Income Uncertainty and Consumption Dynamics

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Overview

1) How does household expenditure respond to income shocks?
   - To transitory shocks?
   - To permanent shocks?
2) How does this vary across the population?
   - Across (liquid) wealth
   - Across age
   - Across interest rate exposure

Empirical evidence on 1 weak, on 2 it is VERY weak

How Have Consumption Responses Been 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

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Our contribution

- Develop a robust method based on 3
- Apply it to Danish registry data

The Danish data allows us to build a detailed picture of the distribution over different household characteristics

Evidence on Magnitude of Consumption Response

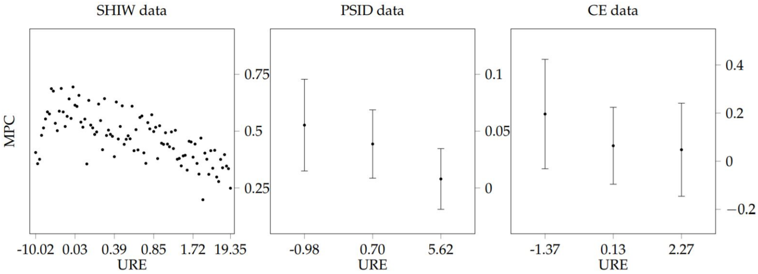
Authors	Consumption Measure: Nondurables	Durables	Total PCE	Horizon*	Event/Sample
Agarwal and Qian (2014)			0.90	10 Months	Growth Dividend Program Singapore 2011
Blundell, Pistaferri, and Preston (2008)‡	0.05				Estimation Sample: 1980–92
Browning and Collado (2001)			~ 0		Spanish ECPF Data, 1985–95
Coronado, Lupton, and Sheiner (2005)			0.36	1 Year	2003 Tax Cut
Hausman (2012)			0.6–0.75	1 Year	1936 Veterans' Bonus
Hsieh (2003)‡	~ 0		0.6–0.75		CEX, 1980–2001
Jappelli and Pistaferri (2014)	0.48				Italy, 2010
Johnson, Parker, and Souleles (2009)	~ 0.25			3 Months	2003 Child Tax Credit
Lusardi (1996)‡	0.2–0.5				Estimation Sample: 1980–87
Parker (1999)	0.2			3 Months	Estimation Sample: 1980–93
Parker, Souleles, Johnson, and McClelland (2013)	0.12–0.30		0.50–0.90	3 Months	2008 Economic Stimulus
Sahm, Shapiro, and Slemrod (2010)			$\sim 1/3$	1 Year	2008 Economic Stimulus
Shapiro and Slemrod (2009)			$\sim 1/3$	1 Year	2008 Economic Stimulus
Souleles (1999)	0.045–0.09	0.29–0.54	0.34–0.64	3 Months	Estimation Sample: 1980–91
Souleles (2002)	0.6–0.9			1 Year	The Reagan Tax Cuts of the Early 1980s

Table from Carroll et al 2018

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

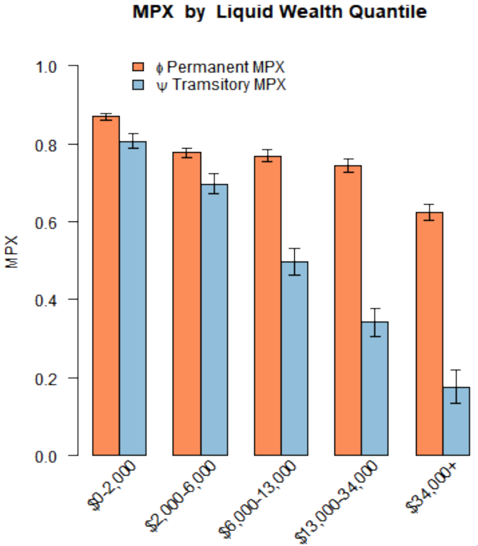
Evidence on Distribution of Consumption Response

Auclert (2018) uses the 3 different methods to identify the distribution of MPC by unhedged interest rate exposure



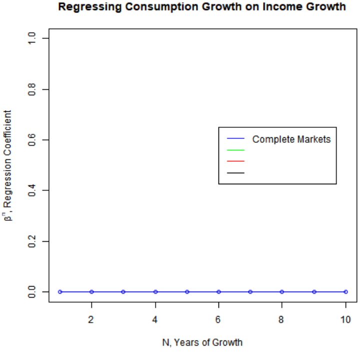
Recent evidence from Norwegian registry data using lottery winnings provides evidence of variation across liquid wealth

Results Preview



Methodology Intuition

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



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

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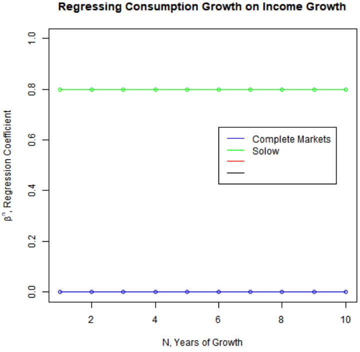

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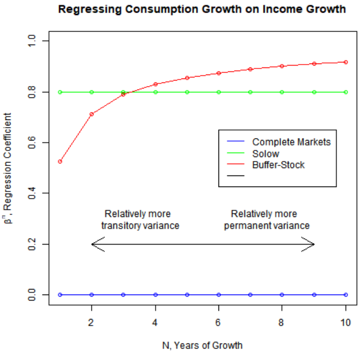

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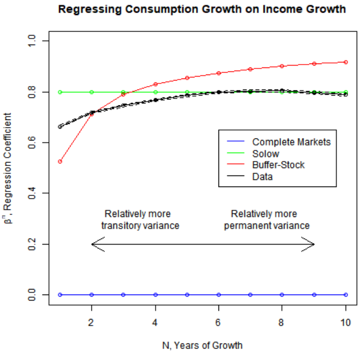

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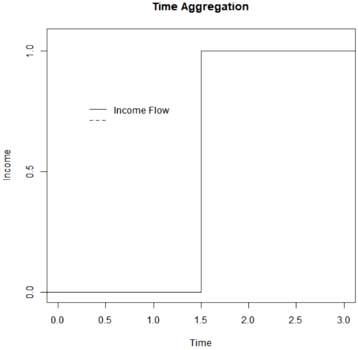
Aside: Why Not Blundell, Pistaferri and Preston 2008?

1) Time Aggregation Problem (Crawley 2018)



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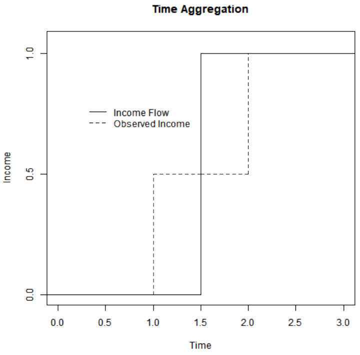

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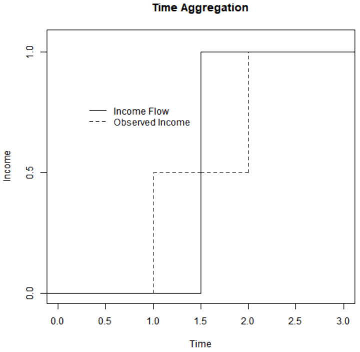

PIH Example:

- 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:

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

Identification of the Income Process

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

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

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

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

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:

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

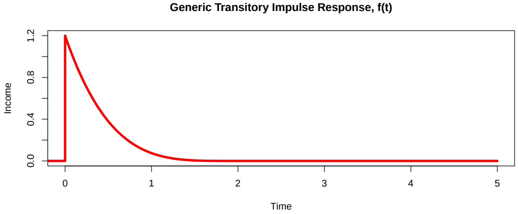
$$\implies \mathrm{Var}(\Delta^N \bar{y}_T) = (N - \frac{1}{3})\sigma_p + 2\sigma_q$$

Identification of the Income Process

Allow a generic persistence in transitory shock

- Following shock, transitory income flow decays as:

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



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

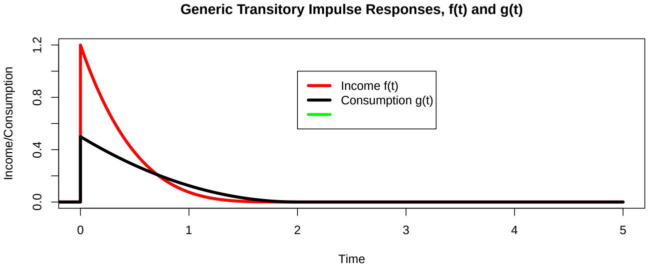
$$\implies \mathrm{Var}(\Delta^n \bar{y}_T) = (n - \frac{1}{3})\sigma_p^2 + 2\sigma_{\tilde{q}}^2 \text{ for } n \geq 3$$

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 $t > 2$



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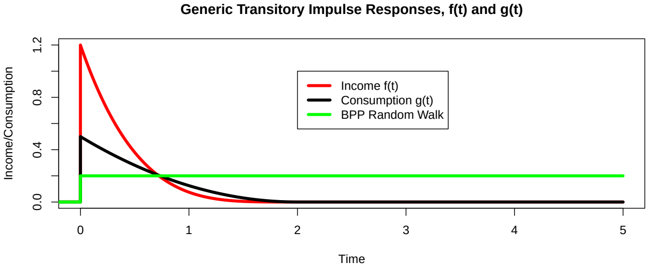

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Identification of the Consumption Response

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
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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

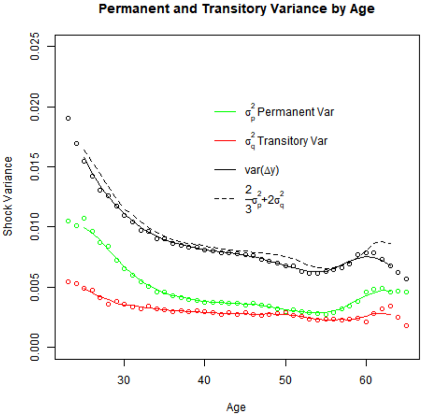
Imputing Expenditure

We use the identity

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

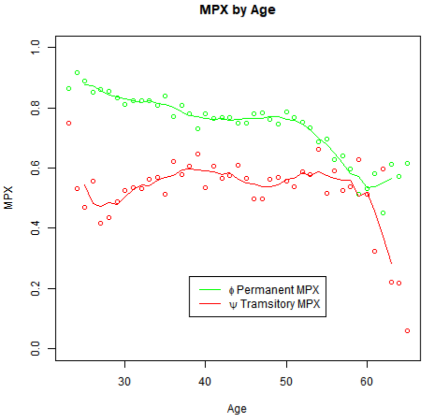
- Works well for households with simple financial lives
- Main issue: Capital gains and losses
  - Exclude households where methodology will not work well (eg Business owners)
  - Exclude housing wealth and years with housing transactions
  - Capital gains for stocks based on a diversified index
- Noisy, but perhaps better than surveys (Browning and Leth-Petersen, 2003; Eika et al., 2017; Fagereng and Halvorsen, 2017; Koijen et al., 2015; Kolsrod et al., 2017; Kreiner et al., 2015)
- Huge sample size advantage: sample covers 23.3 million observations over 2004-2015 (approx 1.9 million per year)

Shock Variance by Age



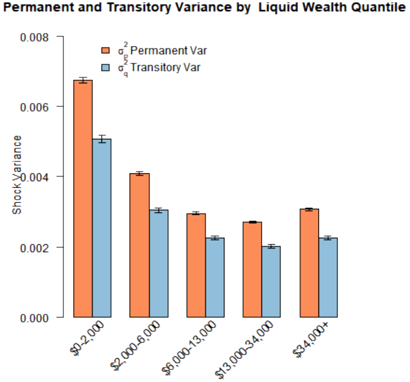
The assumption of constant variance works reasonably well from mid-30's to retirement

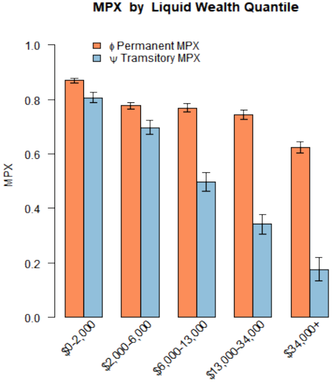
MPX by Age



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

MPX by Liquid Wealth





Durables

Our expenditure measure include ALL expenditure

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

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Durables make up about 10% of total expenditure

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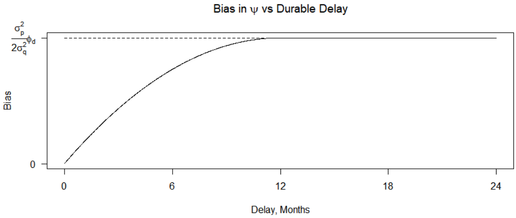
Then our estimates of ϕ and ψ are unbiased. We have no way of estimating ϕ_d

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

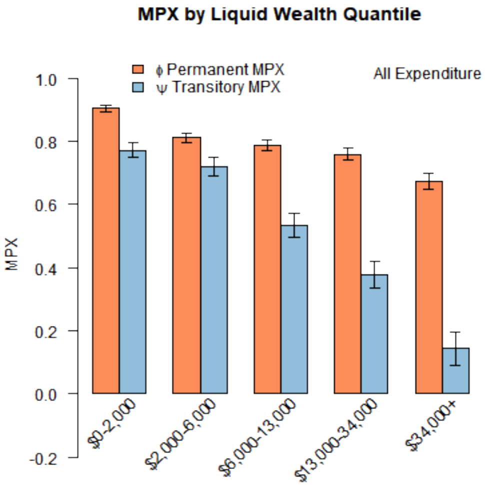
- Construct expenditure excluding car purchases and sales

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

- Construct proxy for non durable consumption (Cars $\approx \frac{1}{3}$ durable expenditure)

$$C_T^{\text{nondurable}} = C_T - 3\Delta\text{CarValue}$$

Durables


MPX by Liquid Wealth Quantile
ϕ Permanent MPX
ψ Transitory MPX
All Expenditure
MPX
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
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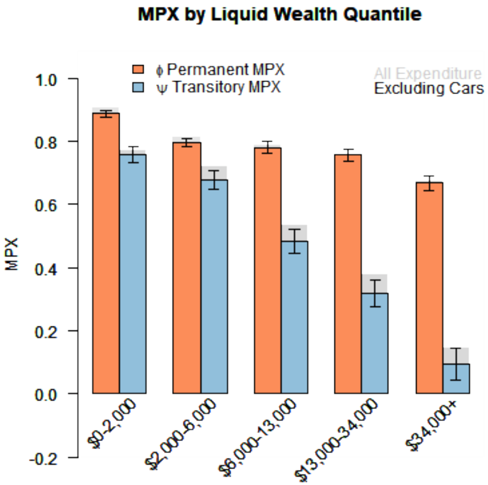
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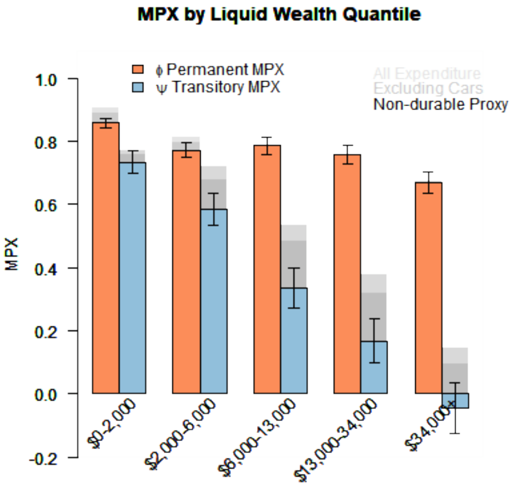
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Model

How does this compare with a standard buffer-stock saving model?

- Build model to match Danish income process
- Allow *heterogeneous discount factors* in order to match the distribution of *liquid* assets in Denmark
- See how the distribution of transitory MPX varies with liquid asset holdings

Model

Given market resources ($\mathbf{m}_t$), households in this model maximize expected utility:

$$\mathbb{E}_t \sum_{i=t}^{\infty} \beta^i (1-D)^i u(\mathbf{c}_i)$$

subject to the constraints:

$$\begin{aligned}
\mathbf{a}_t &= \mathbf{m}_t - \mathbf{c}_t \\
\mathbf{b}_t &= R\mathbf{a}_t \\
\mathbf{y}_t &= \theta_t \mathbf{p}_t \\
\mathbf{p}_t &= \Psi_t \mathbf{p}_{t-1} \\
\mathbf{m}_t &= \mathbf{b}_t + \mathbf{y}_t
\end{aligned}$$

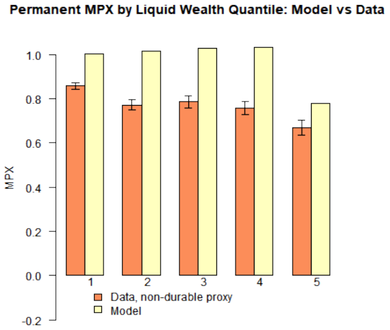
Model

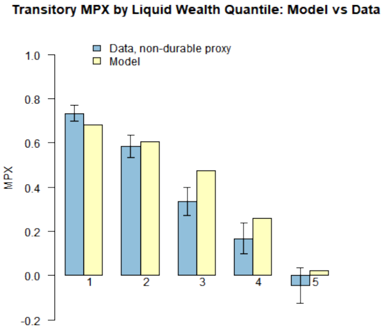
Calibration table

Fit to wealth distribution

Model

How does the model compare with the data?





Sources of Bias

	Direction of Bias	
	Perm MPX	Tran MPX
Income Measurement Error	Neutral	+ve
Permanent Shock Decays	Neutral	+ve
Persistent Consumption Response	+ve	-ve
Endogenous Income Shocks	Neutral	+ve
Non-linear MPX	?	?