Prices versus Preferences: Taste Change and Tobacco Consumption

AEA Session:
Revealed Preference Theory and Applications: Recent Developments

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- Also consider how tastes evolve across different socio-economic strata. Does education matter?

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- Use this approach to address the question: How much of the fall in tobacco consumption is due to the rising price in the relative price of tobacco and how much can be attributed to taste changes?
- Also consider how tastes evolve across different socio-economic strata. Does education matter?
- Implemented on household consumer expenditure survey data using RP inequality conditions on the conditional quantile demand functions for tobacco.

Taste Change

- Consumer i's maximisation problem can be expressed as:

$$\max_{\mathbf{q}} u^i(\mathbf{q}, \boldsymbol{\alpha}_t^i) \text{ subject to } \mathbf{p}'\mathbf{q} = x$$

where $\mathbf{q} \in \mathbb{R}_+^K$ denotes the demanded quantity bundle, $\mathbf{p} \in \mathbb{R}_{++}^K$ denotes the exogenous price vector faced by consumer i and x gives total expenditure.

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- Using this framework we derive revealed preference inequality conditions that incorporate minimal perturbations to preferences to account for taste change.

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Consumer i's choice behaviour, $\{\mathbf{p}_t, \mathbf{q}_t^i\}_{t=1,\ldots,T}$, can be "taste rationalised" by a utility function $u^i(\mathbf{q}, \boldsymbol{\alpha}^i)$ and the temporal series of taste parameters $\{\boldsymbol{\alpha}_t^i\}_{t=1,\ldots,T}$ if the following set of inequalities is satisfied:

$$u^i(\mathbf{q}, \boldsymbol{\alpha}_t^i) \leq u^i(\mathbf{q}_t^i, \boldsymbol{\alpha}_t^i)$$

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- In words, observed behaviour can be rationalised if an individual's choice at t yields weakly higher utility than all other feasible choices at t when evaluated with respect to their time t tastes.

Marginal utility (MU) perturbations

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$$u^i(\mathbf{q}, \boldsymbol{\alpha}_t^i) = v^i(\mathbf{q}) + \boldsymbol{\alpha}_t^{i\prime}\mathbf{q}, \text{ where } \boldsymbol{\alpha}_t^i \in \mathbb{R}^K.$$

- Under this specification, $\alpha_t^{i,k}$ can be interpreted as the taste shift in the marginal utility of good k at time t. The theorems below implies this specification is not at all restrictive.

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- Observed choice behaviour, $\{\mathbf{p}_t, \mathbf{q}_t^i\}_{t=1,\ldots,T}$, can be "good-1 taste rationalised" if the following set of inequalities are satisfied:

$$v^i(\mathbf{q}^i) + \alpha_t^{1i} q^{1i} \leq v^i(\mathbf{q}_t^i) + \alpha_t^{1i} q_t^{1i}$$

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- We show the individual utility function, $u^i(\mathbf{q}, \alpha^{1i}) = v^i(\mathbf{q}) + \alpha^{1i} q^1$ satisfies single crossing in $(\mathbf{q}, \alpha^1)$ space.

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Theorem

The following statements are equivalent:

1. *Individual i's observed choice behaviour, $\{\mathbf{p}_t, \mathbf{q}_t^i\}_{t=1,...,T}$, can be good-1 rationalised by the set of taste shifters $\{\alpha_t^{1i}\}_{t=1,...,T}$.*
2. *One can find sets $\{v_t^i\}_{t=1,...,T}$, $\{\alpha_t^{1i}\}_{t=1,...,T}$ and $\{\lambda_t^i\}_{t=1,...,T}$ with $\lambda_t^i > 0$ for all $t = 1, ..., T$, such that there exists a non-empty solution set to the following inequalities:*

$$\begin{array}{rcl} v_s^i - v_t^i + \alpha_t^{1i}(q_s^{1i} - q_t^{1i}) & \leq & \lambda_t^i \mathbf{p}_t'(\mathbf{q}_s^i - \mathbf{q}_t^i) \\ \alpha_t^{1i} & \leq & \lambda_t^i p_t^{1i} \end{array}$$

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- These inequalities are a simple extension of Afriat (1967). When they hold there exists a well-behaved base utility function and a series of taste shifters on good-1 that perfectly rationalise observed behaviour.

We can then show, under mild assumptions on the characteristics of available choice data, that we can always find a pattern of taste shifters on a single good that are sufficient to rationalise observed choices:

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Definition

There is "perfect intertemporal variation" in good k if $q_t^{k,i} \neq q_s^{k,i}$ for all $t, s = 1, ..., T$.

Theorem

Given an individual i's observed choice behaviour, $\{\mathbf{p}_t, \mathbf{q}_t^i\}_{t=1,...,T}$ where good-1 exhibits perfect intertemporal variation, one can always find sets $\{v_t^i\}_{t=1,...,T}$, $\{\alpha_t^{1i}\}_{t=1,...,T}$ and $\{\lambda_t^i\}_{t=1,...,T}$ with $\lambda_t^i > 0$ for all $t = 1, ..., T$, such that there exists a non-empty solution set to the following inequalities:

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Minimal Taste Change

The minimal squared taste perturbations, relative to tastes in period 1, necessary to rationalise the observed choice behaviour of individuals $i = 1, ..., N$, $\{\mathbf{p}_t, \mathbf{q}_t^i\}_{t=1,...,T}$, are uniquely identified as the set $\{\alpha_t^i\}_{t=1,...,T}^{i=1,...,N}$ from the following quadratic programming procedure:

$$\min_{\{v_t^i, \lambda_t^i, \alpha_t^i\}_{t=1,...,T}} \sum_{t=1}^{T} \alpha_t^{i\prime} \alpha_t^i$$

subject to the rationalisation constraints:

$$\begin{aligned} v_s^i - v_t^i + \alpha_t^i (q_s^{1i} - q_t^{1i}) &\leq \lambda_t^i \mathbf{p}_t' (\mathbf{q}_s^i - \mathbf{q}_t^i) \\ \alpha_t^i &\leq \lambda_t^i p_t^{1i} \end{aligned}$$

and a set of normalisation conditions: $v_1^i = \delta, \lambda_1^i = \beta, \alpha_1^i = 0$, for $i = 1, ..., N$ and $s, t = 1, ..., T$.

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- In implementation we are effectively making a 'common base utility' assumption on marginal utility, ensuring taste change is measured relative to a common scale.

VIRTUAL PRICES AND TASTE CHANGE.

- Given a finite data set $\{\mathbf{p}_t, \mathbf{q}_t^i\}_{t=1,\ldots,T}$, where $\mathbf{q}^i \in \mathbb{R}_+^K$ that satisfies "perfect variation" in some good k, then taste change on the K-dimensional demand system can be summarised by a unidimensional taste parameter in the direct utility function when following a fully nonparametric empirical strategy.

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- The output of the quadratic programming procedure can be used to recover the virtual price of good-1 that supports observed choices. Given the output $\{\widehat{v}_t^i, \widehat{\lambda}_t^i, \widehat{\alpha}_t^i\}_{t=1,\ldots,T}^{i=1,\ldots,N}$, the lowest virtual price of good-1 that individual i could face is constructed as:

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- Taste change can then be represented as variation by agent specific virtual prices, with the term

$$\widehat{\tau}_t^i = \widehat{\alpha}_t^i / \widehat{\lambda}_t^i$$

representing the individual 'taste wedge.'

Empirical Strategy

- Our empirical analysis uses data drawn from the U.K. Family Expenditure Survey (FES) between 1980 and 2000.
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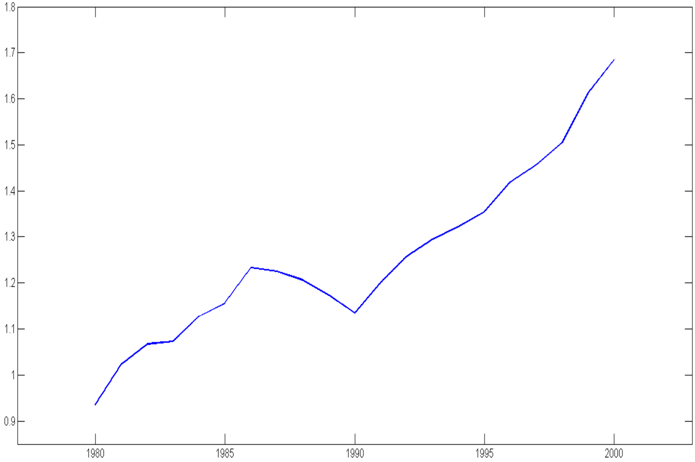
- In our empirical application, we evaluate the minimal taste evolution along the SMP path starting at the *median* demand in 1980 for this cohort and then continues sequentially over time to select the demand that is just weakly preferred to the SMP demand in the previous period.

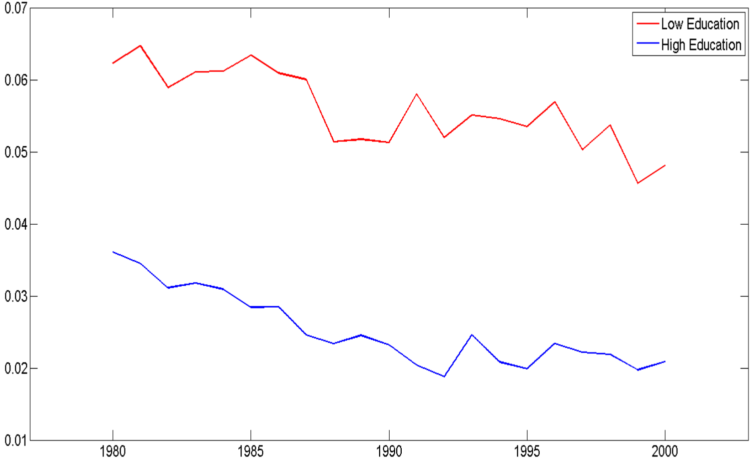
Results

Tobacco Price



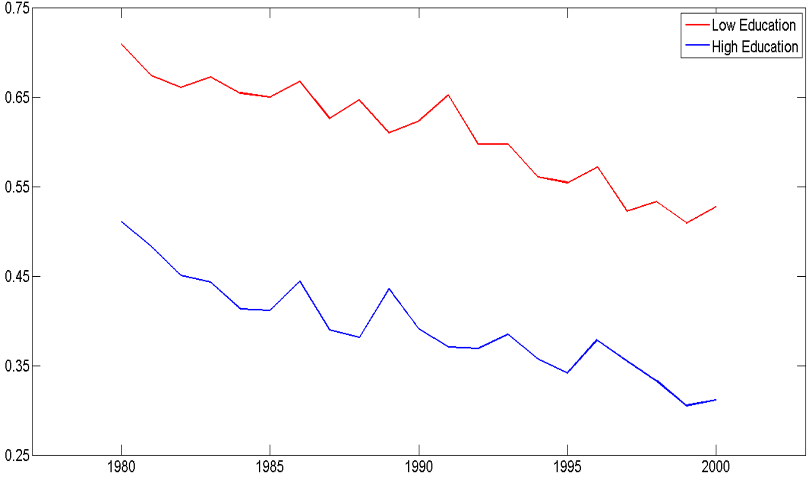
Results

Budget Share Tobacco



Results

Proportion Smoking



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- The quantile rank of an individual α identifies the quantile rank of their tobacco demand. Quantile regression models also allow covariates to shift the location, scale and shape of the distribution of tobacco budget shares at each price regime.
- These demands are then used in the quadratic programming procedure to recover minimal taste change for tobacco at different quantiles of the tobacco distribution for each education group.

RESULTS

- Minimal virtual prices along each psuedo cohort's SMP path are recovered as:

$$\widehat{\pi}_t^{c,\epsilon} = p_t^1 - \frac{\widehat{\alpha}_t^{c,\epsilon}}{\widehat{\lambda}_t^{c,\epsilon}}$$

The "taste wedge", $\widehat{\alpha}_t^{c,\epsilon}/\widehat{\lambda}_t^{c,\epsilon}$ represents the change in the marginal willingness to pay for tobacco relative to base tastes.

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3. The taste change trajectories for light and moderate smokers in the high education cohort are similar.

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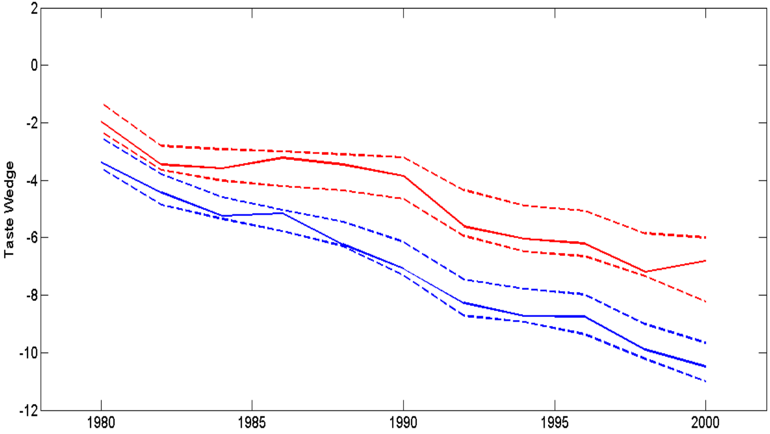
3. The taste change trajectories for light and moderate smokers in the high education cohort are similar.
4. Education is irrelevant for explaining the evolution of virtual prices amongst heavy smokers.

Results

Taste Wedge (55th quantile) - moderate smokers

(low ed in red and high ed in blue)



Results

Taste Wedge (65th quantile)

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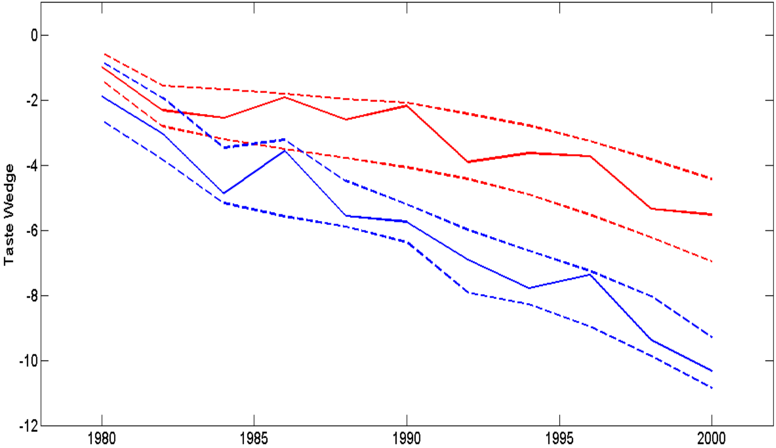

Results

Virtual price (65th quantile)

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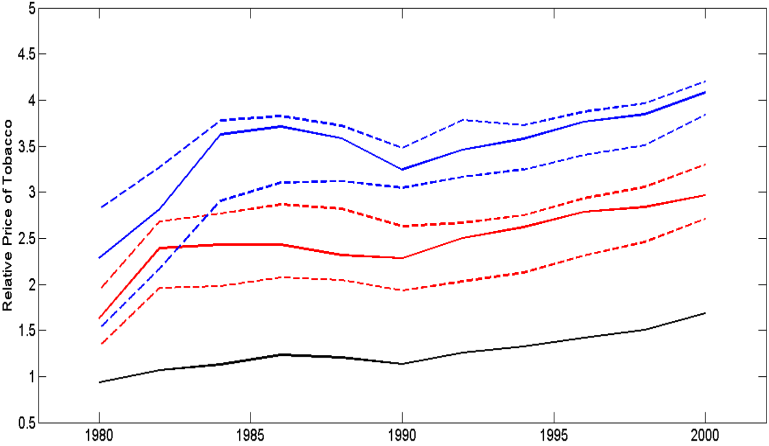

RESULTS

TASTE WEDGE (75TH QUANTILE) - HEAVY SMOKERS

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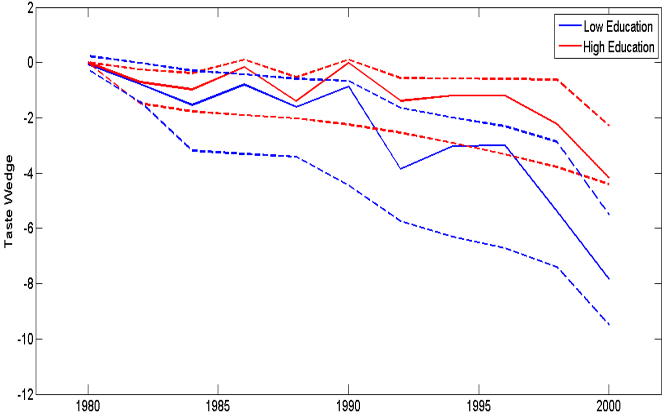

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- To relax this weak separability assumption we re-run our quadratic programming procedure on quantile demands that are estimated *conditional on alcohol consumption*.
- We partition the set of observations into "light" and "heavy" drinkers depending on whether an individual demands below or above the median budget share for alcohol.

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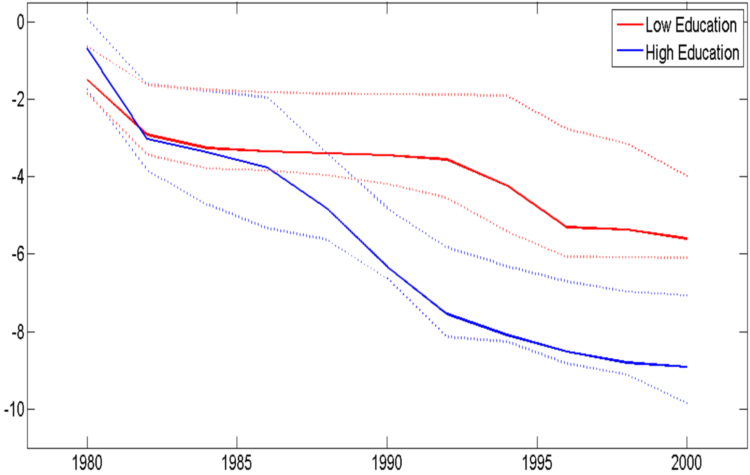
- To relax this weak separability assumption we re-run our quadratic programming procedure on quantile demands that are estimated *conditional on alcohol consumption*.
- We partition the set of observations into "light" and "heavy" drinkers depending on whether an individual demands below or above the median budget share for alcohol.
- The significant difference by education group in the evolution taste change for light and moderate smokers is robust to non-separability.
- 95% confidence intervals on virtual prices and the taste wedge are disjoint across education groups for all cohorts except for the "heavy smoking"-"heavy drinking" group. Effective tastes for this group evolved very little for both education groups.

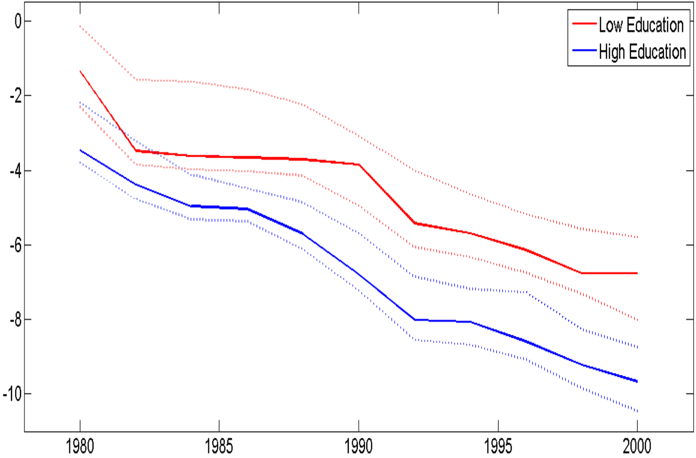
Results: Conditional Quantiles

Taste Wedge (65th quantile), High Alcohol



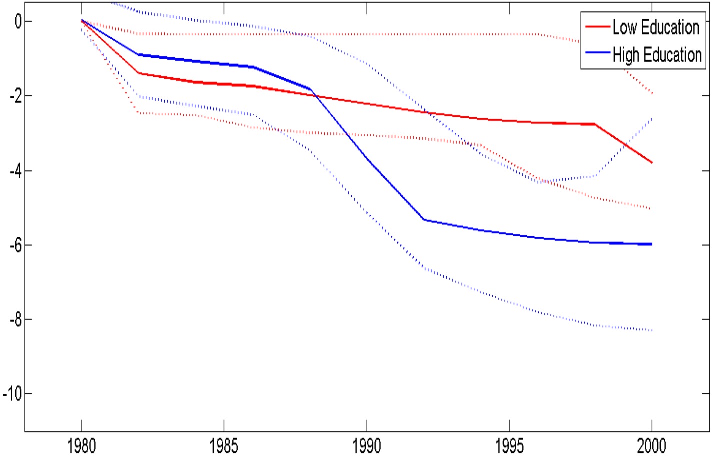
Results: Non-separable Conditional Quantile

Taste Wedge (65th quantile), Moderate Smoker, Low Alcohol



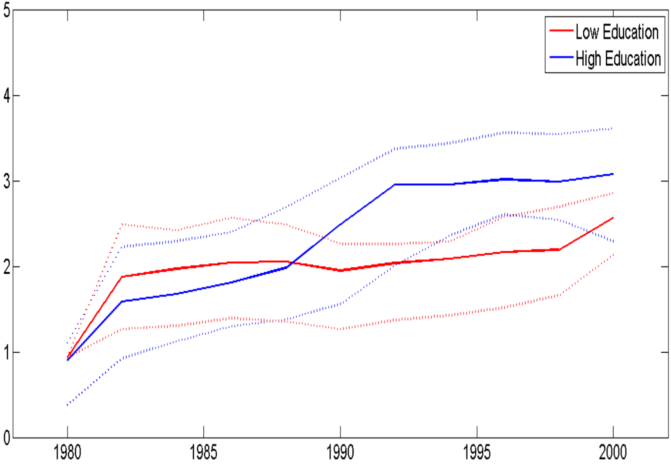
Results: Non-separable Conditional Quantile

Taste Wedge (75th quantile), Heavy Smoker, High Alcohol



Results: Non-separable Conditional Quantile

Effective tastes (75th quantile), Heavy Smoker, High Alcohol



Summary and Conclusions I

- This paper has provided a theoretical and empirical framework for characterising taste change.
- We have uncovered a surprising non-identification result: observational data sets on a K-dimensional demand system can always be rationalised by taste change on a single good in a nonparametric setting.
- Our theoretical results were used to develop a quadratic programming procedure to recover the minimal intertemporal (and interpersonal) taste heterogeneity required to rationalise observed choices.
- A censored quantile approach was used to allow for unobserved heterogeneity and censoring of consumption.
- Non-separability between tobacco and alcohol consumption was incorporated using a conditional (quantile) demand analysis.
- Future work will use intertemporal RP conditions to recover the path of λ_t.

Summary and Conclusions II

- Taste change was required for all groups in our expenditure survey data.
- A series of strictly negative perturbations to the marginal utility of tobacco were found to be sufficient to rationalise the trends in tobacco consumption.
- Statistically significant educational differences in the marginal willingness to pay for tobacco were recovered; more highly educated cohorts experienced a greater shift in their effective tastes away from tobacco.
- We find virtual prices and the taste wedge are disjoint across education groups for all cohorts except for the "heavy smoking"-"heavy drinking" group.
- Education is irrelevant for explaining the evolution of virtual prices amongst heavy smokers. This might suggest diminished differences in smoking behaviour by education group in the future.