

# Consumption Heterogeneity: Micro Drivers and Macro Implications

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# Is Heterogeneity Important for Macroeconomics?

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

- e.g. Recent HANK models

Macroeconomic events can redistribute wealth between High and Low MPC households, affecting aggregate consumption

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

- e.g. Recent HANK models

Macroeconomic events can redistribute wealth between High and Low MPC households, affecting aggregate consumption

**Empirics:** Testing and quantifying these effects often boils down to measuring the distribution of MPC along some dimension of redistribution

Ability to do so is 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

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  - Large sample size reveals clear, systemic heterogeneity
  - Detailed household balance sheets allow us to infer implications for monetary policy transmission

We also test to what extent a buffer-stock model can fit the observed distribution of MPC with liquid wealth

# What does this paper find?

Wealthy Hand-to-Mouth



Poor Hand-to-Mouth



Wealthy



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$MPC \approx 0.5$

Poor Hand-to-Mouth



$MPC \approx 0.8$

Wealthy



$MPC \approx 0.25$

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\$\$

Interest Rate Hike

\$\$



# What does this paper find?



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** ( $\approx 0.5$  including durables)

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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

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

# How Are Consumption Responses Typically Measured?

Three methods:

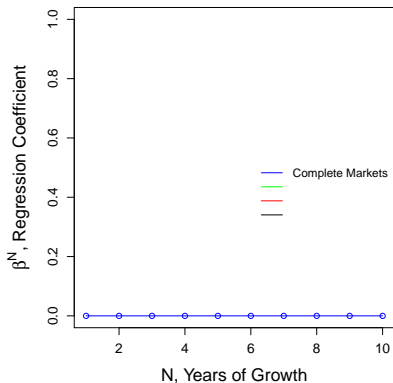
- 1 (Natural) Experiments - stimulus checks, lotteries etc
  - Few true experiments, especially for permanent shocks
  - Data limitations
- 2 Ask people
  - Unclear how to interpret
- 3 Make identifying restrictions on income and consumption dynamics
  - Empirical methods (until now!) have been flawed

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

Regressing Consumption Growth on Income Growth

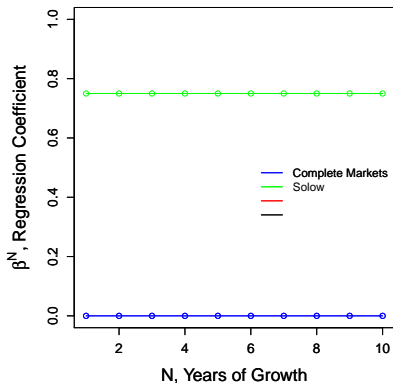


$$\Delta^N c_i = \alpha^N + \beta^N \Delta^N y_i + \varepsilon_i$$

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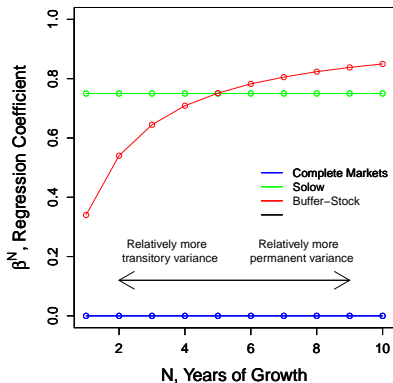


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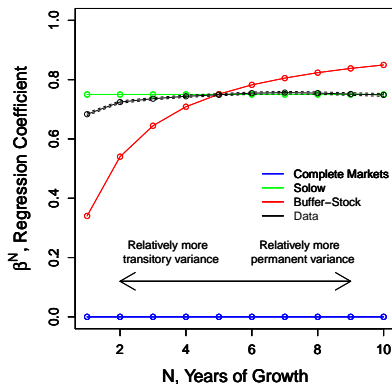


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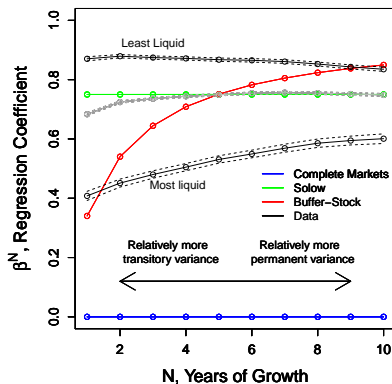
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# Aside: Why Not Blundell, Pistaferri and Preston 2008?

## Common Assumptions

Income  $y_t$  is made up of:

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

## Key to BPP Identification

$\Delta y_{t+1}$  is a *valid instrument* for transitory shocks in year  $t$

- Negatively correlated with transitory shocks in year  $t$
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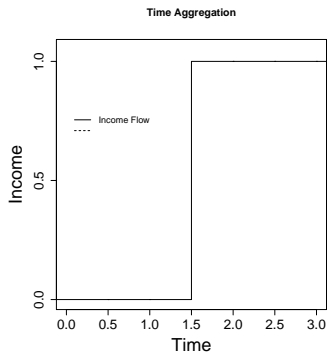
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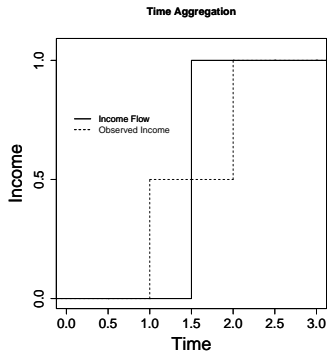
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Fails due to the **Time Aggregation Problem**

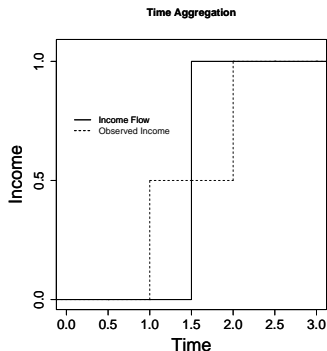
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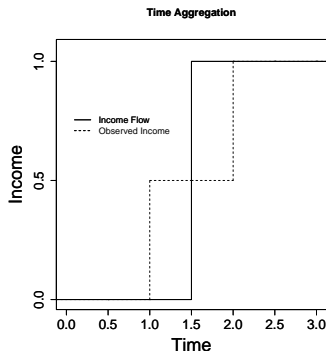


Observed permanent income growth is *positively* autocorrelated

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

⇒ Thinks negative transitory shocks result in consumption *increasing*

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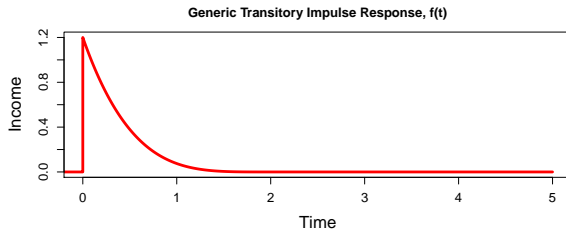
⇒ Thinks negative transitory shocks result in consumption *increasing*

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

# Identification Restrictions: Income

Income flow consists of:

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



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

↓
↓

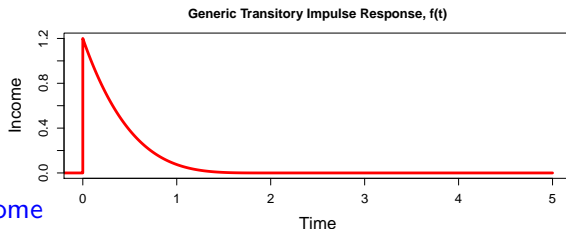
Permanent income flow      Transitory income flow



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Observed Income



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



Time Aggregation

# Identification Restrictions: Income

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$$\Delta^N \bar{y}_T = \bar{y}_T - \bar{y}_{T-N}$$

$$\begin{aligned}
 &= \int_{T-1}^T (p_t - p_{T-1}) dt - \int_{T-N-1}^{T-N} (p_t - p_{T-N}) dt \\
 &\quad + (p_{T-1} - p_{T-N}) \quad \xrightarrow{\text{Independent increments}} \quad \text{Var} = \left(\frac{1}{3} + \frac{1}{3} + N-1\right) \sigma_p^2 \\
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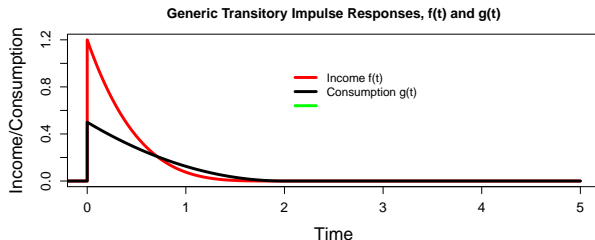
$$\implies \text{Var}(\Delta^N \bar{y}_T) = \left(N - \frac{1}{3}\right) \sigma_p^2 + 2\sigma_q^2 \text{ for } N \geq 3$$

# Identification Restrictions: Consumption

## Assumptions on Consumption

- Permanent: Consumption permanently moves by fraction  $\phi$  of the income shock
- Transitory: Persistence  $< 2$  years

Evidence

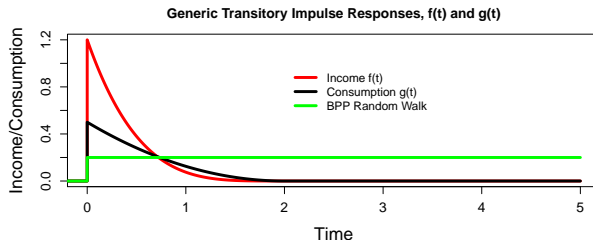


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Evidence



This is a key difference between what we assume and BPP

# Identification Restrictions: Consumption

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

**M**arginal **P**ropensity to e**X**pend (includes durables)



# 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  $N = 3, 4, 5$  (and  $T = 2007, \dots, 2015$ ) 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

# Data

What we need:

- Panel Data on Income and Expenditure
- Household Balance Sheet Data (detail on nominal assets)

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Income:

- Starting point: Register based micro data for all Danish households made available by Statistics Denmark
  - 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 impute expenditure from the budget constraint

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

- 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

# Data: When is Measurement Error a Problem?

Our method has the same measurement error issues as the regressions:

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

That is:

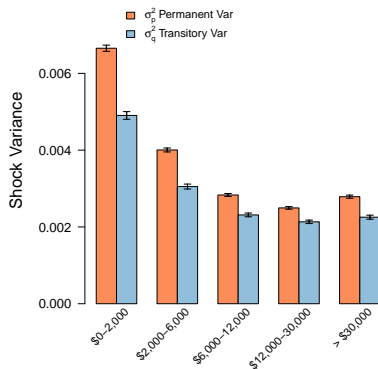
- 1 Measurement error in  $\Delta^N y_i$  leads to attenuation bias
- 2 Measurement error in  $\Delta^N c_i$  should be uncorrelated with  $\Delta^N y_i$

When might 2 fail?

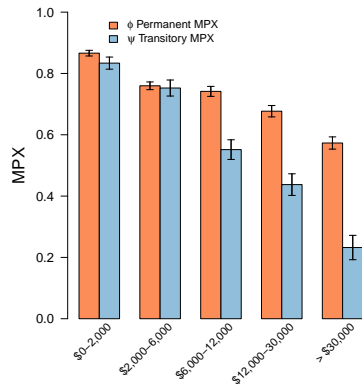
- When a proportion of assets are held off balance sheet
- When returns are correlated with *changes* in income (e.g. own stock in the company you work for)
- When insurance is provided by friends and family

# Results by Liquid Wealth

Permanent and Transitory Variance by Liquid Wealth Quantile

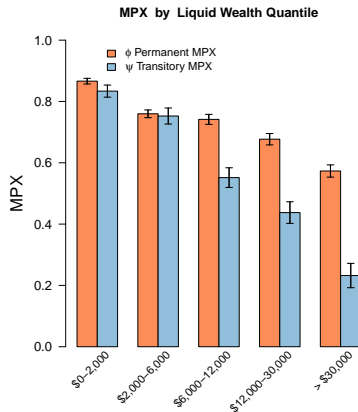
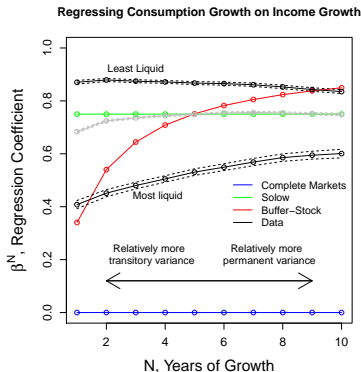


MPX by Liquid Wealth Quantile



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

How does Monetary Policy Effect Aggregate Consumption?

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→ Large in Spender-Saver, or TANK models

# Monetary Policy: Auclert's Decomposition

How does Monetary Policy Effect Aggregate Consumption?

- Intertemporal Substitution
  - Aggregate Income
  - Fisher (Inflationary debt relief)
  - Earnings Heterogeneity
  - Interest Rate Exposure
- } Representative Agent Channels
- } Redistribution Channels

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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: Auclert's Experiment

- Real interest rate increases 1% for 1 year
- Hold constant income and inflation

How does the subsequent redistribution impact aggregate consumption?

Dimension of Redistribution: Unhedged Interest Rate Exposure

# Interest Rate Exposure: Dimension of 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:

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

# Interest Rate Exposure: Aggregation

Aggregate to find size of channel:

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

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

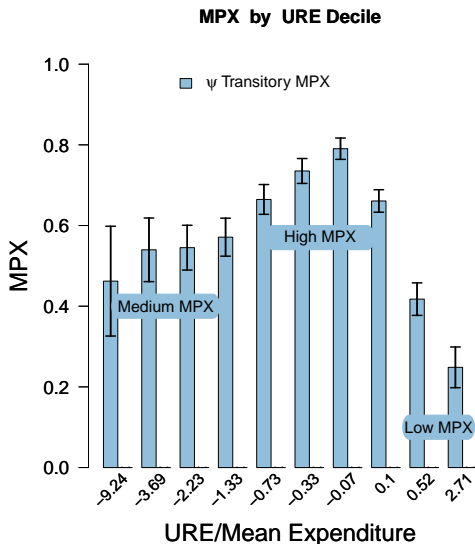
Define sufficient statistic:

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

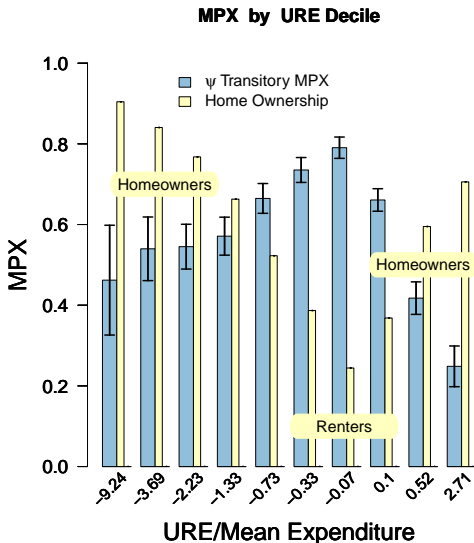
$\Rightarrow$  Need to know the distribution of  $MPC_i$  with  $URE_i$

We can do that!

# Interest Rate Exposure: MPX Distribution

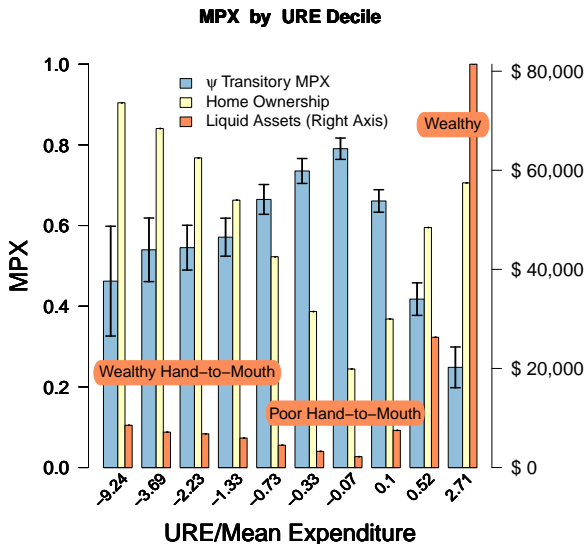


# Interest Rate Exposure: MPX Distribution





# Interest Rate Exposure: MPX Distribution



# Interest Rate Exposure: Out of Sample

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

- -57bn USD

	MPX	URE	$\mathcal{E}_R$ component
<b>Estimation Sample</b>	<b>See Distribution</b>	<b>-57</b>	<b>-0.40</b>
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
<b>Total</b>		<b>-0</b>	<b>-0.35</b>

Notes: URE numbers are in billions of 2015 USD.

# All Five Transmission Channels

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

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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

---

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

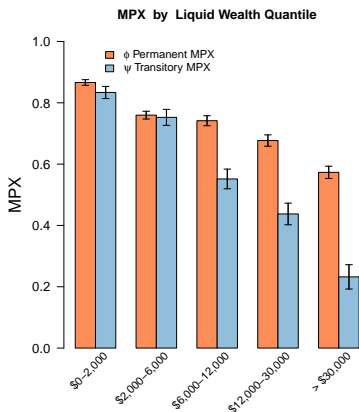
Compare  $\mathcal{E}_R$  to  $\sigma S$ :

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

$$\sigma S \approx 0.05 - 0.25$$

# Aim of Modeling Exercise

Can we calibrate a standard Buffer-Stock saving model to fit the distribution of MPC with liquid wealth?



Key features:

- High overall Transitory MPC
- Decreasing with liquid wealth

# Benchmark Model

Households maximize expected utility

$$\mathbb{E}_t \sum_{i=t}^{\infty} \beta^i u(\mathbf{c}_i)$$

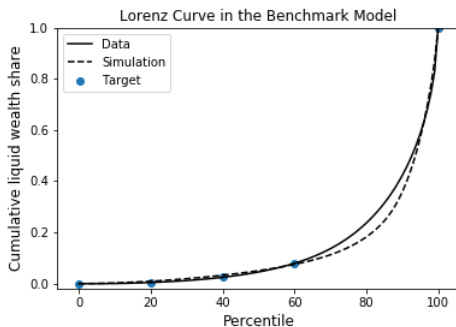
with:

- Permanent and Transitory shocks to income (calibrated to Danish data)
- Saving in one (liquid) asset
- No borrowing
- CRRA utility,  $\rho = 2$

# Benchmark Model: Fitting the Liquid Wealth Distribution

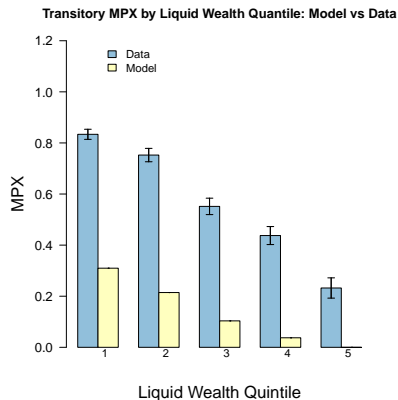
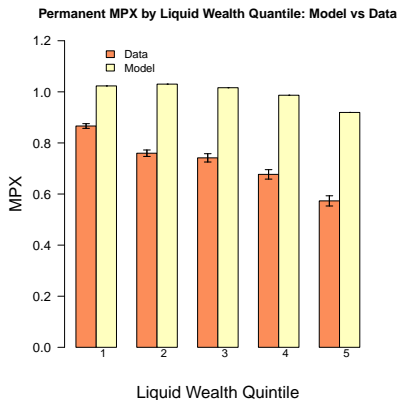
Ex-ante heterogeneity in the discount rate

$\beta^i \sim \text{Unif}[\beta_{\text{low}}, \beta_{\text{high}}]$  Chosen to fit level and distribution of liquid wealth (especially at the low end)



# Benchmark Model: Results

Simulate panel of data and estimate  $\phi$  and  $\psi$





# Taste Shock Model

First order problem: Transitory MPCs are too low

Need to lower  $\beta$ 's without reducing savings

Is income risk the only source of precautionary saving?

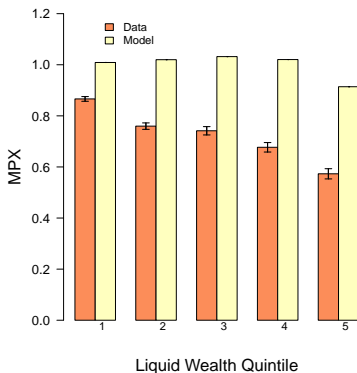
- In the data, expenditure FAR for volatile than income
- Surprise expenses can be large

Simple extension - add large taste shocks

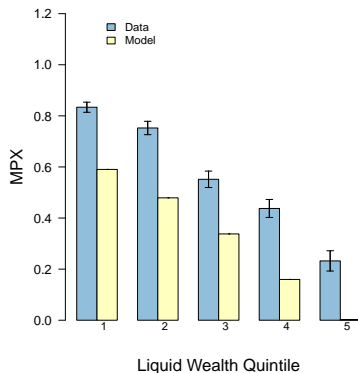
$$\mathbb{E}_t \sum_{i=t}^{\infty} \beta^i \chi_i u(\mathbf{c}_i)$$

# Taste Shock Model: Results

Permanent MPX by Liquid Wealth Quintile: Model vs Data



Transitory MPX by Liquid Wealth Quintile: Model vs Data



# 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!

# Durables

We have data on value of household cars

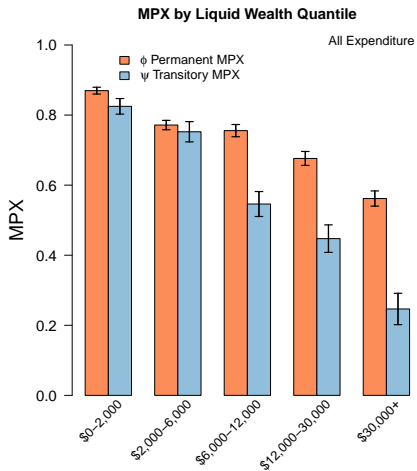
- Construct expenditure excluding car purchases and sales

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

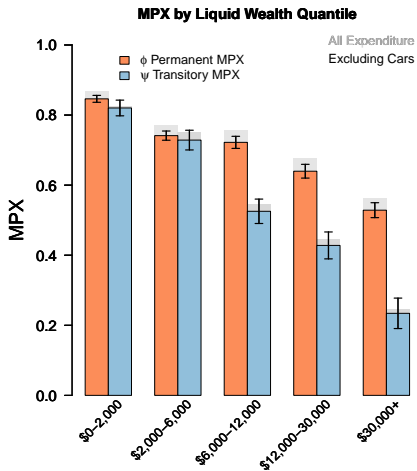
- Construct proxy for non durable consumption (Cars  $\approx 42.1\%$  durable expenditure)

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

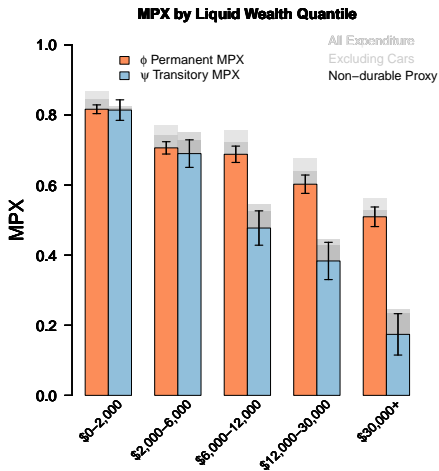
# Durables



# Durables

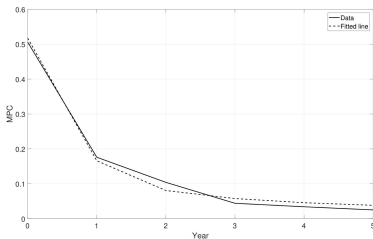


# Durables



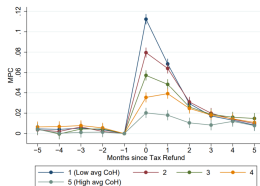
# Evidence of Consumption Decay Within 2 Years

From Fagereng, Holm,  
and Natvik (2016)

[Back](#)

From Gelman (2016)

Figure 10: Tax refund impulse response function

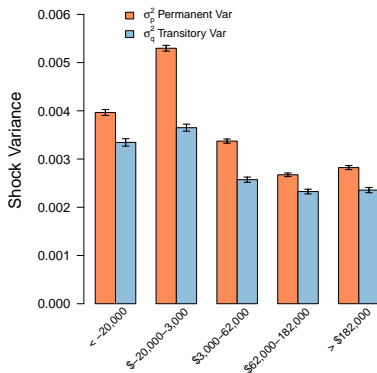


Notes: 1,445,560 observations from 48,050 individuals. The vertical bars on each coefficient represent 95% confidence intervals using heteroskedasticity robust errors clustered at the individual level.



# MPX by Net Wealth

Permanent and Transitory Variance by Net Wealth Quantile



MPX by Net Wealth Quantile

