Shopping Frictions and Household Heterogeneity

Theory and Empirics

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DALL·E prompt:
''Shopping Frictions and Household Heterogeneity''
painted by Salvador Dali

Disclaimer 🕶

The researcher's own analyses calculated (or derived) based in part on data from Nielsen Consumer LLC and marketing databases provided through the NielsenIQ Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business. The conclusions drawn from the NielsenIQ data are those of the researcher and do not reflect the views of NielsenIQ. NielsenIQ is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

Motivation

Research Question ?

How do households make consumption decisions in the presence of price dispersion?

✓ **Motivation**:

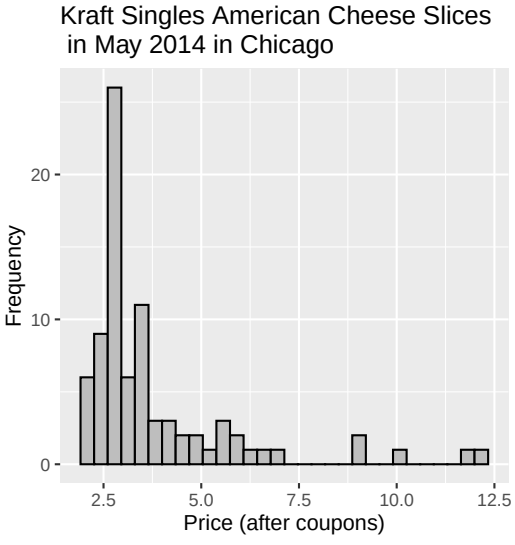
- Traditional consumption-saving models assume no price dispersion and the law of one price.
- Empirical literature reveals price heterogeneity amongst households.

✓ **Focus**: Price and consumption heterogeneity across income distribution.

✓ **Potential implications**:

- Sheds new light on understanding consumption spendings literature.
- Re-evaluates the traditional assumption that consumption is equalized with consumption expenditures.

Price dispersion in the real world



☞ Even with a very narrow definition of goods (product×location×time), we observe substantial price heterogeneity across transactions.

Preview of the (main) results

The main empirical findings

1. Employees with earnings above the median level pay from 1.5% to 7.1% higher prices than employees with below-median earnings.
2. The causal link between the income level and paid prices is established by exploiting a quasi-experimental setup of the Economic Stimulus Act of 2008.
3. The price channel accounts for between 8 and 22% of overall responses in consumption expenditures to transitory shocks.
4. High-income households have a wider variety in their consumption bundles but, on average, purchase fewer units of each item compared to low-income households.

Theory:

1. A standard incomplete-market model where households *endogenously choose paid prices through consumer search*.
2. The calibrated model confirms that substantial impact of the price channel on adjustments of consumption expenditures in other dimensions.

Literature Review

✓ **Consumption responses to shocks:**

Blundell et al. (AER, 2007), Broda and Parker (JME, 2014), Johnson et al. (AER, 2006), Parker et al. (AER, 2013), Parker (AEJ:Macro, 2017) ⚠ *The literature equalizes pc and c*

✓ **Heterogeneity in consumption baskets:**

Handbury (Ecta, 2021), Michelacci et al. (REStud, 2022), Broda et al. (JEP, 2009), Faber and Fally (REStud, 2022) ⚠ *The quality dimension is the main driver for price heterogeneity*

✓ **Price dispersion:**

Stigler (JPE, 1961), Aguiar and Hurst (AER, 2007), Kaplan and Menzio (IER, 2015)

⚠ *No causal links*

✓ **Consumer search:**

Burdett and Judd (Ecta, 1983), Kaplan and Menzio (JPE, 2016), Nord (WP, 2023), Sangani (WP, 2022), Kang (WP, 2018)

⚠ *Price search and consumption decisions made by households are exogenous (or are built on the model presented today)*

Empirical Patterns

Data

Kilts-Nielsen Consumer Panel

- ✔ 40,000-60,000 American households from 2004 through 2014.
- ✔ Each panelist uses in-home scanners or mobile apps to provide information to Nielsen about their grocery purchases from any outlet in all US markets.
- ✔ 630 million transactions for $\approx$ 2 million unique products defined at the barcode level, purchased in 87 million shopping trips.

Household Price Indices

- ✔ The consumption baskets differ across households.
- ✔ To explore heterogeneity in prices, for each household using methodology proposed by Aguiar-Hurst (AER, 2007), I compute individual price indices for each household.
- ✔ Consumption expenditures of household j in month m:

$$\bar{P}_{j,m} = \frac{\sum_{i \in I, t \in m} p^{j}_{i,t} q^{j}_{i,t}}{\sum_{i \in I, t \in m} \bar{p}^{r(j)}_{i,t} q^{j}_{i,t}},$$

where $\bar{p}^{r(j)}_{i,m}$ is the average price of good i in region $r(j)$ in month m.

- ✔ Hypothetical cost of consumption of household j if she paid average prices:

$$Q_{j,m} = \sum_{i \in I, t \in m} \bar{p}^{r(j)}_{i,t} q^{j}_{i,t}.$$

Relative Prices and Aggregate Consumption

- ✓ Methodology computes relative prices for each purchase of every good.
- ✓ By construction, goods purchased only once have the average price $\bar{p}_{i,t}^{r(j)} = p_{i,t}^{j}$.

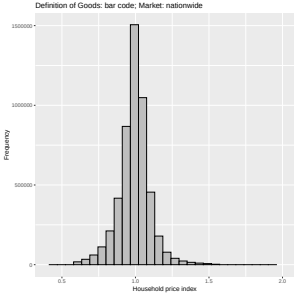
  ▸ How severe is this problem?

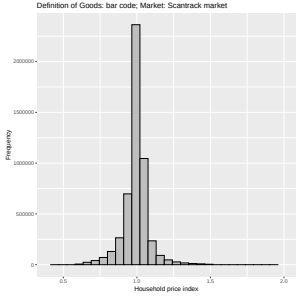
- ✓ Bias of household price indices towards 1 due to positive share of single-transaction goods.
- ✓ Results reported for 4 combinations of definitions of goods and markets: (α, β), where:
  - $\alpha \in \{\text{UPC}, \text{feature}\}$ refers to physical characteristics;
  - $\beta \in \{\text{Scantrack}, \text{Nationwide}\}$ relates to geographical characteristics.

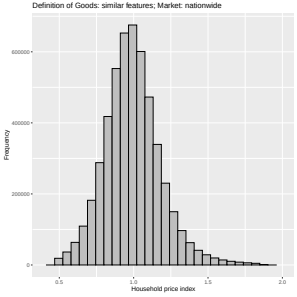
  ▸ Feature aggregation

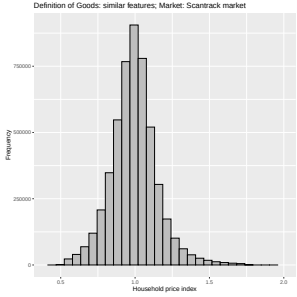
- ✓ Estimates for more restrictive definitions are lower bounds of true price heterogeneity across households.

Distribution of household price indices









High Earners Pay Higher Prices

Aguiar-Hurst price index of household j in month m :

$$\bar{P}_{j,m} = \frac{\sum_{i \in I, t \in m} p^j_{i,t} q^j_{i,t}}{\sum_{i \in I, t \in m} \bar{p}^{r(j)}_{i,t} q^j_{i,t}},$$

where $\bar{p}^{r(j)}_{i,m}$ is the average price of good i in region $r(j)$ in month m.

	$\ln \bar{P}_{j,m}$			
	(1)	(2)	(3)	(4)
HH Earnings > median(HH Earnings)	0.020***	0.015***	0.071***	0.052***
	(0.002)	(0.002)	(0.002)	(0.002)
Non-employed in working age (Male)	−0.007***	−0.006***	−0.014***	−0.010***
	(0.001)	(0.001)	(0.002)	(0.002)
Non-employed in working age (Female)	−0.007***	−0.004***	−0.010***	−0.006***
	(0.001)	(0.001)	(0.002)	(0.001)
Retired (Male)	−0.002	0.0001	−0.00002	−0.001
	(0.002)	(0.002)	(0.004)	(0.003)
Retired (Female)	0.002	0.001	0.002	0.001
	(0.002)	(0.002)	(0.004)	(0.003)
HH composition dummies	*Yes*	*Yes*	*Yes*	*Yes*
Age dummies (both heads)	*Yes*	*Yes*	*Yes*	*Yes*
Month dummies	*Yes*	*Yes*	*Yes*	*Yes*
Year dummies	*Yes*	*Yes*	*Yes*	*Yes*
Scantrack market dummies	*Yes*	*Yes*	*Yes*	*Yes*
Product aggregation	Bar code	Bar code	Features	Features
Area aggregation	Nationwide	Scantrack	Nationwide	Scantrack
Number of observations	5,084,254	5,084,254	5,084,254	5,084,254
Number of panelists	150,153	150,153	150,153	150,153

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where $\bar{p}_{i,m}^{r(j)}$ is the average price of good i in region $r(j)$ in month m.

Remarks

1. High earners pay higher prices than low earners.
2. Low earners pay similar prices to non-employed and retirees.

▸ What about store amenities? ▸ What about financial constraints?

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Prices are causally related to income

- ✔ Quite rich and robust evidence on systematic heterogeneity in price indices across different households

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Prices are causally related to income

- ✔ Quite rich and robust evidence on systematic heterogeneity in price indices across different households *but* is it causal?
- ✔ I exploit a quasi-experimental setup of the Economic Stimulus Act of 2008, a program consisting in sending tax rebates to about 130 million eligible taxpayers. Eligible households received their payments as tax rebates. Due to the scale of the program, *randomization in the timing of disbursement had to be introduced.*
- ✔ For single individuals ESPs were between \$300 and \$600, while for married couples filing jointly, between \$600 and \$1,200.
- ✔ The tax rebates survey conducted by Nielsen on behalf of Broda and Parker (JME, 2014) contains information on the week of receiving the ESP. This is merged with data from the KNCP.

Prices are causally related to income (cont'd)

Response to the ESP	$\ln \bar{P}_{j,m}$			
	(1)	(2)	(3)	(4)
Quarter before, β_{-1}	0.002	0.001	0.002	0.003
	(0.001)	(0.001)	(0.002)	(0.002)
Quarter of receipt, β_0	0.006***	0.004*	0.009**	0.008***
	(0.002)	(0.002)	(0.003)	(0.003)
One quarter after, β_1	0.008***	0.005**	0.009**	0.011***
	(0.003)	(0.002)	(0.005)	(0.004)
Two quarters after, β_2	0.008**	0.006**	0.011**	0.013***
	(0.003)	(0.003)	(0.006)	(0.005)
Month dummies	Yes	Yes	Yes	Yes
Product aggregation	Bar code	Bar code	Features	Features
Area aggregation	Nationwide	Scantrack	Nationwide	Scantrack
Number of observations	345,768	345,768	345,768	345,768
Number of panelists	29,289	29,289	29,289	29,289

Decomposition of the expenditure responses to the ESP

$$\underbrace{\mathbb{E} \ln \left(\frac{\bar{P}_{j,\tau+s} Q_{j,\tau+s}}{\bar{P}_{j,\tau-1} Q_{j,\tau-1}} \right)}_{\text{Overall response to ESP}} = \underbrace{\mathbb{E} \left(\ln \bar{P}_{j,\tau+s} - \ln \bar{P}_{j,\tau-1} \right)}_{\text{Price channel}} + \underbrace{\mathbb{E} \left(\ln Q_{j,\tau+s} - \ln Q_{j,\tau-1} \right)}_{\text{Consumption channel}}, \tag{1}$$

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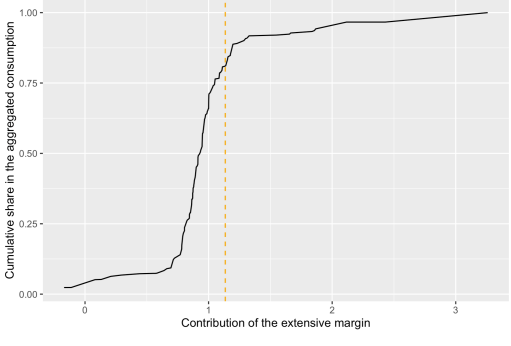
Product aggregation	Area aggregation	Price channel: $\frac{\mathbb{E}\left(\ln\bar{P}_{j,\tau+s}-\ln\bar{P}_{j,\tau-1}\right)}{\mathbb{E}\ln\left(\frac{\bar{P}_{j,\tau+s}Q_{j,\tau+s}}{\bar{P}_{j,\tau-1}Q_{j,\tau-1}}\right)}$			Consumption channel: $\frac{\mathbb{E}\left(\ln Q_{j,\tau+s}-\ln Q_{j,\tau-1}\right)}{\mathbb{E}\ln\left(\frac{\bar{P}_{j,\tau+s}Q_{j,\tau+s}}{\bar{P}_{j,\tau-1}Q_{j,\tau-1}}\right)}$		
		QTR_0	QTR_1	QTR_2	QTR_0	QTR_1	QTR_2
Bar code	Nationwide	12.5%	11.6%	12.0%	87.5%	88.4%	88.0%
Bar code	Scantrack	8.1%	8.5%	10.0%	91.9%	91.5%	90.0%
Features	Nationwide	22.2%	15.3%	18.1%	77.8%	84.7%	81.9%
Features	Scantrack	16.8%	16.3%	19.0%	83.2%	83.7%	81.0%

Deconstructing Heterogeneity in Consumption Bundles

✓ Differences in consumption bundles between high-income and low-income households occur along two primary margins:

- *Intensive Margin*: Increase in the *quantity* of goods already purchased.
- *Extensive Margin*: Diversification in consumption by buying *more types* of goods.



▸ Formal decomposition

Remark

The extensive margin accounts for 113.5% of differences in bundles between high and low earners.

▸ What about a quality ladder?

Shopping Time Differentials Across Households

- ✓ American Time Use Survey (ATUS) data set used
- ✓ Shopping effort positively correlated with earnings
- ✓ High earners spend 2-2.5 minutes more shopping daily (7% increase)
- ✓ Retired and non-employed individuals spend around 7 minutes more daily

	Shopping time		
	(1)	(2)	(3)
Earnings>median(Earnings)	2.590***	2.049***	2.116***
	(0.450)	(0.451)	(0.446)
Nonemployed (in working age)	6.700***	6.712***	6.710***
	(0.508)	(0.508)	(0.503)
Retired	7.916***	7.644***	7.955***
	(0.755)	(0.791)	(0.783)
Age categories	*Yes*	*Yes*	*Yes*
Shopping needs	*No*	*Yes*	*Yes*
Year and day dummies	*No*	*No*	*Yes*
N	149,797	149,797	149,797
R^2	0.010	0.011	0.033

Well-being of Shopping

- ✓ Study uses ATUS Well-Being Module (2010, 2012, 2013)
- ✓ Over 75,000 respondents
- ✓ Objective: Examine differences in perception of shopping across different individuals and employment groups

Key Findings:

- ✓ No significant difference in well-being experienced while shopping across different groups
- ✓ Shopping is not considered more non-market work or leisure activity for specific groups

	WUTIRED	WUHAPPY	WUPAIN	WUSTRESS	WUSAD
	(1)	(2)	(3)	(4)	(5)
Activity:Shopping & Earnings>median(Earnings)	−0.084	0.044	−0.176*	−0.154	−0.082
	(0.106)	(0.093)	(0.092)	(0.100)	(0.077)
Activity:Shopping & Nonemployed (in working age)	0.031	−0.108	−0.242***	0.189**	−0.110
	(0.092)	(0.080)	(0.080)	(0.087)	(0.067)
Activity:Shopping & Retired	0.055	−0.014	−0.230**	0.076	−0.046
	(0.112)	(0.098)	(0.097)	(0.106)	(0.082)
Activity:Shopping	−0.256***	0.052	0.010	−0.033	−0.028
	(0.069)	(0.060)	(0.060)	(0.065)	(0.050)
Earnings>median(Earnings)	0.017	−0.108***	−0.354***	0.238***	−0.171***
	(0.022)	(0.019)	(0.019)	(0.021)	(0.016)
Nonemployed (in working age)	0.014	−0.104***	0.558***	0.090***	0.192***
	(0.020)	(0.018)	(0.018)	(0.019)	(0.015)
Retired	−0.571***	0.188***	0.513***	−0.684***	0.047**
	(0.031)	(0.027)	(0.027)	(0.029)	(0.022)
Age categories	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Shopping needs	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Year and day dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Daytime dummy and duration control	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
N	76,506	76,506	76,506	76,506	76,506
R^2	0.052	0.020	0.068	0.054	0.025

New Findings and Existing Price-Search Theories

✓ **Empirical findings**:

- Price heterogeneity substantial across different income groups.
- High earners spend more time shopping but pay higher prices.

✓ **Inconsistency with existing random price-search theories**

Burdett and Judd (Ecta, 1983), Kaplan and Menzio (JPE, 2016)

- Higher search effort should result in lower prices.

✓ **Inconsistency with existing directed search theories**

Moen (JPE, 1997), Bai et al. (WP, 2019), Qiu and Ríos-Rull (WP, 2022)

- Consumers with higher earnings and consumption choose retailers with shorter queues and higher prices.
- Imperfect representation of shopping; assumes perfect knowledge about prices.

✓ **Conclusion**: No single micro-founded representation of shopping reconciles all presented findings.

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.

Consumption Basket and Its Cost

1. **Consumption (c)**: to buy a unit of consumption, a household needs to make a shopping trip. Higher amount of consumption is involved in a higher number of shopping trips. In addition to the market, goods can also be manufactured through labor endowment with home production: $\zeta \to 1$.

▸ Empirics of search for variety

Consumption Basket and Its Cost

1. **Consumption (c)**: to buy a unit of consumption, a household needs to make a shopping trip. Higher amount of consumption is involved in a higher number of shopping trips. In addition to the market, goods can also be manufactured through labor endowment with home production: $\zeta \to 1$.

   ▸ Empirics of search for variety

2. **The cost of consumption bundle ($p \cdot c$):** The overall cost of the bundle is a sum of many price lotteries.

$$p \cdot c = \int_0^c p(i)di,$$

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

Price Search Intensity

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

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

Price Search Intensity

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

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

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

$$\int_0^c p(i)di \overset{\text{a.s.}}{\to} c \cdot \mathbb{E}(p|s).$$

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.

Shopping effort vs. Monetary cost

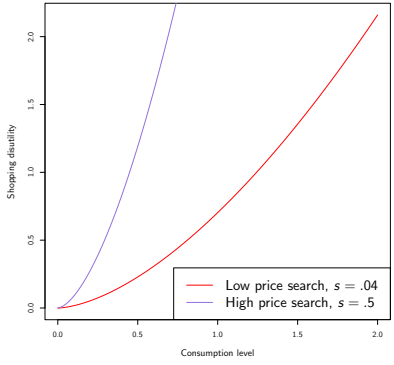
There exists an inherent tension between shopping effort and the prices paid; while a more intense price search leads to lower purchase costs, it simultaneously increases the disutility linked with acquiring a certain quantity of goods due to the additional effort expended.

Shopping disutility

$$v(c,s) = \frac{1}{1+\phi}\left(\underbrace{\frac{1+s}{1-s}}_{\text{unit cost of price search}} \cdot c\right)^{1+\phi}$$

Monetary cost

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



Household's Problem

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

s.t.

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

Retailers' Problem

$$S(p) = \sum_{t=1}^{T} \int \underbrace{\left(1 - \frac{2s_t(x)}{1+s_t(x)} G(p)\right)}_{\text{Business Stealing}} \underbrace{(p-1)}_{\text{Surplus Appropriation}} \overbrace{\frac{c_t(x)(1+s_t(x))}{\sum_{t=1}^{T} \int c_t(x)(1+s_t(x)) d\mu_t(x)}}^{\text{Weighting factor for search distribution, } s_t} d\mu_t(x)$$

- ✓ Retailers maximize sales revenue, influenced by *Surplus Appropriation* and *Business Stealing*.
- ✓ Surplus Appropriation $(p-1)$: net revenue from a purchase increases with price.
- ✓ Business Stealing: risk of a buyer having a better-priced alternative.
- ✓ Higher prices can increase revenue but also decrease offer acceptance.
- ✓ Tension between these factors can generate price dispersion.
- ✓ Aligns with the original problem of retailers proposed by **Burdett and Judd (Ecta, 1983)**.

Equilibrium Price Dispersion

Similar to **Burdett and Judd (Ecta, 1983)**, the equilibrium price dispersion has certain characteristics aiding tractability:

Characterization of the Equilibrium Price Dispersion

The cumulative distribution function $G(p)$ exhibits the following properties:

1. $G(p)$ is continuous.
2. Support of $G(p)$ is a connected set.
3. The highest price charged by retailers is equal to ζ.
4. All retailers yield the same profit, $\forall_{p \in \text{supp } G(p)} S(p) = S^*$,

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

(Semi) Closed-Form Equilibrium Price Dispersion

Equilibrium Price Dispersion

Let:

- ✓ $\Psi_{(-)} := \sum_{t=1}^{T} \int c_t(x)(1 - s_t(x))d\mu_t(x)$ be the measure of captive purchases with one offer only;
- ✓ $\Psi_{(+)} := \sum_{t=1}^{T} \int c_t(x)2s_t(x)d\mu_t(x)$ be the measure of purchases with two price draws.

Then, the equilibrium price dispersion can be expressed in a closed form:

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

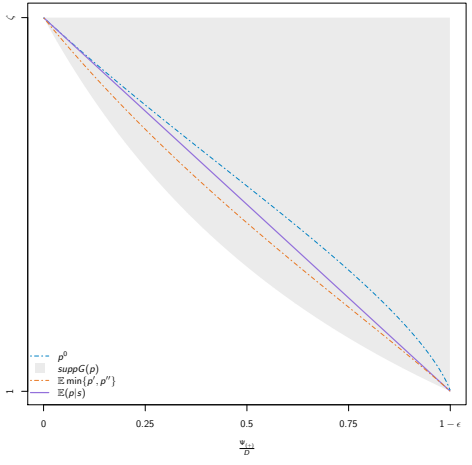
where the lower bound of $\text{supp}G(p)$ is:

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

▸ RSE definition

Price search externalities

- ✓ Price externality impacts all consumers.
- ✓ Average search intensity dictates retailers' pricing.
- ✓ Bargain hunters decrease overall retailer markups.
- ✓ Low-search consumers benefit from others' deal hunting.
- ✓ Demand-side factors heavily influence price and markup distribution.



Model fitness 🚲

5 parameters targeted with 5 moments

Moment		Data	Model
Transaction prices:	top v. bottom decile	1.7	1.7
HH price index:	rich work. v. poor work.	1.045	1.05
	poor HtM v. poor work.	.99	.99
	retirees v. poor work.	1	1.01
Saving-income ratio		2.5	2.5

Price Channel's Contribution

- ✓ Studied price channel's role in consumption changes post-shocks.
- ✓ Ran a regression of prices and expenditures against household states in a synthetic panel.
- ✓ Coefficient ratio offers insights on price adjustments in consumption changes.
- ✓ Compared to ESP 2008's empirical counterpart, the model aligns with the lower bound, thus replicating non-targeted moments.
- ✓ Similar contributions observed across other states.

Channel	$\frac{\mathbb{E}(\ln P_{j,\tau} - \ln P_{j,\tau-1})}{\mathbb{E} \ln\left(\frac{\tilde{P}_{j,\tau} Q_{j,\tau}}{\tilde{P}_{j,\tau-1} Q_{j,\tau-1}}\right)}$
Assets	8.17%
Persistent income shocks	8.13%
Transitory income shocks	7.78%

Counterfactual Analysis

- ✓ The calibrated model enables a simple counterfactual analysis.
- ✓ In the model, a price search externality exists among households.
- ✓ Simulated a hypothetical equilibrium price distribution for non-pooled households.
- ✓ Retailers, aware of the price search intensity ($s(x)$), remain uncertain of the number of consumer offers.
- ✓ Results: 67% would benefit from separation (lower prices), the remaining 33% benefit from pooling (higher prices in counterfactual).

Conclusions

- ✓ Household prices differ across the income distribution. The effect more pronounced that previously documented for other dimensions.
- ✓ Using the 2008 ESP, the causal link between paid prices and income of the households is established. The price channel accounts for between 8 and 22% of overall responses in consumption expenditures.
- ✓ All findings can be rationalized by a new incomplete-market model augmented with a price search protocol.
- ✓ Findings cast a new light on how household consumption responses in fiscal stimuli should be understood.

Thank you for your attention!

Number of Transactions and Shares in Aggregate Consumption

		No. of transactions			
Product aggregation	Area aggregation	≥ 1	≥ 2	≥ 10	≥ 20
Similar features	Nationwide	1	0.990	0.942	0.903
Similar features	Scantrack market	1	0.860	0.517	0.404
Bar code	Nationwide	1	0.963	0.814	0.723
Bar code	Scantrack market	1	0.713	0.287	0.209

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Aggregation of Similar Products

- ✓ Each product is uniquely identified by a UPC, but products with different bar codes may share similar features like brand, size, flavor, etc.
- ✓ Some products have up to 19 extra attributes providing additional details.
- ✓ If no other products share *exactly the same* characteristics, the unique bar code-level definition is retained.

▸ Feature aggregation for *Cheese-processed American*

▸ Go Back

Cheese-processed American: Aggregation of Similar Products

Group 1:

- ✓ Product: *cheese-processed American*
- ✓ Form: *single wrap*
- ✓ Formula: *regular*
- ✓ Weight: *12 oz*

Group 1

Group 2:

- ✓ Product: *cheese-processed American*
- ✓ Form: *slices*
- ✓ Formula: *regular*
- ✓ Weight: *12 oz*

Group 2

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Price Differential and Store-Specific Amenities

- ✓ Store-specific amenities can create a price differential across consumers.
- ✓ Such amenities can contribute to up to 20% of price differentials *across transactions* (Kaplan and Menzio, IER 2015).
- ✓ However, it is not clear how this affects household indices.
- ✓ The revenue-weighted expensiveness value for each store is computed. Subsequently, the expenditure-weighted value $\bar{\mu}_{j,m}$ for each consumer is calculated.

	$\ln \bar{\mu}_{j,m}$			
	(1)	(2)	(3)	(4)
HH Earnings > median(HH Earnings)	0.006***	0.004***	0.013***	0.009***
	(0.0004)	(0.0002)	(0.001)	(0.0004)
Non-employed in working age (Male)	−0.001	−0.0002	−0.001	−0.001
	(0.001)	(0.001)	(0.002)	(0.001)
Non-employed in working age (Female)	−0.0003	−0.0004	−0.003**	−0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
Retired (Male)	−0.001	−0.001***	−0.002**	−0.003***
	(0.001)	(0.0004)	(0.001)	(0.001)
Retired (Female))	−0.002***	−0.001***	−0.001	−0.001**
	(0.0004)	(0.0003)	(0.001)	(0.0005)
HH composition dummies	Yes	Yes	Yes	Yes
Age dummies (both heads)	Yes	Yes	Yes	Yes
Month dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Scantrack market dummies	Yes	Yes	Yes	Yes
Product aggregation	Bar code	Bar code	Features	Features
Area aggregation	Nationwide	Scantrack	Nationwide	Scantrack
Number of observations	4,751,339	4,751,201	4,751,395	4,691,551
Number of panelists	91,150	91,156	91,142	91,150

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Remarks

Store-specific components account for 17-30% of the overall dispersion in HH indices

	$\ln \bar{\mu}_{j,m}$			
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Hand-to-Mouth households pay lower prices

In 2008, a supplemental survey asked households *"In case of an unexpected decline in income or increase in expenses, do you have at least two months of income available in cash, bank accounts, or easily accessible funds?"*

	$\ln \bar{P}_{j,t}$			
	(1)	(2)	(3)	(4)
HH:HtM	−0.003	−0.007***	−0.028***	−0.024***
	(0.002)	(0.002)	(0.004)	(0.003)
HH:HtM & HH Earnings > median(HH Earnings)	0.004	0.004	0.015**	0.013**
	(0.004)	(0.003)	(0.007)	(0.005)
HH Earnings > median(HH Earnings)	0.021***	0.015***	0.071***	0.054***
	(0.002)	(0.002)	(0.004)	(0.003)
Extensive employment dummies	*Yes*	*Yes*	*Yes*	*Yes*
HH composition dummies	*Yes*	*Yes*	*Yes*	*Yes*
Age dummies (both heads)	*Yes*	*Yes*	*Yes*	*Yes*
Month dummies	*Yes*	*Yes*	*Yes*	*Yes*
Year dummies	*Yes*	*Yes*	*Yes*	*Yes*
Scantrack market dummies	*Yes*	*Yes*	*Yes*	*Yes*
Product aggregation	Bar code	Bar code	Features	Features
Area aggregation	Nationwide	Scantrack	Nationwide	Scantrack
Number of observations	284,112	284,112	284,112	284,112
Number of panelists	24,141	24,141	24,141	24,141

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Remarks

- ✓ Estimates show that constrained households with median or lower earnings pay 0-2.8% lower prices.
- ✓ High-earning hand-to-mouth households show a smaller or no effect.

	$\ln \bar{P}_{j,t}$			
	(1)	(2)	(3)	(4)
HH:HtM	−0.003	−0.007***	−0.028***	−0.024***
	(0.002)	(0.002)	(0.004)	(0.003)
HH:HtM & HH Earnings > median(HH Earnings)	0.004	0.004	0.015**	0.013**
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Month dummies	*Yes*	*Yes*	*Yes*	*Yes*
Year dummies	*Yes*	*Yes*	*Yes*	*Yes*
Scantrack market dummies	*Yes*	*Yes*	*Yes*	*Yes*
Product aggregation	Bar code	Bar code	Features	Features
Area aggregation	Nationwide	Scantrack	Nationwide	Scantrack
Number of observations	284,112	284,112	284,112	284,112
Number of panelists	24,141	24,141	24,141	24,141

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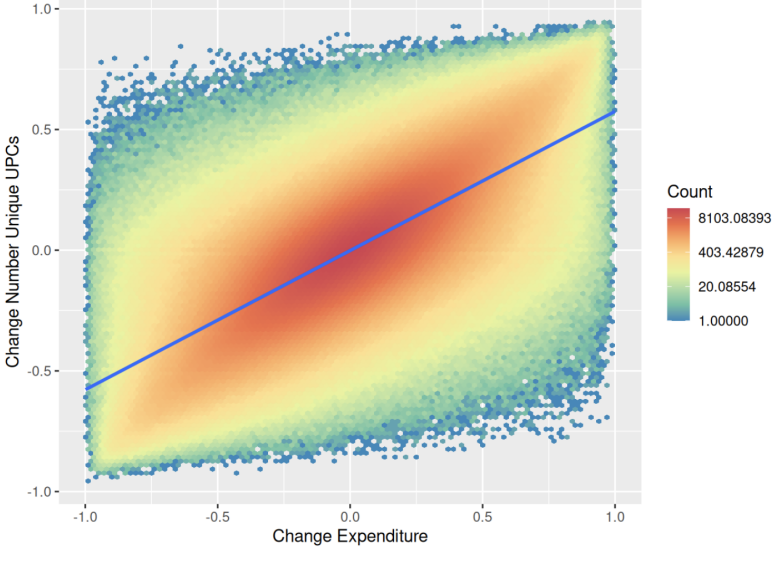
Consumption changes and consumption variety



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Intensive vs. Extensive Margin: Formal Decomposition

The average consumption of product j by household i belonging to group k can be represented as:

$$\mathbb{E}(c_j^k) = \Pr(c_j^{i \in k} > 0) \cdot \mathbb{E}(c_j^k | c_j^k > 0, i \in k)$$

More formally, $\mathbb{E}(c_j^{\text{Rich}}) - \mathbb{E}(c_j^{\text{Poor}})$ can be decomposed into two margins can be done as follows:

$$\mathbb{E}(c_j^{\text{Rich}}) - \mathbb{E}(c_j^{\text{Poor}}) = \underbrace{(Pr(c_j^{\text{Rich}} > 0) - Pr(c_j^{\text{Poor}} > 0)) \times \mathbb{E}(c_j^k | c_j^k > 0, i \in \text{Rich})}_{\text{Extensive Margin}} +$$

$$+ \underbrace{(\mathbb{E}(c_j^k | c_j^k > 0, i \in \text{Rich}) - \mathbb{E}(c_j^k | c_j^k > 0, i \in \text{Poor})) \times Pr(c_j^{\text{Poor}} > 0)}_{\text{Intensive Margin}}$$

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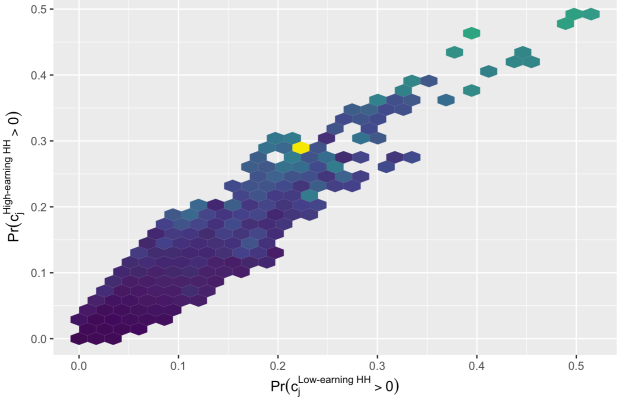
There is not such a thing as a quality ladder!



Remark

Products popular among low-earning consumers are also popular among high-earning consumers.

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Equilibrium

A *Rational Stationary Equilibrium* is a sequence of consumption and shopping plans $\{c_t(x), m_t(x), s_t(x)\}_{t=1}^{T}$, the distribution of quoted and paid prices $G(p)$ and $F(p; s_t(x))$, household distribution $\mu_t(x)$, and interest rate r that satisfy:

- ✓ Optimal consumption, shopping plans given r, w, $G(p)$, $\underline{B}$, and θ;
- ✓ Consistency between individual and aggregate behavior: $D = \sum_{t=1}^{T} \int (1 + s_t(x)) m_t(x) d\mu_t(x)$;
- ✓ Retailers maximize sales revenues considering households' behavior;
- ✓ Private savings sum to $\overline{K}$: $\sum_{t=1}^{T} \int a_t(x) d\mu_t(x) = \overline{K}$;
- ✓ Consistency of $G(p)$ and $F(p; s_t(x))$ with $\mu_t(x)$;
- ✓ Consistency of $\mu_t(x)$ with the policies.

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