The Welfare Effects of Endogenous Product Variety: Evidence from Commodity Taxes in the U.S.

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Motivation

- Governments raise substantial revenue through consumption taxes
- Huge literature in public economics on efficiency costs and incidence effects of taxation
- Most analyses are purely theoretical and take place in competitive models or homogenous good oligopoly
- In differentiated product markets, taxes can distort product variety.
- Growing literature in international trade on welfare effects of variety but so far little research in public economics

Contribution

1. Consider model of imperfect competition with (horizontally) differentiated products + derive new formula for marginal welfare gain of increasing sales tax
   - Formula depends on output effect and variety effect [NEW]
2. Develop model-based approach to identify parameters of welfare formula
3. Use Nielsen Scanner Data combined with detailed state sales tax data (including rates and product exemptions) to estimate effect of taxes on product variety
   - "Difference-in-Differences" design using within- and between-state variation in sales taxes

Related Literature

1. Commodity Taxation with Imperfect Competition
   - Seade (1987), Stern (1987), Myles (1987, 1989), Besley (1989), Delipalli and Keen (1992), Anderson, de Palma and Kreider (2001), Auerbach and Hines (2001), Weyl and Fabinger (2013), Gillitzer, Kleven and Slemrod (2015)
2. Optimal Product Variety
   - Berry and Waldfogel (1999), Gentzkow, Shapiro and Sinkinson (2014), Berry, Eizenberg and Waldfogel (2014)
3. Welfare Economics of New Goods
   - Hausman (1997), Hausman and Leonard (2002), Petrin (2002)
4. Gains from Trade and Product Variety
   - Broda and Weinstein (2006), Arkolakis, Costinaut and Rodriguez-Claire (2012), Melitz and Redding (2012)

Outline

1. Theoretical framework
2. Model-based approach to estimation
3. Regression results
4. Numerical Implementation of Welfare formula
5. Conclusion

The General Model

- Consider a general model of imperfect competition with horizontally differentiated products
  - Do not specify firm interactions or preferences, but consider a general model nesting many standard models: Cournot, Bertrand, Monopolistic Competition (Spence).
  - Impose symmetry in preferences and firms for tractability.
- Consider an ad-valorem tax on all goods in market, except for outside good
- Derive marginal welfare gain of increasing taxes in two cases:
  1. Efficient or exogenous number of varieties.
  2. Number of varieties in equilibrium with free entry.

Preferences

- Consumers i chooses product $j \in \{1,2, \ldots, J\}$ or decides not to buy any goods
- Total utility consumer gets from buying product $j > 0$ is:

$$U_{ij} = U(y_i - p_{j,} X_j) + \varepsilon_{ij}$$

where:

- y_i is consumer $i's$ income
- p_j is price of product j
- X_j are characteristics of product j.
- ε_{ij} is an idiosyncratic error term
- Utility of outside good is: $U_0 + \varepsilon_{i0}$

Demand

- Assume there is a measure 1 population and $y_i = y$ for all i.
- Choose alternative j iff $U_{ij} \geq U_{ik}\ \forall k \neq j$
- Probability of consumer choosing product $j > 0$ is:

$$q_j = Prob\left(U_{ij} > U_{ik}\ \forall k \neq j\right)$$

- Aggregate output is:

$$Q = \sum_{j=1}^{J} q_j = 1 - q_0$$

Consumer Welfare

If $U(y - p_{j,} X_j)$ is linear in $y - p_j$, can use expected consumer surplus as measure of welfare:

$$E[CS] = E\left[max\{U_0, U_1, \dots, U_J\}\right]$$

- More generally, can use compensating variation $CV(p, J)$:

$$E\left[max_{j \leq J}\{U_j(y - p_j - CV)\}\right] = E\left[max_{j \leq J_0}\{U_j(y - p_{0j})\}\right]$$

Symmetric Characteristics and Prices

- Imposing symmetry $p_j = p$ for all $j \neq 0$, define Hicksian demand $\mathrm{h}(p,J)$ from the compensating variation $CV(p,J)$:

$$\mathrm{h}(p,J) = \frac{\partial CV(p,J)}{\partial p}$$

- And so can express

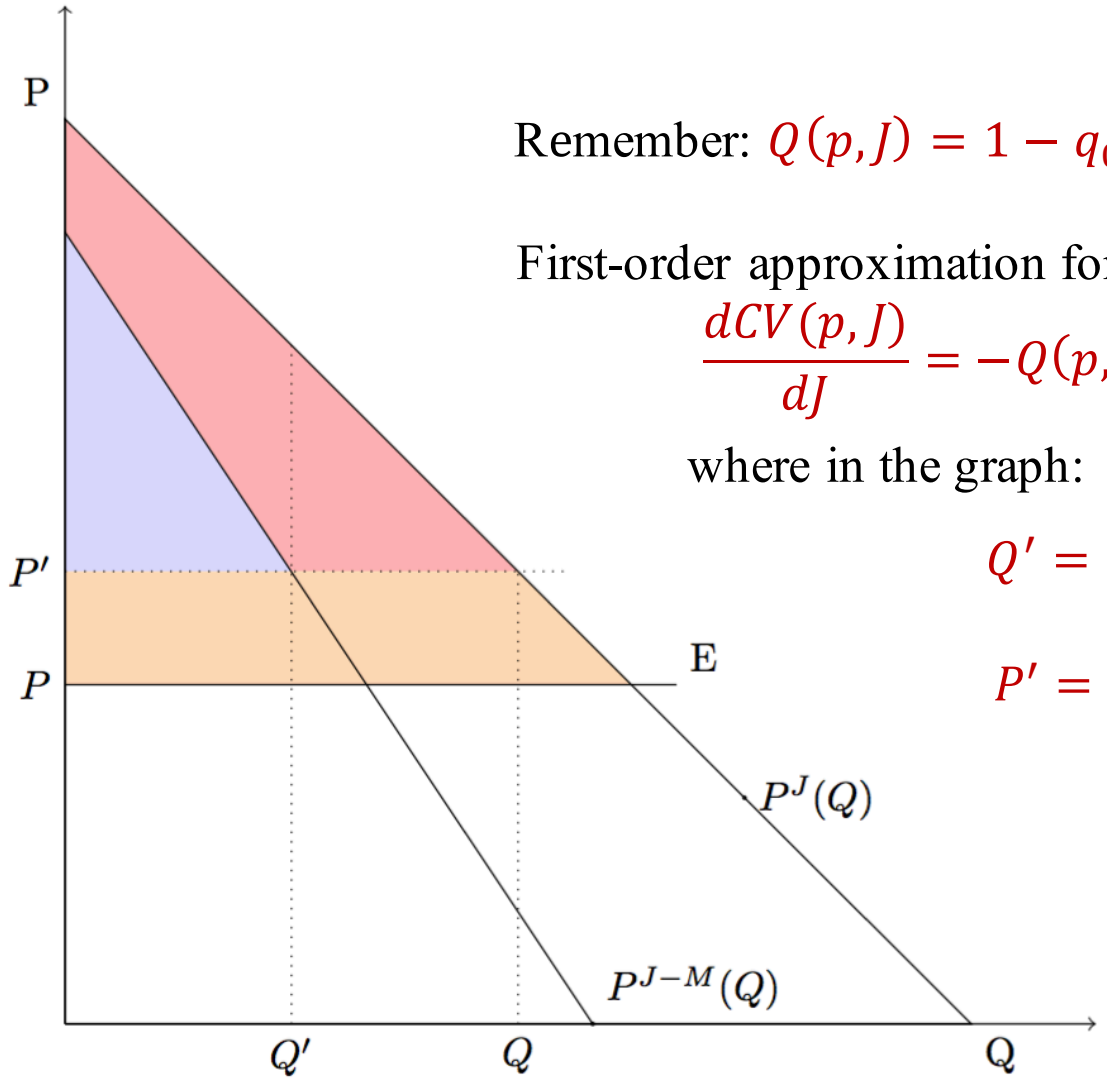
$$\frac{dCV(p,J)}{dJ} = -\mathrm{h}(p,J)\frac{dp}{dJ} + \int_p^{\infty} \frac{\partial h(J,s)}{dJ} ds$$

- With no income effects: $\mathrm{h}(p,J) = \mathrm{Q}(p,J)$.

$$\frac{dCV(p,J)}{dJ} = -Q(p,J)\frac{dp}{dJ} + \int_p^{\infty} \frac{\partial Q(J,s)}{dJ} ds$$

  - Price effect + Variety Effect

Consumer Welfare: **Price Effect** and **Variety Effect**



Remember: $Q(p,J) = 1 - q_0(p,J)$

First-order approximation for Consumer Welfare:

$$\frac{dCV(p,J)}{dJ} = -Q(p,J)\frac{dp}{dJ} + \int_p^{\infty} \frac{\partial Q(J,s)}{dJ} ds$$

where in the graph:

$$Q' = Q + \frac{dQ}{dJ}\Delta J$$

$$P' = P + \frac{dp}{dJ}\Delta J$$

Figure 1: Consumer Surplus: Price Effect and Variety Effect

Preferences: Further Structure

- Assume utility consumer i gets from buying product $j > 0$ is:

$$U_{ij} = \alpha\, lny - \alpha\, lnp_j + \varepsilon_{ij}$$

- Assume ε_{ij} iid extreme value with location parameter $\mu = 0$ and dispersion parameter σ.
- Quantity demanded of product $j > 0$ is:

$$q_j = \frac{p^{-\alpha/\sigma}}{p_0^{-\alpha/\sigma} + Jp^{-\alpha/\sigma}} * \frac{y}{p}$$

- Then we can get closed form for Variety Effect:

$$\int_p^{\infty} \frac{\partial h(J,s)}{dJ} ds = \frac{\sigma}{\alpha} pq$$

- And so $\frac{dCV(p,J)}{dJ} = -Q(p,J)\frac{dp}{dJ} + \frac{\sigma}{\alpha} pq$

Firms

- Single-product firms in imperfectly competitive market
- Two stages: 1) entry decision, 2) production decision
- Focus on symmetric equilibrium where $q_j = q \; \forall J$
- Profits given by $\pi = (p(1-\tau) - c)q - f$
- Firm problem:

$$\max_q \{(p(1-\tau) - c)q - f\} \; s.t. \; p = p(Q)$$

- FOC:

$$p(Q) + \frac{dp}{dQ}\theta q = \frac{c}{(1-\tau)}$$

- where $\theta = \frac{dQ}{dq}$ [Cournot: $\theta = 1$, Competitive: $\theta = 0$]

Firms

- The equilibrium number of firms J^* is determined by the free-entry condition $\pi = 0$:

$$\left(p(J^*, q^*(J^*))(1-\tau) - c\right)q^*(J^*) = f$$

- Key aspect of problem: privately optimal and socially optimal J might diverge.
- Taxes can ↑ or ↓ wedge between private and social optimum.

Government and Total Welfare

- In a symmetric equilibrium total welfare is defined as:

$$W = \underbrace{CV(p,J)}_{CS} + \underbrace{J[(p(1-\tau)-c)q-f]}_{PS} + \underbrace{J\tau q}_{R}$$

- Objective: derive marginal welfare gain for small increase in τ
- Will derive $\frac{dW}{d\tau}$ with first-best (or fixed) J and free-entry J.

Marginal Welfare Gain: First-Best or Exogenous Variety

- First assume planner can set J optimally
- Can also think of this as short-run case when variety is fixed
- If J is efficient $\frac{dW}{dJ} = 0$ or fixed $\frac{dJ}{d\tau} = 0$, the marginal welfare gain of a small change in the tax is:

$$\frac{\partial W}{\partial \tau} = \underbrace{-Q\left.\frac{dp}{d\tau}\right|_J}_{\Delta CS} + \underbrace{(1-\tau)\left(1-\frac{\theta}{J}\right)Q\left.\frac{dp}{d\tau}\right|_J - pQ}_{\Delta PS} + \underbrace{pQ + \tau\left.\frac{d(pQ)}{d\tau}\right|_J}_{\Delta R}$$

Marginal Welfare Gain: First-Best or Exogenous Variety

- Collecting terms yields:

$$\frac{\partial W}{\partial \tau} = \tau \left.\frac{dpQ}{d\tau}\right|_J - \left(\frac{\theta}{J}(1-\tau)Q + \tau Q\right)\left.\frac{dp}{d\tau}\right|_J$$

- $\theta = 0 \rightarrow \frac{\partial W}{\partial \tau} = p\tau \left.\frac{dQ}{d\tau}\right|_J$ (=0 if $\tau = 0$)
- Pecuniary effects matter with imperfect competition
- Can show equivalent to Auerbach and Hines (2001):

$$\frac{\partial W}{\partial \tau} = \left.\frac{dQ}{d\tau}\right|_J (p - c)$$

- With imperfect competition ($p > c$), $\frac{\partial W}{\partial \tau} < 0$ even if $\tau = 0$
- Sufficient to estimate $\left.\frac{dQ}{d\tau}\right|_J$ along with markup $p - c$

Marginal Welfare Gain: Second-Best Variety

- Now suppose planner takes the equilibrium level of J as given
- The marginal welfare gain is:

$$\frac{dW}{d\tau} = \frac{\partial W}{\partial \tau} + \boxed{\frac{dW}{dJ}} \frac{dJ}{d\tau}$$

- First examine welfare effect of a change in variety

$$\frac{dW}{dJ} = \underbrace{\pi}_{\text{Private Gain}} + \underbrace{\frac{\sigma}{\alpha} qp}_{\text{Variety Effect}} + \underbrace{J \frac{dq}{dJ}(p - c)}_{\text{Business Stealing}}$$

- $\frac{\sigma}{\alpha} = 0$ → Mankiw and Whinston (1986)

Marginal Welfare Gain: Second-Best Variety

- The sum of direct and indirect effects are:

$$\frac{dW}{d\tau} = \underbrace{(p-c)\frac{dQ}{d\tau}}_{\text{Quantity Effect}} + \underbrace{\left(\frac{\sigma}{\alpha}qp - f\right)\frac{dJ}{d\tau}}_{\text{Entry Effect}}$$

- $\frac{\sigma}{\alpha} = 0$ → Besley (1989)
- Can think of this as long-run welfare effect of tax

Marginal Welfare Gain: Second-Best Variety

- Now let us evaluate this expression when profits are zero:

$$\left.\frac{dW}{d\tau}\right|_{\pi=0} = \frac{dCV}{d\tau} + \frac{dR}{d\tau}$$

$$\left.\frac{dW}{d\tau}\right|_{\pi=0} = \left(\frac{d(\tau pQ)}{d\tau}\right) - \frac{dp}{d\tau}Q + \frac{\sigma}{\alpha}qp\frac{dJ}{d\tau}$$

- The first term is government revenue effect
- The second and third terms correspond to consumer surplus effect

Summary of Theory

- Dividing by total revenue pQ we get:

$$\frac{1}{pQ}\frac{dW}{d\tau}\bigg|_{\pi=0} = \tau\frac{dlog(pQ)}{d\tau} + 1 - \frac{dlog(p)}{d\tau} + \frac{\sigma}{\alpha}\frac{dlog(J)}{d\tau}$$

- To implement formula empirically, need:
  1. Structural parameter estimate of taste for variety $\frac{\sigma}{\alpha}$.
  2. Reduced-form estimates of $\frac{dlog(pQ)}{d\tau}$, $\frac{dlog(p)}{d\tau}$ and $\frac{dlog(J)}{d\tau}$.
- Formula does NOT need:
  1. Fixed cost of entry (f)
  2. Marginal cost of production (c)

Scanner and Sales Tax Data

1. **Nielsen Retail Scanner Data (2006-2011)**
   - Retail channels: covers more than half the total sales volume of US grocery and drug stores and 1/3 of mass merchandise
   - Weekly price, output and variety data for 2.6 million Universal Product Codes (UPCs)
   - Data collected from more than 35,000 participating stores and 90 retail chains. Counties and 3-digit zip codes for stores
   - UPCs are grouped into *modules* (609 food modules and 475 non-food modules)
   - Product variety: Number of unique UPCs within a module

2. **Sales Tax Rates and Exemption Data**
   - Hand collected for each state using tax codes and regulations
   - A sales tax exemption status is assigned to each Nielsen module, for each state
   - Includes state sales tax rates from 2006 to 2011

UPCs, Modules, Groups, Departments

UPC Description	Product Module Description	Product Group Description	Department Description	Brand Description	Multi	Size	Unit
M&M PLN DK CH HDY-M HDY	CANDY-CHOCOLATE-SPECIAL	CANDY	DRY GROCERY	M&M MARS M&M PLAIN	1	12.6	OZ
M&M PLN CH/TY SHREK 2 HL	CANDY-CHOCOLATE-SPECIAL	CANDY	DRY GROCERY	M&M MARS M&M PLAIN	1	1.75	OZ
M&M PLN CH DSP STAR WARS	CANDY-CHOCOLATE-SPECIAL	CANDY	DRY GROCERY	M&M MARS M&M PLAIN	1	1.06	OZ
R SSY E-C MSE AP CHFN	COSMETICS-EYE SHADOWS	COSMETICS	HEALTH & BEAUTY CARE	REVLON STAR STYLE	1	0.17	OZ
R SSY E-S PWD SQN	COSMETICS-EYE SHADOWS	COSMETICS	HEALTH & BEAUTY CARE	REVLON STAR STYLE	1	0.05	OZ
AXE AR R TWIST	DEODORANTS - COLOGNE TYPE	DEODORANT	HEALTH & BEAUTY CARE	AXE	1	4	OZ
CTL BR EGGS A LG	EGGS-FRESH	EGGS	DAIRY	CTL BR	1	12	CT
CTL BR B-E JMB	EGGS-FRESH	EGGS	DAIRY	CTL BR	1	12	CT
COKE CLS R CL NB 6P	SOFT DRINKS - CARBONATED	CARBONATED BEVERAGES	DRY GROCERY	COCA-COLA CLASSIC R	6	8	OZ
COKE CLS R CL CN &	SOFT DRINKS - CARBONATED	CARBONATED BEVERAGES	DRY GROCERY	COCA-COLA CLASSIC R	1	12	OZ
GPC 2 UL L M F UT 85 P - .30	CIGARETTES	TOBACCO & ACCESSORIES	NON-FOOD GROCERY	GPC	1	20	CT
GPC 2 UL L M F UT 85 C - 2.00	CIGARETTES	TOBACCO & ACCESSORIES	NON-FOOD GROCERY	GPC	10	20	CT

Sample

- Product modules are finest level of variation in state sales tax exemptions.
- Match Nielsen product module codes to product exemptions in state sales tax data for 2006 (for now).
- Use geographic information on location of store, and collapse data to county x product module, and use largest county in each state in analysis.
- Main outcomes (which vary by state i and module j)
  - Log of # of UPC codes ($\frac{dlogJ}{d\tau}$)
  - Weighted-average price ($\frac{dlogp}{d\tau}$)
  - Total expenditure ($\frac{dlogpQ}{d\tau}$)

Price Elasticity and Love of Variety

- It can be shown that log expenditure share for product j is:

$$logs_j = -\frac{\alpha}{\sigma} logp_j - \frac{\alpha}{\sigma} log\left(\sum_{k=0}^{J} p_k^{-\alpha/\sigma}\right)^{\frac{\sigma}{\alpha}}$$

- The parameter $(\frac{\sigma}{\alpha})$ governs taste for variety *and* price elasticity of demand
- This is feature of logit/CES preferences
- For now, this is how we will recover the taste for variety

Model-Based Estimation

- To derive estimating equation, let m be the module and c be the county.
- We will assume that the county is the market. For market c, we can write:

$$logs_{jmc} = -\frac{\alpha}{\sigma} logp_{jmc} - \frac{\alpha}{\sigma} log\left(\sum_{k=0}^{J_{mc}} p_{kmc}^{-\alpha/\sigma}\right)^{\sigma/\alpha}$$

- Assuming prices are symmetric within module:

$$logs_{mc} = -\frac{\alpha}{\sigma} logp_{mc} + logJ_{mc} - \frac{\alpha}{\sigma} log\left(\sum_{m\prime=1}^{M_c} J_{m\prime c} p_{m\prime c}^{-\alpha/\sigma}\right)^{\sigma/\alpha}$$

Model-based estimation

- Thus:

$$\frac{d\widehat{log(s_{mc})}}{d\tau_{mc}} = -\frac{1}{\frac{\sigma}{\alpha}}(1-\hat{s}_{mc})\frac{d\widehat{log(p_{mc})}}{d\tau_{mc}} + (1-\hat{s}_{mc})\frac{d\widehat{log(J_{mc})}}{d\tau_{mc}}$$

- Assuming s_{mc} is small. It simplifies to:

$$\frac{d\widehat{log(s_{mc})}}{d\tau_{mc}} = -\frac{1}{\frac{\sigma}{\alpha}}\frac{d\widehat{log(p_{mc})}}{d\tau_{mc}} + \frac{d\widehat{log(J_{mc})}}{d\tau_{mc}}$$

- From above formula, can recover estimate $\frac{\sigma}{\alpha}$
- Previous literature does not use exogenous variation in variety to estimate $\frac{\sigma}{\alpha}$.
- By contrast, formula above uses full structure of model to estimate the taste for variety (combining price, quantity, and variety effects).

Empirical Strategy

- To estimate $\frac{dlog(s)}{d\tau}$, $\frac{dlog(p)}{d\tau}$ and $\frac{dlog(J)}{d\tau}$, research design combines both within- and between-state variation in tax rates at state-by-product level.
- Estimating equation is following (where i is state and j is product module):

$$logY_{it} = \gamma_i + \delta_j + \beta \log(1 + \tau_{ij}) + X_i\Gamma + \varepsilon_{ij}$$

- Y_{it} = variety, price and expenditure share
- γ_i = state fixed effect
- δ_j = product module fixed effect
- τ_{ij} = specific tax rate for product j in state i
- X_i = rich set of county demographics (such as income, education, race)
- ε_{ij} = error term

Empirical Strategy

- β = key parameter of interest, the coefficient on $\log(1 + \tau_{ij})$.
- **Key identifying assumption**: conditional on fixed effects and X vector, there are no unobserved determinants of product variety correlated with tax rates.
- Useful placebo test to test plausibility of identifying assumption: take products that are always exempt in all states, variety for them should not vary with statutory tax rate, conditional on fixed effects and controls.

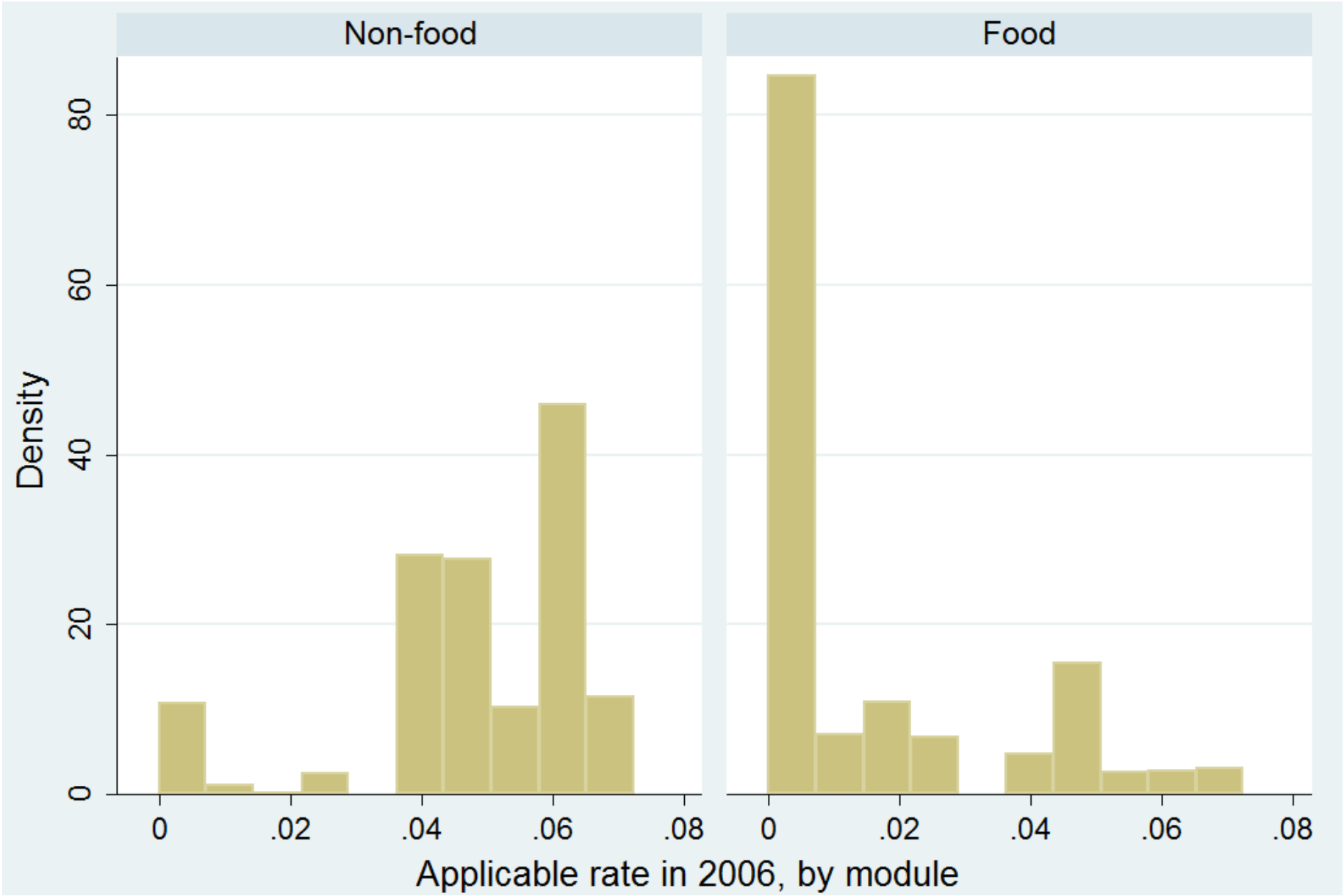
Sales Taxes

- 1930s – retail sales tax introduced in U.S.
- Applies to grocery stores and restaurants
- Depression – exempt food in groceries, tax food in restaurants
- Hugely complicated tax code
- E.g., in CA, cold pastrami tax-exempt, hot pastrami is taxed (prepared food), cold pastrami sandwich you took out exempt, cold pastrami eat inside taxable
- E.g., in NY, burrito constitutes sandwich and taxable, but taco not taxable
- In 1971, CA taxed candy but not cake. Candy lobby fought to have candy tax-exempt and tax was repealed.

Module Description	Avg. Market Share (%)	States taxing all food	States taxing module at reduced rate	States taxing module at full rate
SOFT DRINKS - CARBONATED	2.50	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, TN, UT, VA	CA, CT, FL, IA, IN, KY, MD, ME, MN, NC, ND, NY, OH, PA, RI, TX, WA, WI, WV
DAIRY-MILK-REFRIGERATED	2.28	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	
CEREAL - READY TO EAT	1.68	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	
BAKERY - BREAD - FRESH	1.61	AL, ID, KS, MS, OK, SC, SD	IL, MO, TN, UT, VA, WV	
SOFT DRINKS - LOW CALORIE	1.57	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, TN, UT, VA	CA, CT, FL, IA, IN, KY, MD, ME, MN, NC, ND, NY, OH, PA, RI, TX, WA, WI, WV
WATER-BOTTLED	1.36	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	LA, MD, ME, MN, NY
FRUIT DRINKS-OTHER CONTAINER	1.16	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	
COOKIES	1.13	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	
CANDY-CHOCOLATE	1.09	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, TN, UT, VA	CT, FL, IA, IN, KY, MD, ME, MN, NC, ND, NJ, NY, RI, TN, TX, WI
ICE CREAM - BULK	0.96	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	FL, MD
SOUP-CANNED	0.89	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	
BABY MILK AND MILK FLAVORING	0.79	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	
PIZZA-FROZEN	0.77	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	
YOGURT-REFRIGERATED	0.77	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	
SNACKS - POTATO CHIPS	0.77	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	
GROUND AND WHOLE BEAN COFFEE	0.74	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	
FRUIT JUICE - ORANGE - OTHER CONTAINER	0.72	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, NC, TN, UT, VA, WV	
CANDY-NON-CHOCOLATE	0.72	AL, ID, KS, MS, OK, SC, SD	AR, IL, MO, TN, UT, VA, WV	CT, FL, IA, IN, KY, MD, ME, MN, NC, ND, NJ, NY, RI, TN, TX, WI

Module Description	Avg. Market Share (%)	States with no sales tax	States exempting module	States taxing module at reduced rate
CIGARETTES	2.40	DE, MT, NH, OR	CO, MN, OK	
VIDEO PRODUCTS PRERECORDED	1.60	DE, MT, NH, OR		
TOILET TISSUE	1.39	DE, MT, NH, OR	NJ, PA	
DISPOSABLE DIAPERS	1.16	DE, MT, NH, OR	MA, MN, NJ, PA, VT	IL
DETERGENTS - HEAVY DUTY - LIQUID	1.14	DE, MT, NH, OR		
PAPER TOWELS	0.85	DE, MT, NH, OR	NJ	
COLD REMEDIES - ADULT	0.72	DE, MT, NH, OR	CT, FL, MD, MN, NJ, NY, PA, TX, VA, VT	IL
PAIN REMEDIES - HEADACHE	0.69	DE, MT, NH, OR	CT, FL, MD, MN, NJ, NY, PA, TX, VA, VT	IL
BATTERIES	0.69	DE, MT, NH, OR	FL	
NUTRITIONAL SUPPLEMENTS	0.62	DE, MT, NH, OR	CT, FL, MI, MD, NJ, NY, PA, TX, UT, VT, WY	IL, WV
DOG FOOD - DRY TYPE	0.53	DE, MT, NH, OR		TN
SHAMPOO-AEROSOL/ LIQUID/ LOTION/ POWDER	0.51	DE, MT, NH, OR		IL
DEODORANTS - PERSONAL	0.50	DE, MT, NH, OR		IL
TOOTH CLEANERS	0.49	DE, MT, NH, OR	PA	IL
MAGAZINES SELECTED TITLES	0.49	DE, MT, NH, OR	MA, NY, OK	
FACE CLEANSERS & CREAMS & LOTIONS	0.49	DE, MT, NH, OR		IL
STORAGE AND SPACE MANAGEMENT	0.44	DE, MT, NH, OR		
ANTACIDS	0.42	DE, MT, NH, OR	CT, FL, MD, MN, NJ, NY, PA, TX, VA, VT	IL
FACIAL TISSUE	0.38	DE, MT, NH, OR	NJ	
BABY ACCESSORY	0.38	DE, MT, NH, OR	FL, MD, MN	
HAND & BODY LOTIONS	0.38	DE, MT, NH, OR		IL
SANITARY NAPKINS	0.37	DE, MT, NH, OR	MA, MD, PA	
SOAP - BAR	0.35	DE, MT, NH, OR		IL

Sales Tax Variation



Reduced-form Estimates

Table 2

Main reduced-for results

Dependent variable:	**log of variety (# of UPCs)**		**log of avg. consumer price**		**log of expenditure shares**	
	(1)	(2)	(3)	(4)	(5)	(6)
log(1+tax rate)	-0.076	-0.902	-0.122**	-0.095**	-1.127	-1.937**
	[0.679]	[0.580]	[0.050]	[0.041]	[1.244]	[0.735]
Specification:						
Module fixed effects (430 modu	y	y	y	y	y	y
State fixed effects (48 states)		y		y		y
N	20,638	20,638	20,638	20,638	20,638	20,638
r2	0.979	0.984	0.526	0.564	0.932	0.942

Preliminary model-based estimates

- Recover estimate of $(\frac{\sigma}{\alpha})$ from reduced-form estimates:

$$\frac{\widehat{dlog(s)}}{d\tau} = -1.93, \frac{\widehat{dlog(p)}}{d\tau} = 0.91, \frac{\widehat{dlog(J)}}{d\tau} = -0.90$$

$$=> \frac{\sigma}{\alpha} = \frac{\frac{\widehat{dlog(p)}}{d\tau}}{\frac{dlog(J)}{d\tau} - \frac{dlog(s)}{d\tau}} = \frac{0.91}{-0.90-(-1.93)} = 0.88$$

- Compare to estimate of $(\frac{\sigma}{\alpha})$ ignoring variety effect:

$$=> \frac{\sigma}{\alpha} = \frac{\frac{\widehat{dlog(p)}}{d\tau}}{-\frac{dlog(s)}{d\tau}} = \frac{0.91}{-(-1.93)} = 0.47$$

Preliminary model-based estimates

- Scale welfare change by tax revenue:

$$\frac{\frac{dW}{d\tau}\tau}{\tau pQ} = \frac{\sigma}{\alpha}\frac{d\widehat{log(J)}}{d\tau} + \left(1 - \frac{d\widehat{log(p)}}{d\tau}\right) + \tau\frac{d\widehat{log(pQ)}}{d\tau}$$

$$= (0.88)(-0.90) + (1 - 0.91) + 0.05(-1.93) = -.80$$

- Ignoring variety effect, welfare change is -0.01. Very large share of negative welfare effect comes from variety effect.
- Compare to "standard" formula:

$$\frac{\frac{dW}{d\tau}\tau}{\tau pQ} = \tau\frac{d\widehat{log(pQ)}}{d\tau}$$

$$= 0.05(-1.93) = -.10$$

Conclusion

- Have shown that endogenous product variety can modify conclusions about welfare effect of tax
- Used model-based approach to estimate welfare effects of taxes
- Effect can be quantitatively large and dominate standard effect
- Future work:
  - More data: 2007-2011 scanner data, county sales tax rates
  - Moments rely strongly on symmetric structure; need to evaluate robustness to deviations from this.
  - Use Gentzkow and Shapiro "identification" method
  - Conjecture: with modest heterogeneity, model will provide good first-order approximation to actual welfare change.