichenko, Kariv, Koustas, Shapiro, Silverman, and Tadelis (2016)		1.0	$\sim$	3	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)		$\sim 1/3$	1y	1	2008 Economic Stimulus
Shapiro and Slemrod (2009)		$\sim 1/3$	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

Rough consensus on (3 month) transitory MPC $\sim 30\%$

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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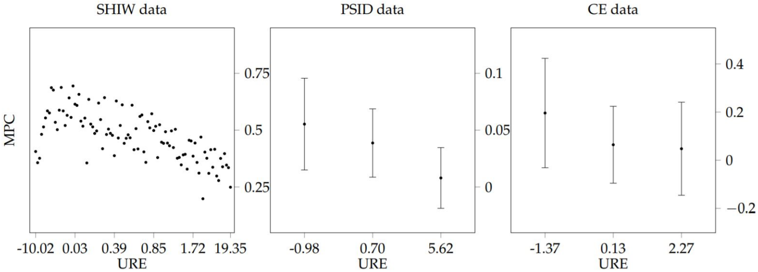
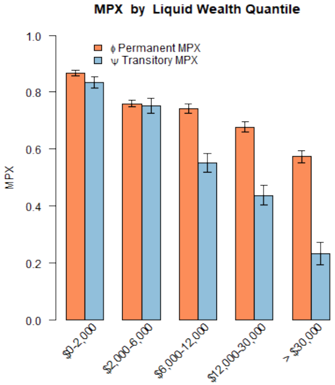


He doesn't have the right data or methods to be able to do this

Results Preview



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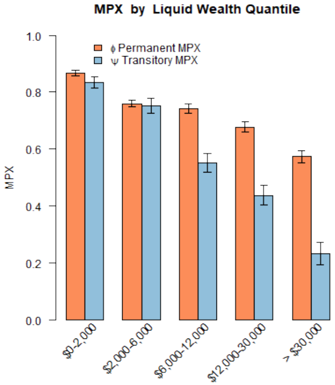


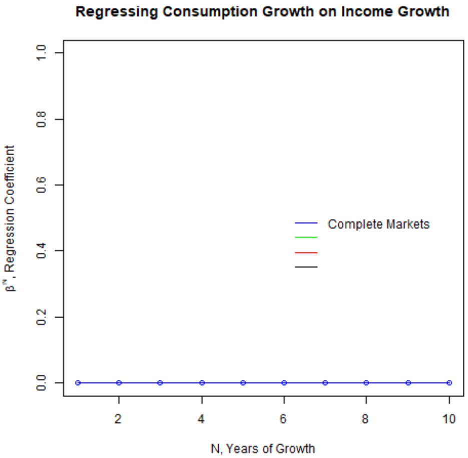
Monetary Policy Application

A 1% increase in R decreases consumption by 0.24% due to heterogeneity in interest rate exposure

This channel is 1 to 4x larger than intertemporal substitution

Methodology Intuition

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



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

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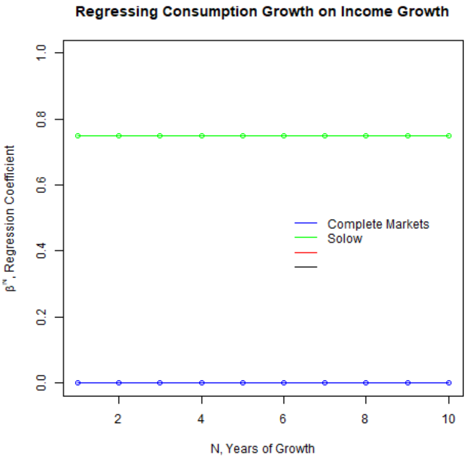

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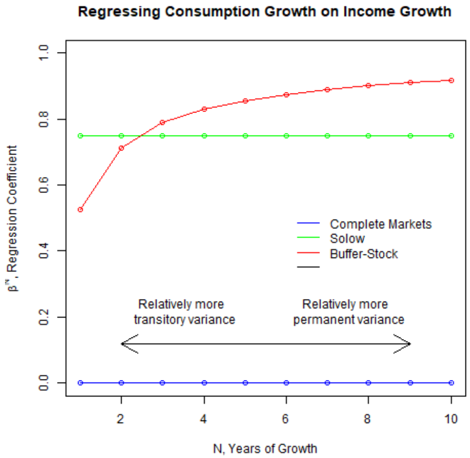

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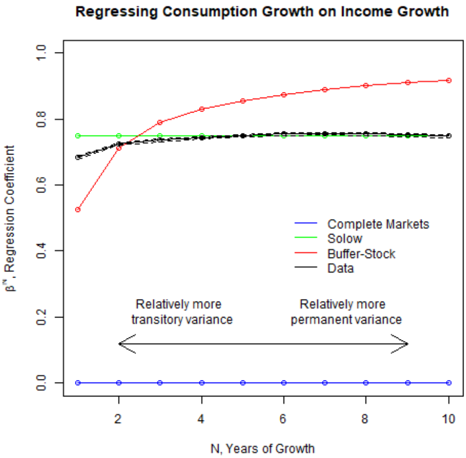

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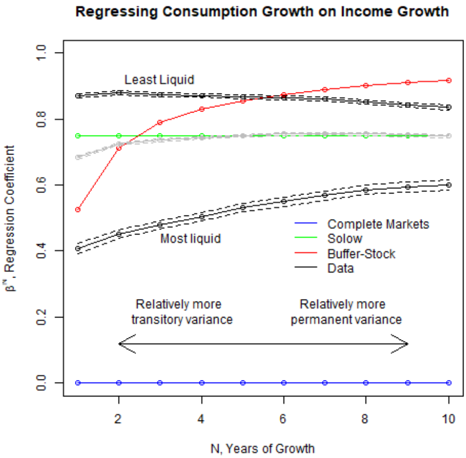

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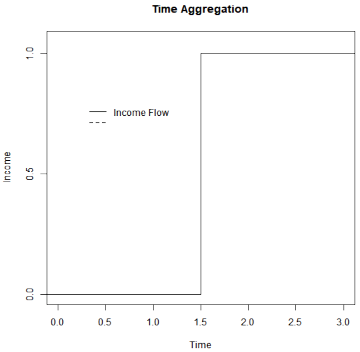
Aside: Why Not Blundell, Pistaferri and Preston 2008?

1) Time Aggregation Problem (Crawley 2018)



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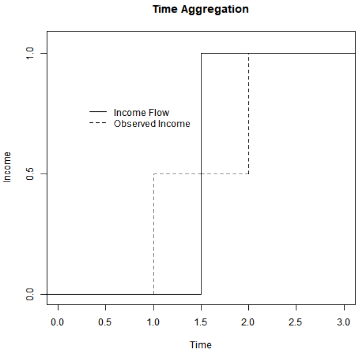

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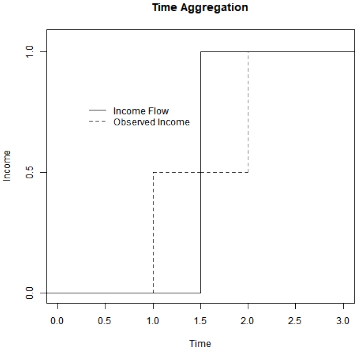

PIH Example:

- 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:

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

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:

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

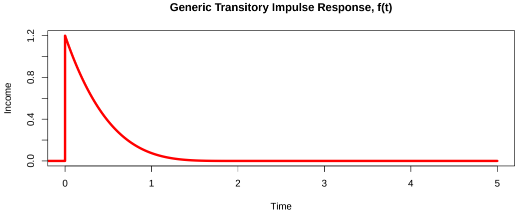
$$\implies \mathrm{Var}(\Delta^N \bar{y}_T) = (N - \frac{1}{3})\sigma_p + 2\sigma_q$$

Identification of the Income Process

Allow a generic persistence in transitory shock

- Following shock, transitory income flow decays as:

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



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

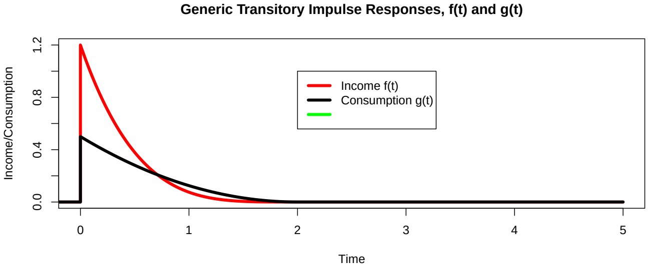
$$\implies \mathrm{Var}(\Delta^N \bar{y}_T) = (N - \frac{1}{3})\sigma_p^2 + 2\sigma_{\tilde{q}}^2 \text{ for } N \geq 3$$

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 $t > 2$



This is a key difference between what we assume and BPP

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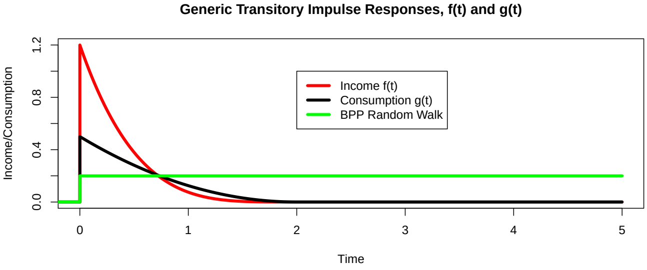

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Identification of the Consumption Response

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
Endogenous Income Shocks	Neutral	+ve
Persistent Consumption Response	+ve	-ve
Income Measurement Error	Neutral	+ve
Permanent Shocks are AR(1)	Neutral	+ve
Non-linear MPX	?	?

Data

- 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
- 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)
- Expenditure data imputed from income and wealth
  - Deposit and brokerage accounts all third party reported
  - Less accurate than income data

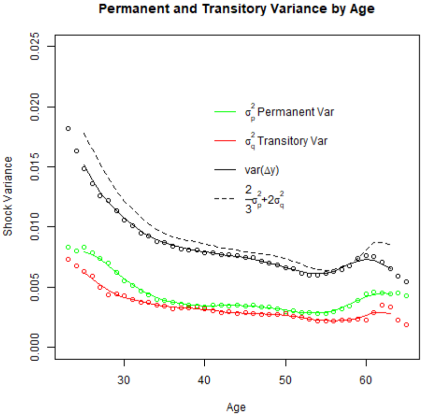
Imputing Expenditure

We use the identity

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

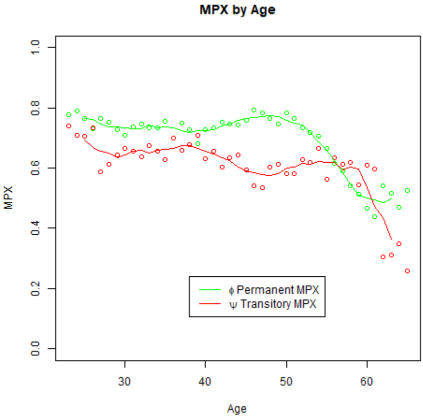
- Works well for households with simple financial lives
- Main issue: Capital gains and losses
  - Exclude households where methodology will not work well (eg Business owners)
  - Exclude housing wealth and years with housing transactions
  - Capital gains for stocks based on a diversified index
- Noisy, but perhaps better than surveys (Kuchler et al. 2018)
- Huge sample size advantage: sample covers 23.3 million observations over 2004-2015 (approx 1.9 million per year)

Shock Variance by Age



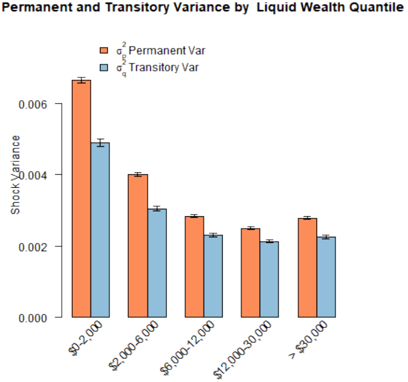
The assumption of constant variance works reasonably well from mid-30's to retirement

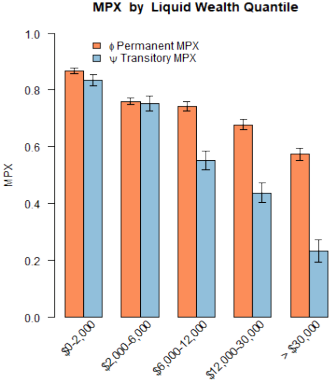
MPX by Age



- $\phi \approx 0.8$, declines towards retirement
- $\psi \approx 0.5$, constant

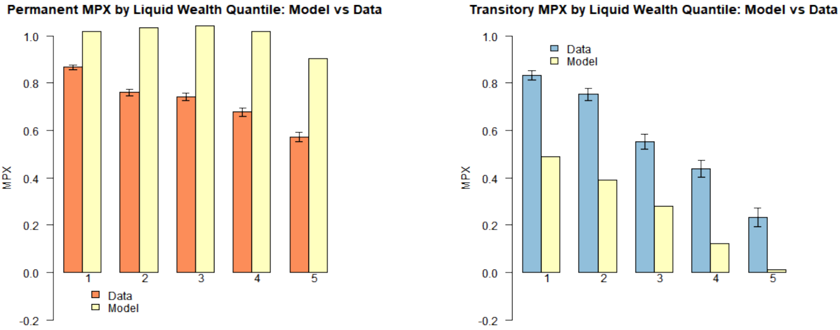
MPX by Liquid Wealth





Model vs Data

How does a standard model compare with the 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:

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

Monetary Policy: Measuring Redistribution

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

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

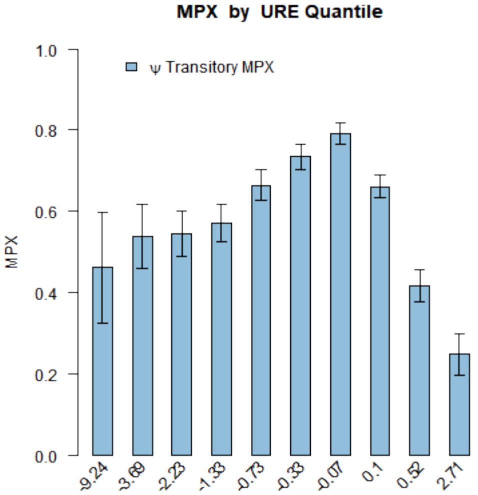
Define sufficient statistic:

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

$\implies$ 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

Group	Total URE (bn Kr)	MPC	$\mathcal{E}_R$ component
Our sample (head age 35-55)	-338	See Distribution	-0.42
Head $<$ 30	-38	0.5	-0.02
Head $>$ 55	-10	0.2	0.00
Pension Funds	143	0.1	0.02
Government	-120	0	0.00
Non-financial Corporate	-66	0.1	-0.01
Financial Sector	380	0.1	0.05
Rest of World	45	0	0.00
Total	**0**		**-0.40**

Monetary Policy: Measuring Redistribution

The Five Transmission Channels:

$$\frac{dC}{C} = \left(\mathcal{M} + \gamma \mathcal{E}_Y\right)\frac{dY}{Y} - \mathcal{E}_P \frac{dP}{P} + \left(\mathcal{E}_R - \sigma S\right)\frac{dR}{R}$$

We calculate

- $\mathcal{E}_R \approx -0.24$
- $S \approx 0.6$, 1-consumption-weighted MPC
- σ in the range of 0.1 to 0.5

$\implies$ the intertemporal substitution channel, $\sigma S \approx 0.06 - 0.3$, is potentially much smaller than the interest rate exposure channel

Durables

Our expenditure measure include ALL expenditure

- Household goods (electronics, kitchen equipment, etc)
- Cars
- Home improvements (roof repair, extensions)

Durables make up 10.05% of total expenditure in Denmark

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Durables make up 10.05% of total expenditure in Denmark

But theory suggests durable expenditures should not be proportional to permanent income changes

- This may bias our results

Durables

Suppose households *instantaneously* upgrade their durable goods and then pay a constant flow of depreciation:

$$dc_t = \phi p_t dt + \phi_d dp_t + \psi dq_t$$

- ϕ can be interpreted as the MPC to permanent shocks, where consumption includes non-durables and the service *flow* from durable goods
- ϕ_d is the proportion of the (annual) permanent shock that is spent instantaneously on durables
- ψ is the MPX out of transitory income, exactly as before

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- ϕ_d is the proportion of the (annual) permanent shock that is spent instantaneously on durables
- ψ is the MPX out of transitory income, exactly as before

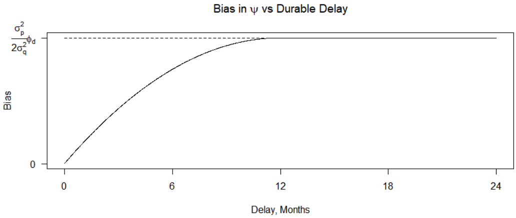
Then our estimates of ϕ and ψ are unbiased. We have no way of estimating ϕ_d

Durables

If households act with some delay things are different. Suppose they wait 1 year

$$dc_t = \phi p_t dt + \phi_d dp_{t-1} + \psi dq_t$$

- $\mathbb{E}(\hat{\phi}) = \phi$ Permanent MPC is unbiased
- $\mathbb{E}(\hat{\psi}) = \psi + \frac{\sigma_p^2}{2\sigma_q^2}\phi_d$ Transitory MPX is upward biased



Durables

We have data on value of household cars

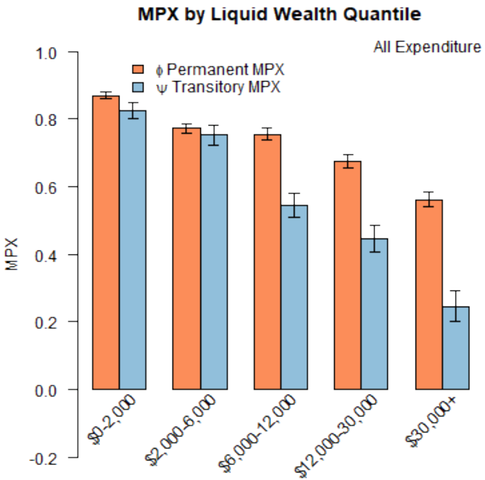
- Construct expenditure excluding car purchases and sales

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

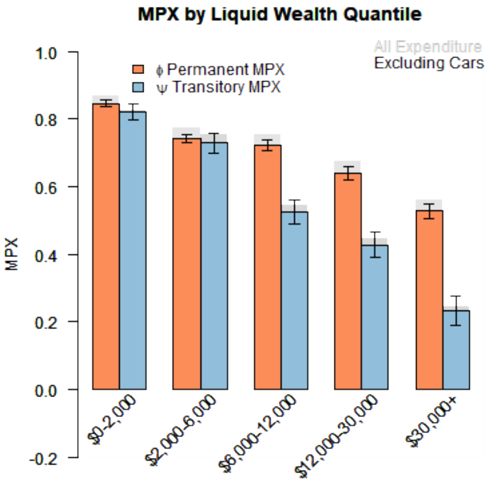
- Construct proxy for non durable consumption (Cars $\approx$ 42.1% durable expenditure)

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

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
$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
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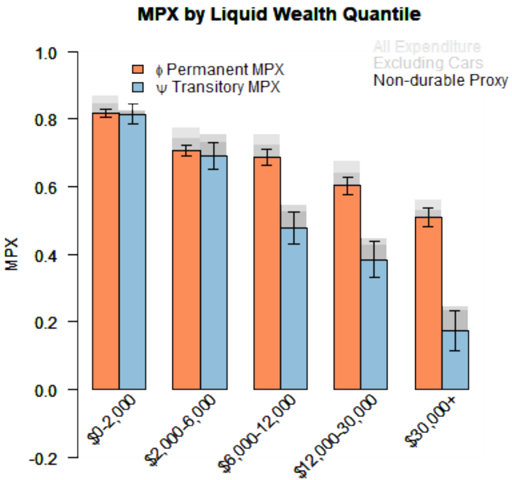
$2,000-6,000
$6,000-12,000
$12,000-30,000
$30,000+

Durables


MPX by Liquid Wealth Quantile
ϕ Permanent MPX
ψ Transitory MPX
All Expenditure
Excluding Cars
Non-durable Proxy
MPX
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
$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!