Institute for Fiscal Studies

Public policy and food choices

Rachel Griffith, Martin O'Connell and Kate Smith

July 2017

Public policy

- A wide range of policies aim to alter food choices
  - some costs of excess consumption fall on others, e.g. through increased health care costs, lost productivity, etc.
  - some costs fall on the person themselves in the future, but are not fully accounted for, e.g. diet-related disease, child development, etc.
  - public policy can potentially improve welfare by helping people make better choices
- Policy include
  - regulation of location of fast food outlets, products at check out
  - taxes on specific goods such as alcohol or sugary soft drinks
  - restrict advertising of junk foods
  - labelling of food products
  - etc.

Understanding the effects of policy interventions

- The effect of policy will depend on
  - how individuals (consumers) respond
    - it is crucial to understand not only the impact on average, but also how policies affect different individuals
  - how producers and retailers respond
- we have well developed tools to do this
  - understand the determinants of inequalities in outcomes
  - not only evaluate existing policies, but study the reasons why policies work or don't work, and so improve design
  - integrate insights from psychology, sociology, etc. into economic modelling

Research programme at IFS

- Preference formation
  - the role of home and environment in child preference formation
  - interactions between work and food choices
- Self-control and temptation
  - who has self-control problems
  - what factors influence this (advertising, labelling, ...)
- Advertising
  - what affects on consumer choice
  - what is the impact of restrictions or a ban
- Corrective taxes
  - soft drinks levy and sugar taxes
  - alcohol taxes

Alcohol tax design

Role of alcohol taxes

- Widely accepted that alcohol consumption is associated with "social costs", including those imposed:
  - directly on others (e.g. victims of alcohol related crime)
  - on taxpayers (e.g. higher public health and policing costs)
  - on drinkers themselves in the future
- These provide a clear rationale for public policy to discourage socially harmful consumption
- Main role of alcohol tax system is to do this by raising prices and hence discouraging socially costly drinking

Role of alcohol taxes

- Challenge is to design system in way that most efficiently targets socially costly drinking
- Levying very high taxes imposes large costs on consumers, as people derive pleasure through consuming alcohol
- And may actually serve to harm those we're most trying to assist through the policy
  - e.g. if people that suffer in future from disease are very price inelastic

Role of alcohol taxes

- Challenge is to design system in way that most efficiently targets socially costly drinking
- Levying very high taxes imposes large costs on consumers, as people derive pleasure through consuming alcohol
- And may actually serve to harm those we're most trying to assist through the policy
  - e.g. if people that suffer in future from disease are very price inelastic
- Alcohol tax should target the most socially harmful drinking
- And rates will depend importantly on price responsiveness of different types of drinkers

Research question

- How can alcohol taxes best be designed to target problem drinking?
  - Write down and solve model of government's task in setting alcohol tax rates
  - Use longitudinal data on representative sample of British households' grocery purchases to estimate consumer choice in alcohol market
  - Combine to compute "optimal" alcohol taxes for UK

Government's tax problem

- Consider government to set tax rates on ethanol content of alcohol products
- Aim is to discourage most socially costly alcohol consumption, taking account of fact that higher taxes also impose costs on consumers
- We consider a single ethanol tax rate
  - Optimal rate is increasing in the covariance of social harm drinkers create and how price sensitive their ethanol choices are to price increases
- And optimal "alcohol type" tax rates
  - These can improve on a single rate by allowing government to tax more highly products that problem drinkers will switch away from more strongly

▸ Details

Estimating consumer choice

- Optimal tax rates depend on consumer's price sensitivities
  - If tax on one type of alcohol is raised, how strongly do people switch from it?
  - And to what alternatives and how strongly do they switch?
- Crucially we need to know not just average responses, but how they vary across different groups (e.g. heavy drinks, responsible for bulk of social costs, versus light drinkers)

Data

- We use data from Kantar Worldpanel:
  - Contain rich product information (including prices)
  - Many repeated observation for each household
- Panel of 11,634 households
- Use pre-sample period (2010) to group households into lightest to heaviest drinkers based on quintile of drinking distribution ▸ Fig
- Estimate consumer choice using data for 2011
- Data cover off-trade market (grocery stores and off licenses) – covers around 77% of alcohol market
- We group 7000 UPCs into 69 product-sizes

Choice model

- Challenge in demand estimation arises when consumers select only one (or a small number) of options at one time
- Solutions include
  - Aggregate all alcohol together

Choice model

- Challenge in demand estimation arises when consumers select only one (or a small number) of options at one time
- Solutions include
  - Aggregate all alcohol together – Cannot obtain switching patterns between different types of alcohol

Choice model

- Challenge in demand estimation arises when consumers select only one (or a small number) of options at one time
- Solutions include
  - Aggregate all alcohol together – Cannot obtain switching patterns between different types of alcohol
  - Estimate continuous demand over alcohol types

Choice model

- Challenge in demand estimation arises when consumers select only one (or a small number) of options at one time
- Solutions include
  - Aggregate all alcohol together – Cannot obtain switching patterns between different types of alcohol
  - Estimate continuous demand over alcohol types – Statistical problem of zero demands

Choice model

- Challenge in demand estimation arises when consumers select only one (or a small number) of options at one time
- Solutions include
  - Aggregate all alcohol together – Cannot obtain switching patterns between different types of alcohol
  - Estimate continuous demand over alcohol types – Statistical problem of zero demands
  - Discrete choice model

Choice model

- Challenge in demand estimation arises when consumers select only one (or a small number) of options at one time
- Solutions include
  - Aggregate all alcohol together – Cannot obtain switching patterns between different types of alcohol
  - Estimate continuous demand over alcohol types – Statistical problem of zero demands
  - Discrete choice model
- Advantage of latter is it is designed to capture people purchasing one or small number of products
- And it's very well suited to capture variation in parameters (and hence switching patterns) across people

Choice model

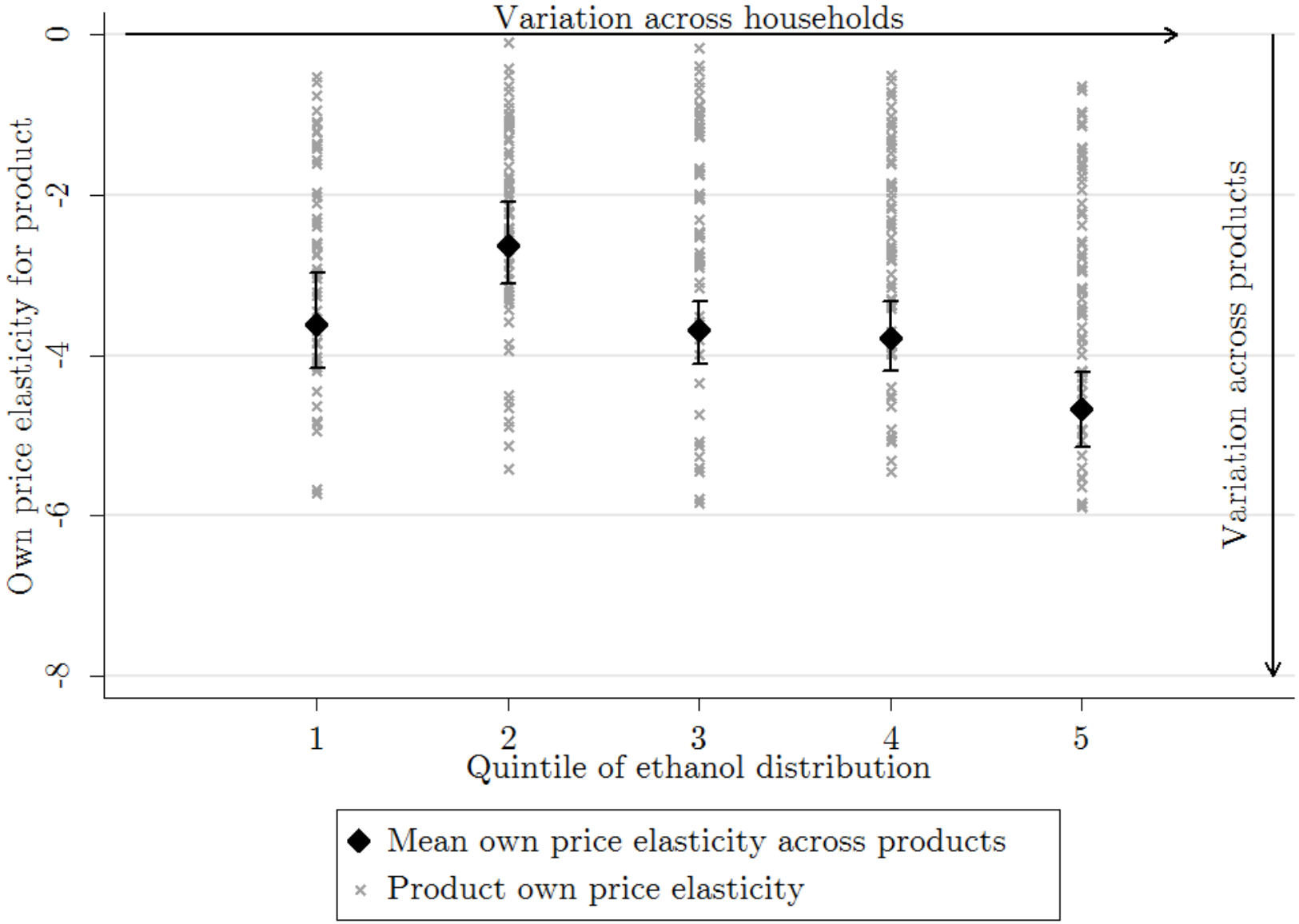
- Model captures decision household makes when visiting the store over:
  - Whether or not to buy alcohol
  - Which product to buy (e.g. branded vodka vs. own brand gin)
  - How much to buy
- Yields estimates of own and cross price elasticities at product level
  - What is change in demand for 0.7l bottle of vodka if it's price increases by a given amount
  - What is change in demand for other products (0.7l bottle of gin, 500ml of craft beer etc)
- Plus price effects for alcohol at a whole
- And crucially, how these price effects vary across people (e.g. with how much alcohol they purchase in the long run)

▸ Details

Price elasticities

- Product own price elasticities:
  - As an example, price elasticity for 0.7l bottle of vodka is -4 for lightest group of drinkers and -3.7 for heaviest
  - Variation across products is substantial; variation in average across drinkers modest
- Product cross price elasticities:
  - As an example, cross price elasticity between 0.7l bottle of gin and vodka is 0.02 for lightest group of drinkers and 0.08 for heaviest
  - Variation across products is substantial; variation in average across drinkers also large
- Overall ethonal price elasticity
  - Ranges from -2.1 for lightest to -1.0 for heaviest drinkers

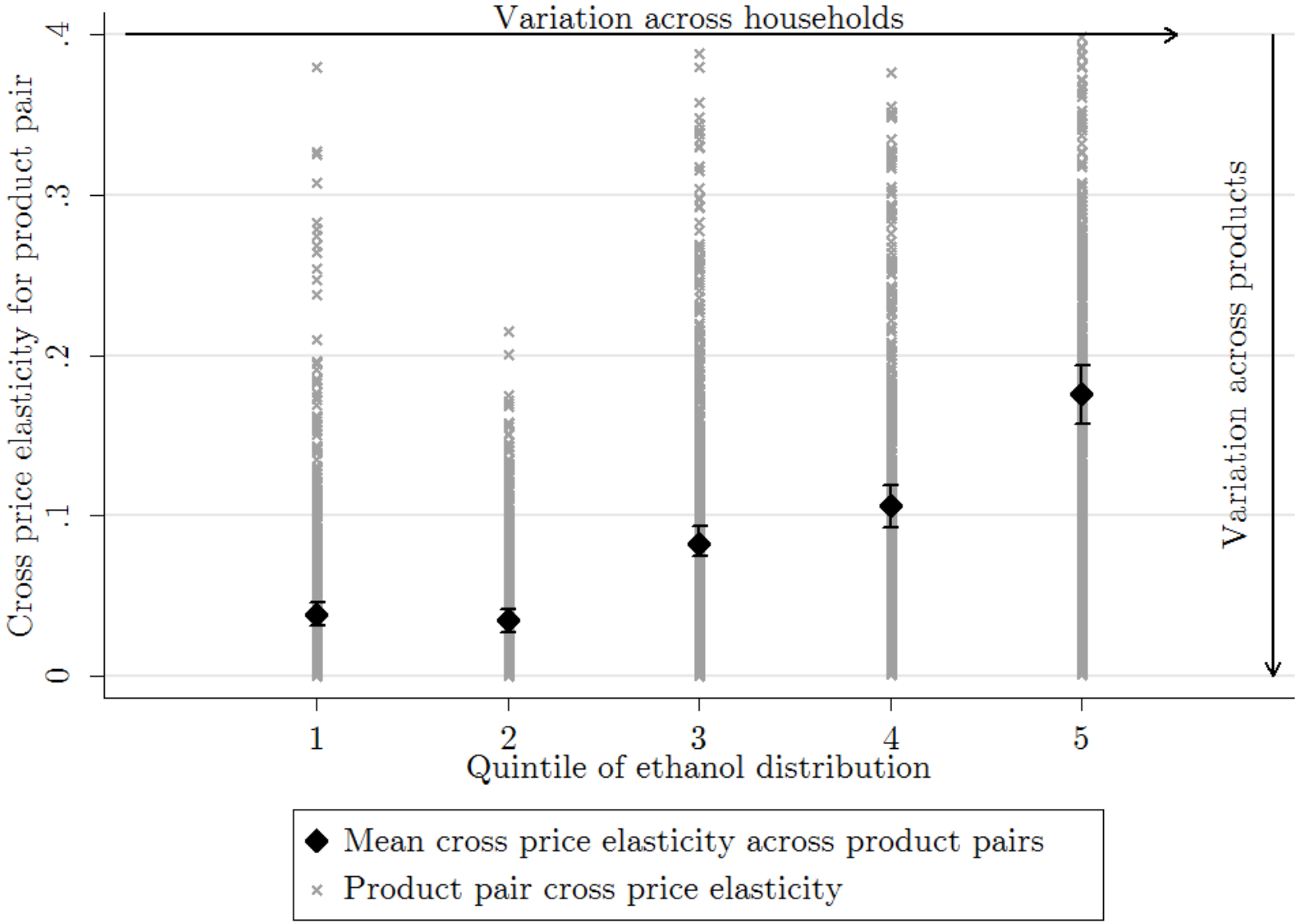
Product own price elasticities



Price elasticities

- Product own price elasticities:
  - As an example, price elasticity for 0.7l bottle of vodka is -4 for lightest group of drinkers and -3.7 for heaviest
  - Variation across products is substantial; variation in average across drinkers modest
- Product cross price elasticities:
  - As an example, cross price elasticity between 0.7l bottle of gin and vodka is 0.02 for lightest group of drinkers and 0.08 for heaviest
  - Variation across products is substantial; variation in average across drinkers also large
- Overall ethonal price elasticity
  - Ranges from -2.1 for lightest to -1.0 for heaviest drinkers

Product cross price elasticities



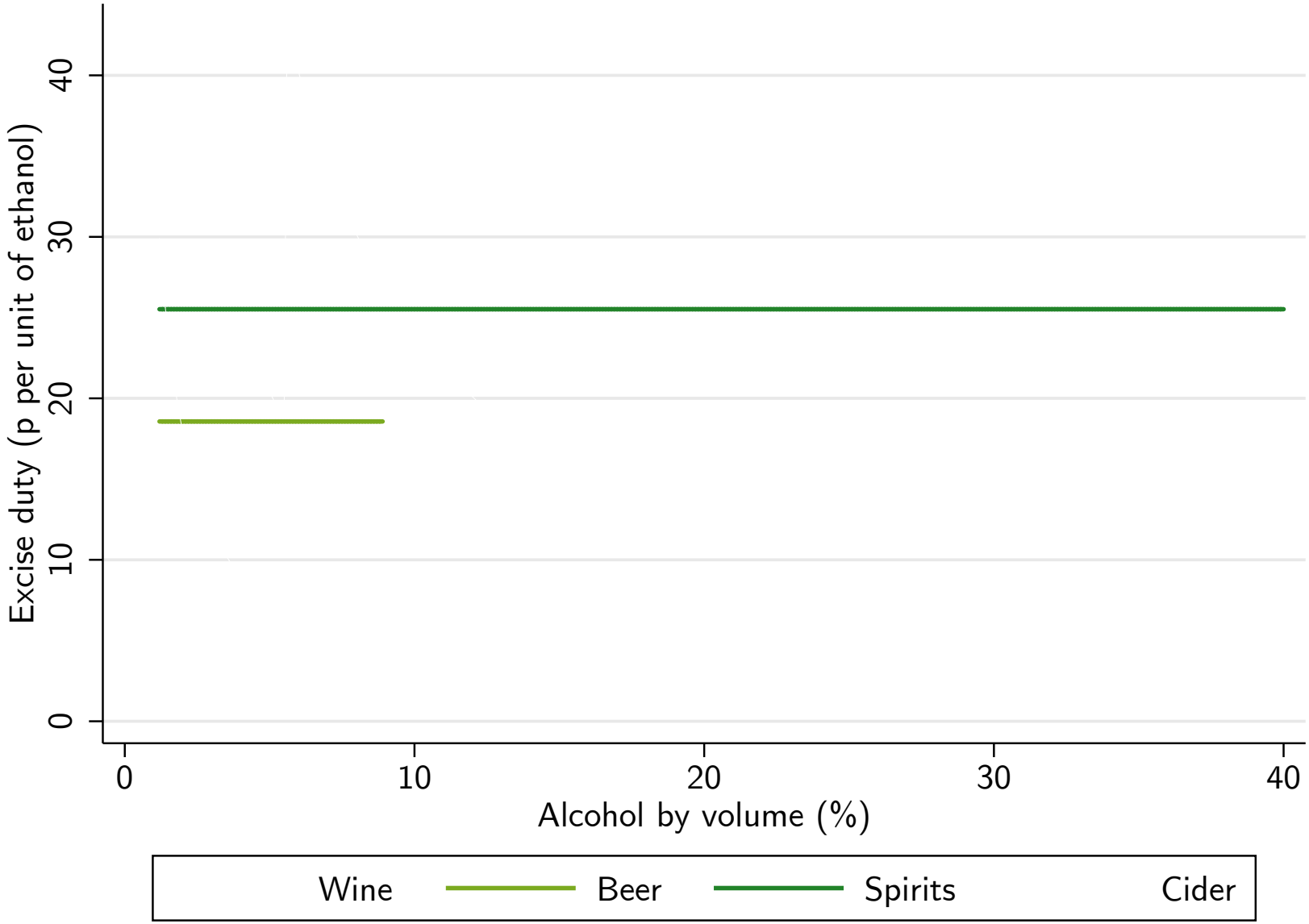
Price elasticities

- Product own price elasticities:
  - As an example, price elasticity for 0.7l bottle of vodka is -4 for lightest group of drinkers and -3.7 for heaviest
  - Variation across products is substantial; variation in average across drinkers modest
- Product cross price elasticities:
  - As an example, cross price elasticity between 0.7l bottle of gin and vodka is 0.02 for lightest group of drinkers and 0.08 for heaviest
  - Variation across products is substantial; variation in average across drinkers also large
- Overall ethonal price elasticity
  - Ranges from -2.1 for lightest to -1.0 for heaviest drinkers

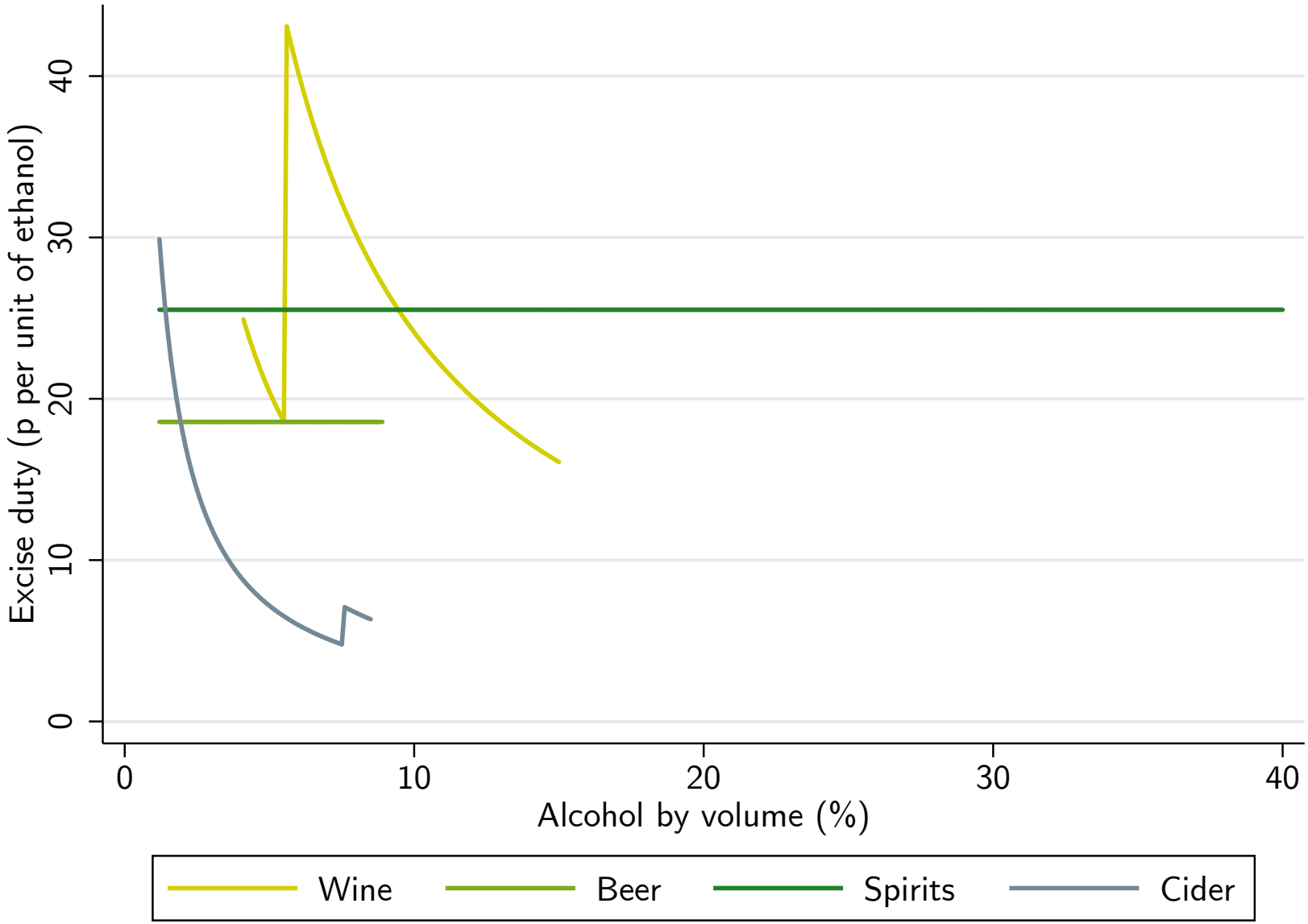
Computing alcohol tax rates

- We combine estimates of alcohol choice behaviour with evidence on how these choices map into social costs
- Exact quantitative results depend on how concentrated social costs are among heavy drinkers
- Qualitative results hold across broad range of calibrations

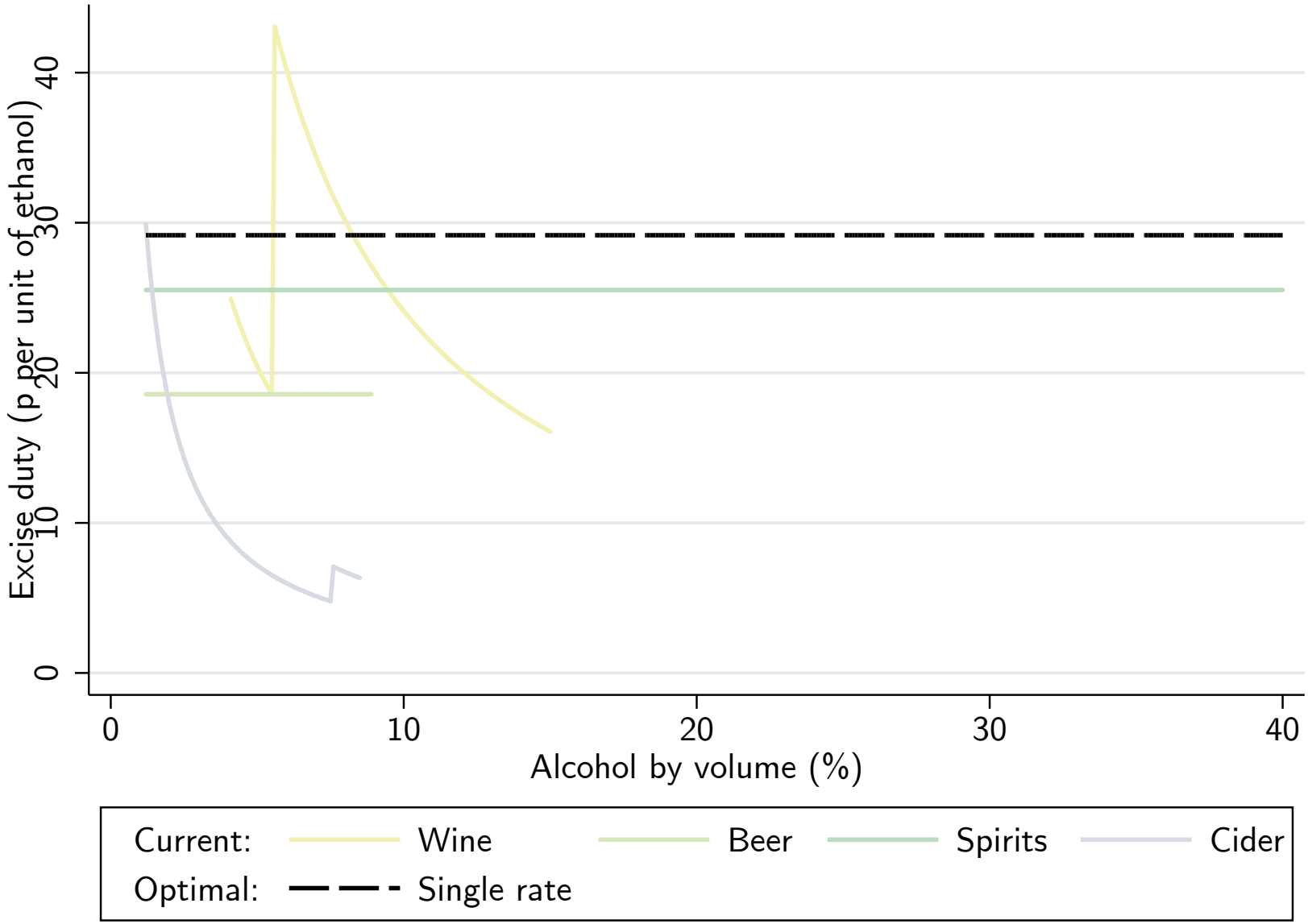
Current UK system



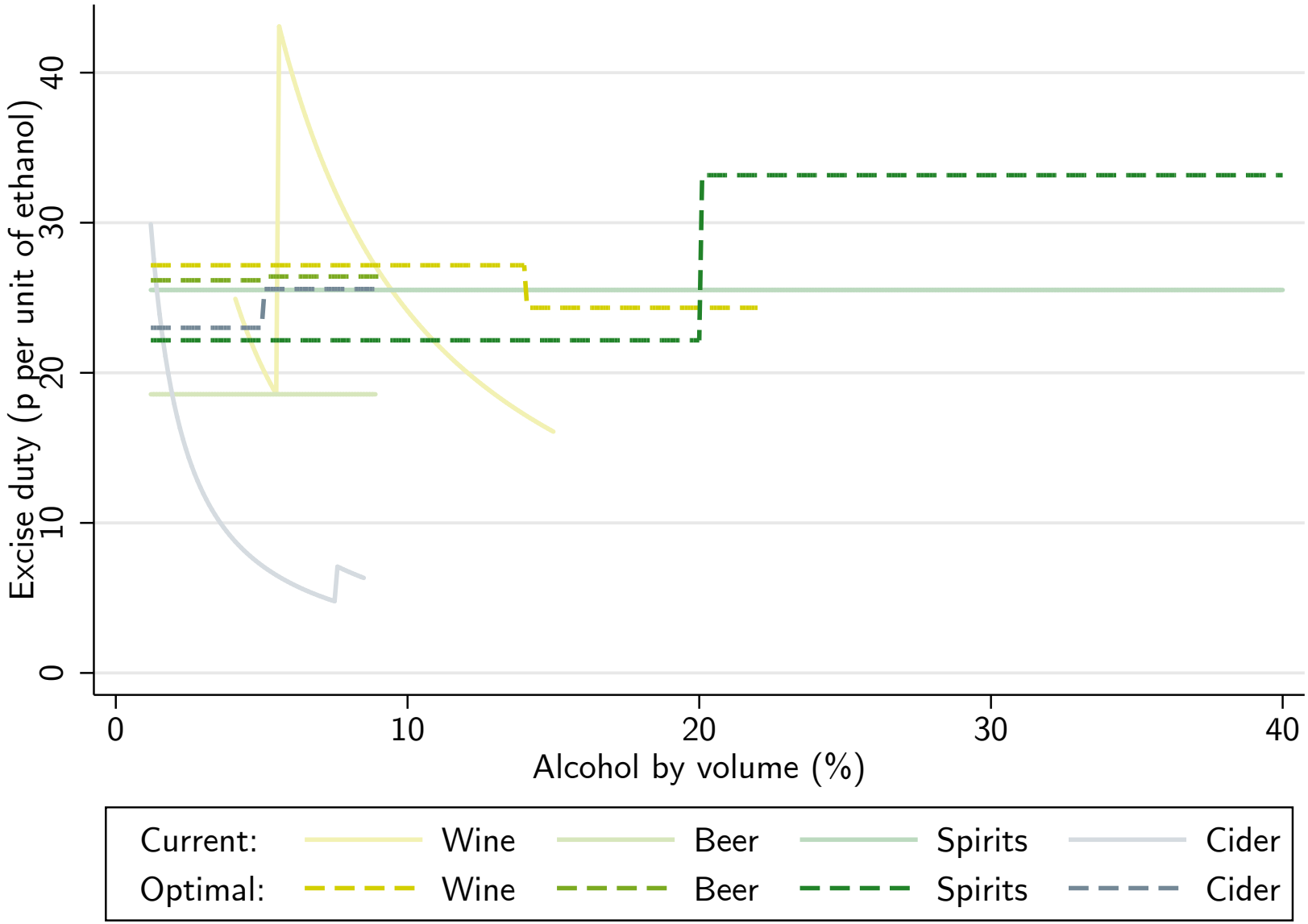
Current UK system



Optimal single rate



Optimal multi rate



Summary

- In this work we take leading edge economics and apply it directly to policy relevant question
- Important to capture how different people switch across products in response to price changes
- We show how UK tax system could be redesigned to substantially improve outcomes

- Project ties into broader agenda in which we also study self control problems, advertising, sugar policy, role played by industry ...

APPENDIX

Consumer demand

Consumer indirect utility:

$$V_i(y_i, \mathbf{p}, \mathbf{x}) = \alpha_i y_i + v_i(\mathbf{p}, \mathbf{x})$$

- i consumers; j alcohol products
- y_i income; α_i marginal utility of income
- $\mathbf{p} = (p_1, \ldots, p_J)'$ post-tax prices
- $\mathbf{x}_j$ product characteristics; first element z_j ethanol

Yields demand functions:

$$q_{ij} = f_{ij}(\mathbf{p}, \mathbf{x})$$

which we collect in a vector, $\mathbf{q}_i = (q_{i1}, \ldots, q_{iJ})'$

External costs of alcohol consumption

- Alcohol consumption generates costs that are not considered by the individual when making their consumption decision e.g. health care costs, crime costs

- We specify the external cost from consumption as a function of derived ethanol demand $Z_i = \sum_j z_j q_{ij}$

- The external cost associated with consumer i's ethanol consumption is $\phi_i(Z_i)$, and total external costs are $\Phi = \sum_i \phi_i(Z_i)$

- Consumers ignore the externality when making choices; the goal of the planner is to use taxes to get consumers to internalise the externality

Social planner's problem

- The social planner trades off benefits of minimising social costs and minimising the reduction in consumer surplus that arises due to the higher prices

Social planner's problem

- The social planner trades off benefits of minimising social costs and minimising the reduction in consumer surplus that arises due to the higher prices

- The planner sets rates, τ, levied per unit of ethanol

Social planner's problem

- The social planner trades off benefits of minimising social costs and minimising the reduction in consumer surplus that arises due to the higher prices

- The planner sets rates, τ, levied per unit of ethanol

- To maximise the sum of consumer surplus and tax revenue minus the externality cost:

$$\max_{\tau} W(\tau) = \underbrace{\sum_i \left[y_i + \frac{v_i(\tau)}{\alpha_i} \right]}_{\text{consumer surplus}} + \underbrace{R(\tau)}_{\text{tax revenue}} - \underbrace{\Phi(\tau)}_{\text{external costs}}$$

Social planner's problem

- The social planner trades off benefits of minimising social costs and minimising the reduction in consumer surplus that arises due to the higher prices

- The planner sets rates, τ, levied per unit of ethanol

- To maximise the sum of consumer surplus and tax revenue minus the externality cost:

$$\max_{\tau} W(\tau) = \underbrace{\sum_i \left[y_i + \frac{v_i(\tau)}{\alpha_i} \right]}_{\text{consumer surplus}} + \underbrace{R(\tau)}_{\text{tax revenue}} - \underbrace{\Phi(\tau)}_{\text{external costs}}$$

Social planner's problem

- The social planner trades off benefits of minimising social costs and minimising the reduction in consumer surplus that arises due to the higher prices

- The planner sets rates, τ, levied per unit of ethanol

- To maximise the sum of consumer surplus and tax revenue minus the externality cost:

$$\max_{\tau} W(\tau) = \underbrace{\sum_i \left[y_i + \frac{v_i(\tau)}{\alpha_i} \right]}_{\text{consumer surplus}} + \underbrace{R(\tau)}_{\text{tax revenue}} - \underbrace{\Phi(\tau)}_{\text{external costs}}$$

Social planner's problem

- The social planner trades off benefits of minimising social costs and minimising the reduction in consumer surplus that arises due to the higher prices

- The planner sets rates, τ, levied per unit of ethanol

- To maximise the sum of consumer surplus and tax revenue minus the externality cost:

$$\max_{\tau} W(\tau) = \underbrace{\sum_i \left[y_i + \frac{v_i(\tau)}{\alpha_i} \right]}_{\text{consumer surplus}} + \underbrace{R(\tau)}_{\text{tax revenue}} - \underbrace{\Phi(\tau)}_{\text{external costs}}$$

Social planner's problem

- The social planner trades off benefits of minimising social costs and minimising the reduction in consumer surplus that arises due to the higher prices

- The planner sets rates, $\boldsymbol{\tau}$, levied per unit of ethanol

- To maximise the sum of consumer surplus and tax revenue minus the externality cost:

$$\max_{\boldsymbol{\tau}} W(\boldsymbol{\tau}) = \underbrace{\sum_i \left[y_i + \frac{v_i(\boldsymbol{\tau})}{\alpha_i} \right]}_{\text{consumer surplus}} + \underbrace{R(\boldsymbol{\tau})}_{\text{tax revenue}} - \underbrace{\Phi(\boldsymbol{\tau})}_{\text{external costs}}$$

- Notice under consumer specific taxes, we get first best $\tau_i^* = \phi_i'(Z_i(\tau_i^*))$

Optimal tax policy

- Now suppose planner can set alcohol type tax rates $\boldsymbol{\tau} = (\tau_1, ..., \tau_K)'$ (with $K \leq J$); rate τ_k applies to products in set $\mathcal{K}_k$
- Define ethanol from alcohol type k as $Z_{ik} = \sum_{j \in \mathcal{K}_k} q_{ij}(\boldsymbol{\tau}) z_j$
- Optimal tax rates pinned down by first order conditions for $l = 1, ..., K$

$$\sum_i \sum_k (\tau_k - \phi_i') \frac{\partial Z_{ik}}{\partial \tau_l} = 0$$

Back

Optimal tax policy

- Now suppose planner can set alcohol type tax rates $\boldsymbol{\tau} = (\tau_1, ..., \tau_K)'$ (with $K \leq J$); rate τ_k applies to products in set $\mathcal{K}_k$
- Define ethanol from alcohol type k as $Z_{ik} = \sum_{j \in \mathcal{K}_k} q_{ij}(\boldsymbol{\tau}) z_j$
- Optimal tax rates pinned down by first order conditions for $l = 1, ..., K$

$$\sum_i \sum_k (\tau_k - \phi_i') \frac{\partial Z_{ik}}{\partial \tau_l} = 0$$

- Optimal taxes will vary across k as long as it is not the case that $\text{Cov}(\phi_i', Z_{ikl}') = 0 \; \forall (k, l)$ – i.e. as long as:
  - There is heterogeneity in externalites ($\phi_i \neq \phi$),
  - There is heterogeneity in demands ($Z_{ik} \neq Z_k \; \forall \; k$), and
  - Both forms of heterogeneity are correlated

Back

Discrete choice demand

- j product, s size; $j = 0, s = 0$ no purchase outside option
- Utility household i obtains from selecting option (j, s) in period t is given by:

$$u_{ijst} = \nu(p_{jst}, z_{js}, \mathbf{x}_{jst}; \theta_i) + \epsilon_{ijst}$$

  where ϵ_{ijst} is distributed Type I extreme value

- Households i's demand for option (j, s) is

$$q_{ijst} = \frac{\exp(\nu(p_{jst}, z_{js}, \mathbf{x}_{jst}; \theta_i))}{1 + \sum_{j'>0, s'>0} \exp(\nu(p_{j's't}, z_{j's'}, \mathbf{x}_{j's't}; \theta_i))}$$

- And expected utility is

$$v_{it}(\mathbf{p}_{jt}, \mathbf{z}_{jst}, \mathbf{x}_{jst}) = \ln \sum_{j>0, s>0} \exp\{\nu(p_{jst}, z_{js}, \mathbf{x}_{jst}; \theta_i)\} + C$$

Utility specification

- We model utility household i obtains from selecting option (j, s) in period t as

$$\nu(.) = \alpha_i p_{jst} + \beta_i w_j + \sum_{m=1}^{4} 1[j \in \mathcal{M}_m] \cdot (\gamma_{i,1m} z_{js} + \gamma_{i,2m} z_{js}^2) + \xi_{ijt}.$$

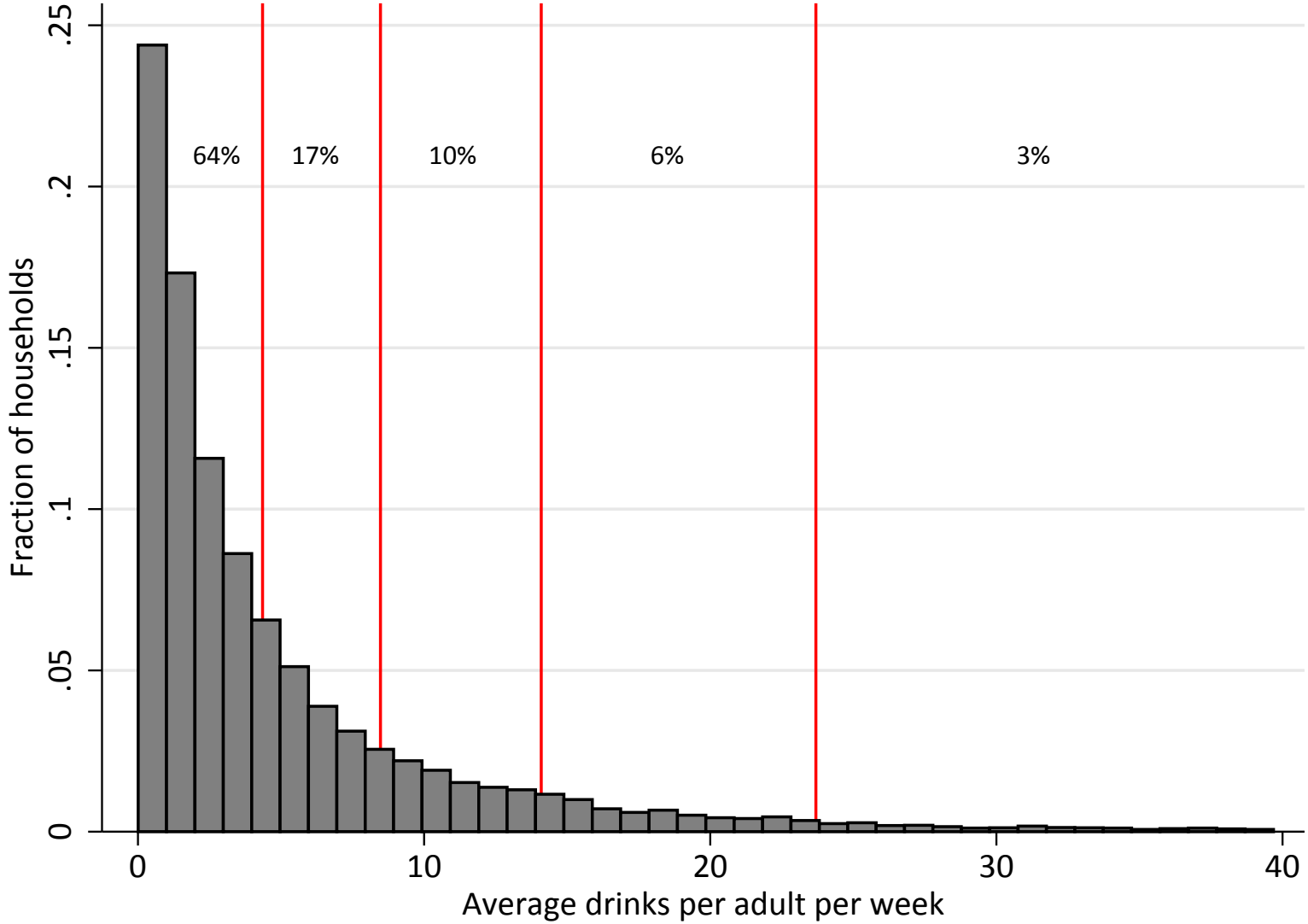
  where p is price, w is strength, z is ethanol and $m = 1, ..., 4$ indexes beer, wine, spirits and cider segments

- Unobserved product characteristic:

$$\xi_{ijt} = \eta_{ij} + \zeta_{k_j t}$$

Back

Distribution of drinkers



Back