Shopping Effort in Self-Insurance Economies

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Motivation

Research Question

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How are income fluctuations transmitted to consumption decisions in the presence of price dispersion?

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This project: *Aiyagari-Huggett go shopping*

The model combines two strands of macroeconomic literature:

1. Standard incomplete-markets models:

   (e.g., Aiyagari, QJE 1994; Huggett, JEDC 1993)

   - ✓ idiosyncratic shocks to household income,
   - ✓ self-insurance through one risk-free asset,
   - ✗ frictionless purchasing technology ($\rightarrow$ competitive pricing).

Applications of SIM

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Applications of SIM

2. Models of search for consumption:

   (e.g., Kaplan and Menzio, JPE 2016; Burdett and Judd, Ecta 1983)

   ✓ price dispersion,

   ✓ heterogeneity in shopping,

   ✗ no savings, risk-neutral agents,

   ✗ price search intensity is exogenous.

Evidence: Heterogeneity in Prices and Shopping

Heterogeneity in prices:

1. unemployed pay 3% less than employed.

   Kaplan and Menzio (JPE, 2016)

2. retired pay 5% less than employed.

   Aguiar and Hurst (AER, 2007).

What does "less" mean?

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What does "less" mean?

Heterogeneity in shopping:

1. unemployed spend 17-30% more time shopping:
   - Krueger and Mueller (JEEA, 2012);
   - Kaplan and Menzio (JPE, 2016).
2. retired spend 20% more time shopping than employed:
   - Aguiar and Hurst (AER, 2007).

Preview of Results

1. New theoretical model that incorporates search for consumption into standard incomplete-markets models:
    - search intensity – household decision,
    - price distribution – an equilibrium object.
2. Empirical Patterns:
    - Unemployed and retired people spend more time shopping.
    - Conditioned on employment, richer individuals spend more time shopping.
3. Quantitative exercise – shopping frictions
    - increase consumption smoothness,
    - amplify inequality, both in net wealth and consumption expenditures.

Empirical Patterns

Data

- American Time Use Survey - conducted by U.S. Census Bureau (supplement to CPS).
- Each wave is based on 24-hour time diaries where respondents report activities from the previous day in detailed time intervals.

Waves of ATUS

Shopping Time

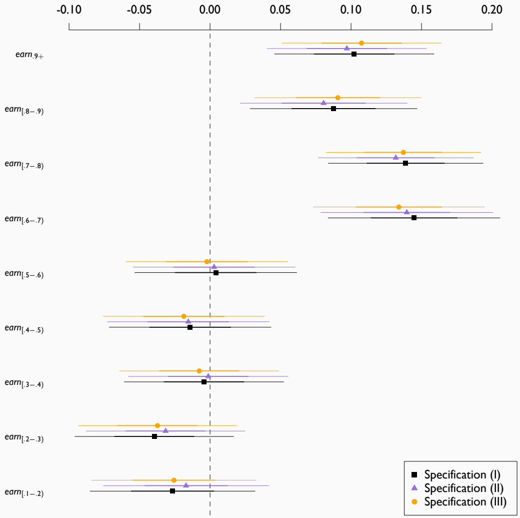
$$\log shopping_i = \alpha + \sum_j \beta_j earn_i^j + \delta_u unemployed_i + \delta_r retirement_i + \gamma X_i + \varepsilon_i,$$

- $shopping_i$ - cummulative daily time (in minutes) spent shopping and travels related to consumer purchases Examples of activities,
- $earn_i^j$ - dummy for j-th decile of weekly labor income Values,
- $unemployed_i$ - dummy accounting for the employment status,
- $retirement_i$ - dummy accounting for the retirement status,
- X_i - control variables (age, race, gender, year dummies, and ‘shopping needs’).

Results

	Dependent variable		
	log(*shopping*)		
	(I)	(II)	(III)
Earnings dummies	■	▲	●
Retired	0.147***	0.161***	0.165***
Unemployed	0.302***	0.314***	0.321***
Male	−0.484***	−0.466***	−0.470***
Age	0.007**	−0.002	−0.003
Age^2	−0.0001*	0.00004	0.00005
Black	−0.151***	−0.128***	−0.127***
Single		−0.125***	−0.124***
Unemployed Partner		−0.170***	−0.170***
Child		0.041***	0.041***
Constant	1.979***	2.182***	2.217***
Shopping needs	*No*	*Yes*	*Yes*
Year and day dummies	*No*	*No*	*Yes*
N	132,131	132,131	132,131

Results (coefficients for earnings deciles)



Year and day dummies

Shopping Behavior *(Summary)*

In the ATUS 2003-2015 we observe the following patterns:

- ☞ the unemployed people spent on average 37.85% more time shopping than the bottom earnings decile;
- ☞ the retired people spent on average 17.94% more time shopping than the bottom earnings decile;
- ☞ people from top earning deciles spent on average 11.63% more time shopping than the bottom earnings decile.

Empirical Time-Use and Price-Search Literature

Type	Shopping effort	Effective prices
$\frac{\text{Unemployed}}{\text{Employed}}$	> 1 Kaplan-Menzio (JPE, 2016), this paper	3% less Kaplan-Menzio (JPE, 2016)
$\frac{\text{Retired}}{\text{Employed}}$	> 1 Aguiar-Hurst (AER, 2007), this paper	5% less Aguiar-Hurst (AER, 2007)
$\left(\frac{\text{High-income}}{\text{Low-income}} \middle\| Employed\right)$	> 1 Petrosky-Nadeau et al. (EL, 2016), this paper	2% more Aguiar-Hurst (AER, 2007)

Theoretical Framework

Building Blocks of the Economy

1. Standard incomplete-markets economy with life cycle.

   (Huggett, JME 1996; Ríos-Rull, REStud 1996; Imrohoroglu et al., ET 1995)

2. Two classes of agents:
   - fixed measure of households,
   - continuum of retailers.

3. Households:
   - face idiosyncratic productivity shocks;
   - make shopping decisions:
     - ✓ search for bargain prices,
     - ✓ number of purchases;
   - make consumption-savings decisions using risk free bond.

Consumer's Utility

$$\mathbb{E}_0 \sum_{t=1}^{T} \beta^{t-1} \left\{ u(c_t) - v(s_t, m_t) \right\}$$

where:

- m_t – number of purchases,
- $s_t \in [0, 1]$ – price search intensity,
- $\frac{\partial v(s_t, m_t)}{\partial s_t} > 0$, $\frac{\partial v(s_t, m_t)}{\partial m_t} \geq 0$,
- $\frac{\partial^2 v(s_t, m_t)}{\partial s_t \partial m_t} \geq 0$.

Consumption Basket and Its Cost

1. Consumption:

$$c = m \cdot \underbrace{\theta^{1-\alpha}}_{\substack{\text{matching} \\ \text{probability}}}.$$

Matching technology

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2. The cost of consumption bundle:

$$p \cdot c = \int_0^{m\theta^{1-\alpha}} p(i)di,$$

where $p(i) \sim_{iid} F(p; s)$.

Price Search Intensity

Let $G(p)$ be the cdf of prices quoted by retailers.

$$F(p;s) = (1-s)\underbrace{G(p)}_{\substack{\text{Captive} \\ \text{purchase}}} + s\underbrace{\left(1 - [1 - G(p)]^2\right)}_{\substack{\text{Non-captive} \\ \text{purchase}}}.$$

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Using the weak law of large numbers proposed by Uhlig (ET, 1996):

$$\int_0^{m\theta^{1-\alpha}} p(i)di \overset{\text{a.s.}}{\to} \underbrace{m\theta^{1-\alpha}}_{c}\mathbb{E}(p|s).$$

Price Search Intensity (cont'd)

Proposition

The effective price is linear in the search intensity, s:

$$\mathbb{E}(p|s_t) = p^0 - s_t MPB,$$

where:

i. $p^0 := \int_{\underline{p}}^{\zeta} x dG(x)$ is the price for the fully captive consumer;

ii. $MPB := \mathbb{E}\max\{p', p''\} - p^0$ is the marginal (price) benefit of increasing the search intensity s_t.

Income process of HHs

1. Active in the labor market ($t \in \overline{1, T_{work}}$):

$$\log y_t = \kappa_t + \eta_t + \varepsilon_t,$$
$$\eta_t = \eta_{t-1} + \nu_t.$$

   where κ_t - deterministic lifecycle profile, $\varepsilon_t \sim_{\text{iid}} (0, \sigma_\varepsilon^2)$ - transitory income shock, $\nu_t \sim_{\text{iid}} (0, \sigma_\nu^2)$ - permanent income shock.

2. Retirement ($t \in \overline{T_{work} + 1, T}$):

$$\log y_t = log(repl) \cdot \{\kappa_{T_{work}} + \eta_{T_{work}} + \varepsilon_{T_{work}}\}.$$

Household's Problem

$$\mathcal{V}_t(a, \varepsilon, \eta) = \max_{c,m,s,p,a'} u(c) - v(s, m) + \beta \mathbb{E}_{\eta'|\eta} \mathcal{V}_{t+1}(a', \varepsilon', \eta')$$

s.t.

$$\begin{aligned}
(1 + \tau_{cons}) p c + a' &\leq (1 + r)a + wy, \\
c &= m\theta^{1-\alpha}, \\
p &= p^0 - sMPB, \\
a' &\geq \underline{B}, \\
s &\in [0, 1], \\
\log y &= \begin{cases} \kappa_t + \eta + \varepsilon, & \text{for } t \leq T_{work}, \\ log(repl) \cdot \{\kappa_{T_{work}} + \eta_{T_{work}} + \varepsilon_{T_{work}}\}, & \text{for } t > T_{work}, \end{cases} \\
\eta' &= \eta + \nu'.
\end{aligned}$$

Shopping Aggregation

- Aggregate measure of captive purchases:

$$\Psi_{(-)} := \sum_{t=1}^{T} \int m_t(x)\,(1 - s_t(x))\,d\mu_t(x),$$

- Aggregate measure of non-captive visits:

$$\Psi_{(+)} := \sum_{t=1}^{T} \int m_t(x) 2 s_t(x) d\mu_t(x),$$

  where $x = (a, \varepsilon, \eta)$.

- Aggregate measure of visits:

$$D = \Psi_{(-)} + \Psi_{(+)}.$$

- Probabilities:
  - ✓ $\frac{\Psi_{(-)}}{D}$ – probability that a visiting buyer is captive,
  - ✓ $\frac{\Psi_{(+)}}{D}$ – probability that a visiting buyer has an alternative from another retailer.

Retailer's Revenues

$$\max_p S(p) = \max_p \theta^{-\alpha} \left(\underbrace{\frac{\Psi_{(-)}}{D}(p-1)}_{\substack{\text{Surplus}\\\text{Appropriation}}} + \underbrace{\frac{\Psi_{(+)}}{D} \overbrace{(1-G(p))}^{\text{Competing offer}} (p-1)}_{\substack{\text{Business}\\\text{Stealing}}} \right)$$

Equilibrium definition

Equilibrium Price Dispersion

Proposition

Given households' decisions the equilibrium price dispersion can be expressed in a closed form:

$$G(p) = \begin{cases} 0, & \text{for } p < \underline{p}, \\ \frac{D}{\Psi_{(+)}} - \frac{\Psi_{(-)}}{\Psi_{(+)}} \cdot \frac{\zeta - 1}{p - 1}, & \text{for } p \in [\underline{p}, \zeta], \\ 1, & \text{for } p > \zeta, \end{cases}$$

where:

$$\underline{p} = \frac{\Psi_{(+)}}{D} + \frac{\Psi_{(-)}}{D}\zeta.$$

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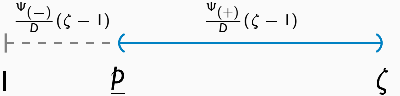
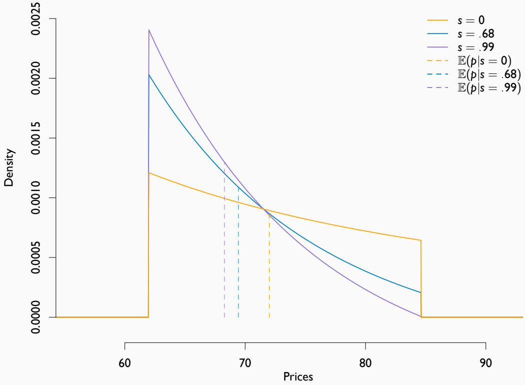
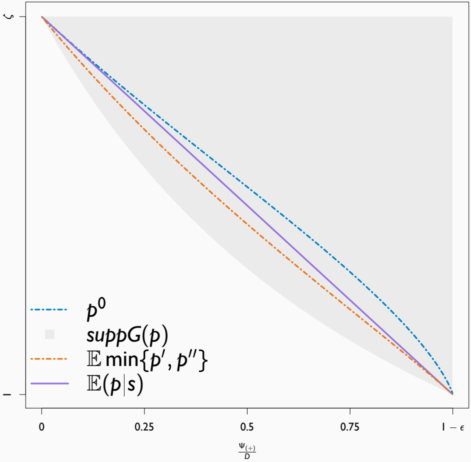


Individual price lotteries



Exemplary CDFs

Price dispersion and the aggregate search intensity



Quantitative Results

Aggregate Consumption

Two economies in comparison:

1. *SIM economy* – standard incomplete markets economy with competitive prices,
2. *Shopping economy* – incomplete markets economy with frictions in the purchasing technology.

Measures used for comparison:

1. *"Dynamic"* – pass-through of income shocks into consumption expenditure.
2. *Static* – cross-sections of net wealth and consumption expenditures.

External Choices

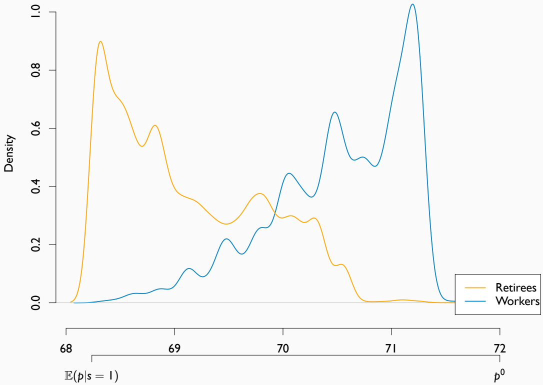
Parameter	Interpretation	Value
T_{work}	Age of retirement	30
T	Length of life	65
σ	Risk aversion	2.0
$repl$	Retirement replacement rate	.45
σ_ε^2	Variance of the transitory shock	.05
σ_η^2	Variance of the permanent shock	.01
r	Interest rate	.04
τ_{cons}	Consumption tax	.08454
$\underline{B}$	Borrowing constraint	0

Targeted moments in the calibration

Target	Data Value	Source	Model Value
Shopping effort:			
Shopping time of retired relative to the referential group	1.245	This paper	1.251
Shopping time of the top earn. tercile relative to the referential group	1.11	This paper	1.112
Age trend for shopping time	0	This paper	.010
Price dispersion:			
$95^{th}\text{decile} / 5^{th}\text{decile}$ of paid prices	1.7	Kaplan-Menzio (JPE, 2016)	1.369
Price differential between high earners and low earners	.02	Aguiar-Hurst (AER, 2007)	.011
Price differential between the retired and employed	-.039	Aguiar-Hurst (AER, 2007)	-.051
Aggregate state:			
Aggregate wealth-income ratio	2.5	Kaplan-Violante (AEJ:Macro,2010)	2.498

Parameters

Price Dispersion at Play



Consumption expenditures: working-age households vs retirees

Economy	$\frac{\mathbb{E}(pc \mid retired)}{\mathbb{E}(pc \mid working)}$
USA (PSID, 2006)	.701
Shopping	.742
SIM	.809

Pass-through

$$\Delta(p_{it}c_{it}) = \alpha + MPC^{\varepsilon}\varepsilon_{it} + MPC^{\eta}\eta_{it} + \xi_{it}$$

where:

- η_{it} - permanent shock,
- ε_{it} - transitory shock,

Examples

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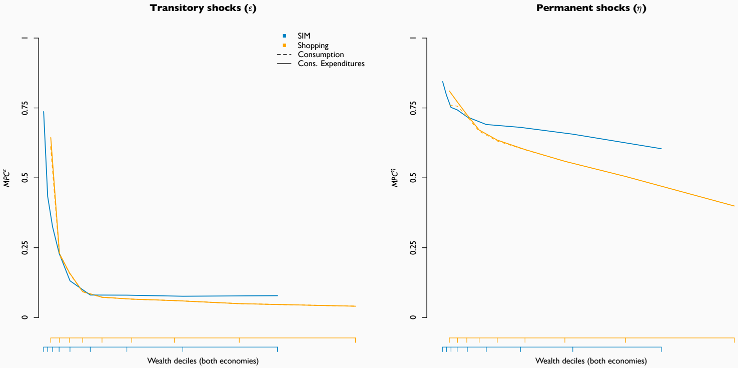
Examples

Economy	$\widehat{MPC^{\eta}}$	$\widehat{MPC^{\varepsilon}}$
USA	.64	.05
Shopping	.602	.152
SIM	.8	.280

where $\widehat{MPC^{\eta}}$, $\widehat{MPC^{\varepsilon}}$ - BPP-type pass-through coefficients. BPP

Distribution of MPCs



Wealth distribution

		Quintile				
Economy	Gini	First	Second	Third	Fourth	Fifth
USA (PSID 2006)	.771	-.015	.005	.042	.142	.826
Shopping	.667	.011	.031	.065	.198	.696
SIM	.569	.014	.052	.128	.258	.549

Consumption (expenditure) distribution

		Quintile				
Economy	Gini	First	Second	Third	Fourth	Fifth
USA (PSID 2006)	.353	.051	.113	.165	.224	.440
Shopping	.402	.053	.112	.163	.208	.457
SIM	.234	.100	.150	.190	.235	.330

Conclusions

- New empirical evidence on shopping.
- New theoretical framework – shopping frictions in an incomplete-markets economy:
  - shopping effort as choice variables in the household problem,
  - price dispersion – result of a game between households and retailers.
- The calibrated version of the shopping model generates smoother consumption responses and amplifies inequality.

Thanks!

SIM model - workhorse of quantitative macro

Examples of applications:

- Optimal capital income taxation.

  Aiyagari (JPE, 1995)
- Benefits of insuring unemployed people.

  Hansen and Imrohoroğlu (JPE, 1992)
- Effects of fiscal stimulus payments in a recession.

  Kaplan and Violante (Ecta, 2014)
- Welfare cost of inflation under imperfect insurance.

  Imrohoroğlu (JEDC, 1992)
- Redistributional role of monetary policy.

  Auclert (2016), Kaplan, Moll, and Violante (2016)
- Effects of a credit crunch on consumer spending.

  Guerrieri and Lorenzoni (2015)

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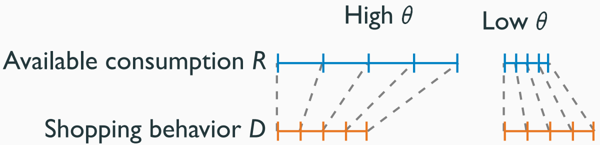
Matching Technology

1. CRS matching function: $M(D, R) = D^{\alpha} R^{1-\alpha}$, where:
   - R - measure of retailers;
   - D - measure of aggregate shopping effort.
2. Market tightness: $\theta := \frac{R}{D}$.
3. Efficiency of being matched:
   - for unit of m: $Pr(m \text{ is matched}) = \frac{M(D,R)}{D} = \theta^{1-\alpha}$;
   - for retailers: $Pr(\mathit{firm} \text{ is matched}) = \frac{M(D,R)}{R} = \theta^{-\alpha}$.



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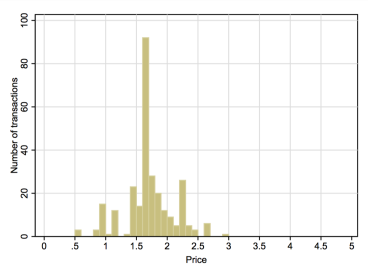
Price dispersion (retailers' side)

Figure 1: Distribution of prices for a 36-oz bottle of Heinz ketchup in Minneapolis in 2007:Q1



Source: Kaplan and Menzio (IER, 2015) More statistics

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Price dispersion (retailers' side)

1. The average coefficient of variation of prices ranges between 19 and 36 %.

   Kaplan and Menzio (IER, 2015)

2. The average 90-to-10 percentile ratio ranges between 1.7 and 2.6.

   Kaplan and Menzio (IER, 2015)

3. Only 15% of the variance of prices is due to the variance in the store component.

   Kaplan and Menzio (IER, 2015);

   Kaplan et al. (2016)

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Waves of ATUS

Wave	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
No of households	20720	13973	13038	12943	12248	12723	13133	13260	12479	12443	11385	11592	10905

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Examples of shopping activities

Examples of *included* activities:

- grocery shopping,
- shopping at warehouse stores (e.g., WalMart or Costco) and malls,
- doing banking,
- getting haircut,
- reading product reviews,
- researching prices/availability,
- travelling to stores,
- online shopping.

Examples of *excluded* activities:

- restaurant meals,
- medical care.

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Deciles of weekly labor income

10%	20%	30%	40%	50%	60%	70%	80%	90%
250.00	360.00	461.53	570.00	675.00	807.69	961.53	1192.30	1538.46

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Calibrated Parameters

Parameter	Value	Description
ϕ	0.104	$\frac{c^{1-\sigma}}{1-\sigma} - (\frac{1+s}{1-s}m)^{1+\phi}$
$\theta^{1-\alpha}$	0.113	matching efficiency
w	14.04	wage
ζ	84.60547	upperbound of $G(p)$
χ^{ret}	0.5882813	$\frac{c^{1-\sigma}}{1-\sigma} - \chi^{ret}(\frac{1+s}{1-s}m)^{1+\phi}$
β	.951	discount factor

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Rational Stationary Equilibrium

Definition

A stationary equilibrium is a sequence of consumption and shopping plans $\{c_t(x), m_t(x), s_t(x), f_t(x), p_t(x), a'_t(x)\}_{t=1}^{T}$, and the distribution of prices $G(p)$, distribution of households $\mu_t(x)$, and interest rate r such that:

1. $c_t(x), m_t(x), s_t(x)$ are optimal given r, w, $G(p)$, $\underline{B}$, and θ;
2. individual and aggregate behavior are consistent:
   $D = \sum_{t=1}^{T} \int \theta^{1-\alpha}(1+s_t)m_t d\mu_t(x)$;
3. retailers post prices p to maximize the sales revenues taking as given households' behavior;
4. the private savings sum up to an exogenous aggregate level $\overline{K} : \sum_{t=1}^{T} \int a(x) d\mu_t(x) = \overline{K}$;
5. $\mu_t(x)$ is consistent with the consumption and shopping policies.

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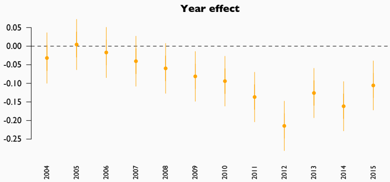
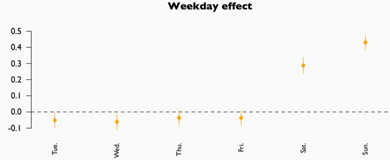
Estimates for year and day dummies





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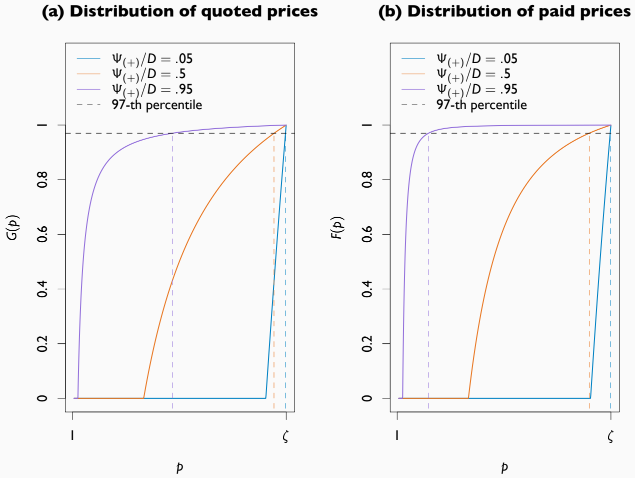
Exemplary CDFs



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BPP approach

$$\Delta(p_{it}c_{it}) = \alpha + MPC^{\varepsilon}\varepsilon_{it} + MPC^{\eta}\eta_{it} + \xi_{it}$$

Under some assumptions consistent estimator of *MPC*

$$\widehat{MPC^{x}} = \frac{cov(\Delta(p_{it}c_{it}), g(x_{it}))}{var(g(x_{it}))},$$

where:

- $g(\varepsilon_{it}) = \Delta y_{i,t+1}$,
- $g(\eta_{it}) = \Delta y_{i,t-1} + \Delta y_{i,t} + \Delta y_{i,t+1}$.

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Examples of pass-through

1. complete markets (with separable labor supply): $MPC^{\varepsilon} = MPC^{\eta} = 0$ – households are able to smooth the marginal utility of consumption fully and all shocks are insured away,
2. autarky with no storage technology: $MPC^{\varepsilon} = MPC^{\eta} = 1$,
3. the classical version of the permanent income-life cycle model: $MPC^{\eta} = 1$ and the response to transitory shocks MPC^{ε} depends on the time horizon. For a long horizon it should be very small and close to zero, while for a short horizon it tends to one.

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Theorem

The c.d.f. $G(p)$ exhibits the following properties:

1. $G(p)$ is continuous;
2. supp $G(p)$ is a connected set;
3. $\max \operatorname{supp} G(p) = \zeta$;
4. $\forall_{p \in \operatorname{supp} G(p)} S(p) = S^*$;

where supp $G(p)$ is the smallest closed set whose complement has probability zero.

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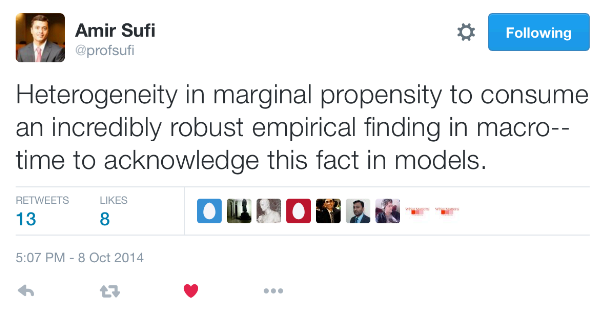
Twitter-based argument



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