

A new year, a new you?

Temptation and self-control in food purchases

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joint work with

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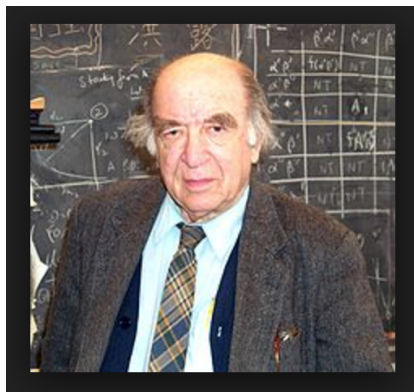
Kate Smith and Frederic Vermeulen

Lecture in Honour of Leonid Hurwicz

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Leonid Hurwicz

"I had the belief that many troubles you could observe ... were due to politicians not understanding economic phenomena. Even if they had good intentions, they didn't have the skills to solve problems."



Introduction

- ▶ The theoretical and behavioural literatures posits that consumers have self-control problems and have a taste for immediate gratification
 - ▶ if these errors are large public policy can potentially improve welfare by increasing the cost of consumption today to reflect the unanticipated future costs or by facilitating the use of other commitment devices
- ▶ Governments are increasingly adopting policy with this rationalisation
 - ▶ "nudge units" in the UK and US have encouraged this
- ▶ Yet we know little about the extent of these self-control problems
 - ▶ based on lab experiments, or correlations that do not adequately separately out heterogeneity in preferences and other potentially confounding issues from behaviour that represents time inconsistency
- ▶ We aim to learn about the extent of self-control problems in food choices

Policy relevance

- ▶ A range of policies are predicated on the idea that people suffer from these self-control problems in food choices
 - ▶ regulate the location of fast food outlets
 - ▶ tax specific goods such as soda or sugary soft drinks
 - ▶ restrict advertising of junk foods
- ▶ For example, corrective taxes
 - ▶ traditional used to address externalities
 - ▶ taxes on fuel, alcohol, tobacco, gambling are examples
 - ▶ more recently advocated to reduce consumption that imposes costs on your future self, **“internalities”**
 - ▶ Gruber and Koszegi, 2004; ODonoghue and Rabin, 2006; Haavio and Kotakorpi, 2011; Allcott, Mullainathan and Taubinsky, 2014, ...
 - ▶ which individuals suffer from these internalities, and to what extent

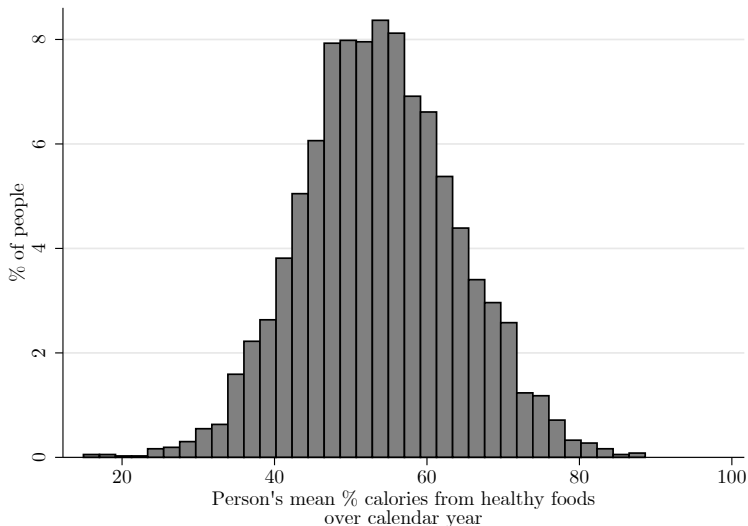
Example, soda or sugary drinks taxes

- ▶ Soda taxes largely aim to correct for internalities
 - ▶ people make errors, we might be able to design policies to help them make better choices
 - ▶ but only if they respond to tax, if they have inelastic demand they might both pay the tax and bear the internal costs in future
 - ▶ poverty is correlated with errors (possibly causally related) so maybe distributional concerns
- ▶ In order to evaluate the efficiency and equity implications of recently introduced soda taxes we need to
 - ▶ estimate shape of demand
 - ▶ and how this correlates with marginal internalities
 - ▶ we have well developed tools that allow us to understand the shape of demand, but less good evidence identifying which individuals suffer from internalities, and by how much

Self-control

- ▶ We are interested in understanding the extent to which individuals make decisions over food choices that they later regret
 - ▶ this is a lack of self-control
 - ▶ a lack of self-control is a deviation from an individual's stable or long-run preferences
 - ▶ these stable preferences will be heterogenous across individuals
- ▶ There is considerable heterogeneity
 - ▶ across individuals in the mean share of healthy food
 - ▶ in the extent of variation over time
 - ▶ in the extent and periodicity with which individuals vary

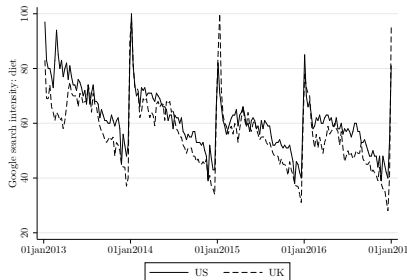
Mean share of calories from “healthy” foods



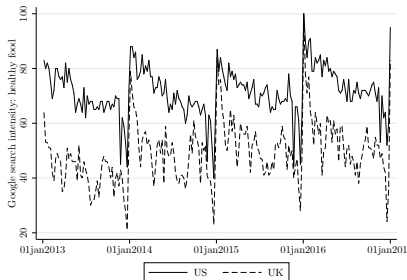
Self-control problems?

Google search intensity for “healthy food”

(a) Searches for “Diet”

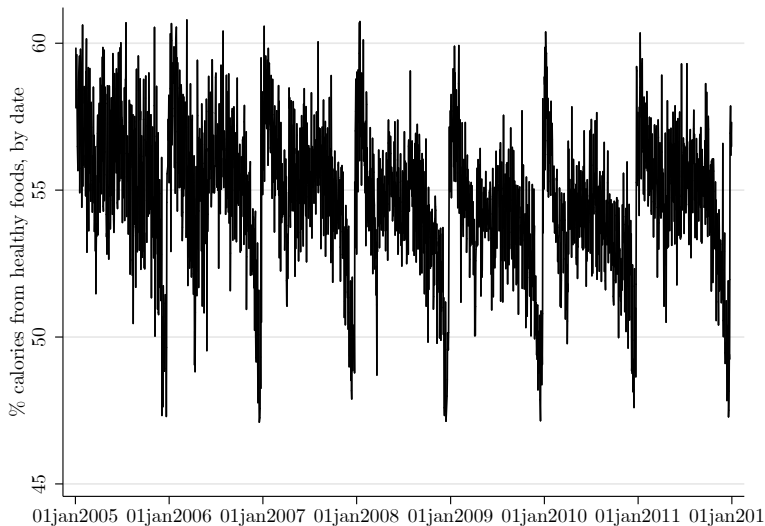


(b) Searches for “Healthy food”



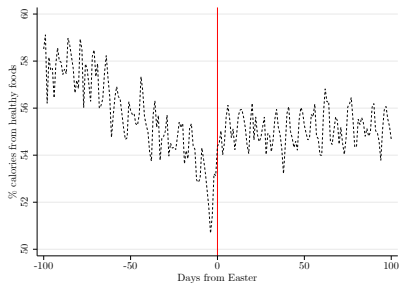
Self-control problems?

Share of calories from “healthy” foods declines from January to December

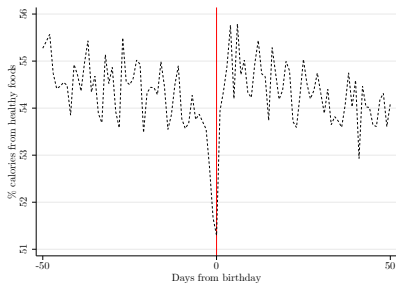


It's not only New Year

(a) Easter



(b) Birthdays



The need for a model of demand

- ▶ These patterns could be driven by temptation and a lack of self-control
 - ▶ potentially affected by external factors, such as advertising
- ▶ or could be rational responses to changes in economic environment
 - ▶ if the relative prices of healthy and unhealthy foods varies over time
 - ▶ or if (un)healthy foods are a luxury and total food budgets fluctuated
 - ▶ variation in share of healthy food over time could then be rationalised by a utility function with stable preference
- ▶ Motivates the need for a model of demand that we can take to data
 - ▶ important that it can accommodate considerable heterogeneity, so that we can distinguish self-control problems from differences in stable preferences

Model of demand

- ▶ We present a two-selves model of demand
 - ▶ incorporates both cross sectional and within person preference heterogeneity
 - ▶ allows us to capture the possibility of self-control problems
- ▶ We use a revealed preference methodology
 - ▶ show that the observed purchasing behaviour can largely be rationalised by the two-selves model
 - ▶ the test is non-parametric and done separately for each individual so accounts for very rich preference heterogeneity

A two-selves model

- ▶ We model an individual's food purchase behaviour as a compromise between two selves
 - ▶ each has stable preferences over separate food and drink baskets
 - ▶ a healthy self
 - ▶ products associated with a healthy lifestyle such as fruits, vegetables and whole grains
 - ▶ an unhealthy self
 - ▶ products such as soda drinks, crisps and confectionery
 - ▶ the allocation of products between the two selves is determined endogenously and is individual specific

Multi-selves models

- ▶ Rich theoretical literature using multiple-selves models
 - ▶ Strotz (1955), Peleg and Yaari (1973), Gul and Pesendorfer (2001, 2004), Kalai et al. (2002), Fudenberg and Levine (2006), Manzini and Mariotti (2007, 2015, 2016), Spiegler (2010), de Clippel and Eliaz (2012), Ambrus and Rozen (2015), ...
- ▶ Captures the concepts of temptation, commitment and naivete
 - ▶ sophisticated consumer can anticipate the choices of the unhealthy self and engage in (potentially costly) actions to limit temptation
 - ▶ a naive consumer makes dynamically inconsistent choices, reneges on the intended choices of the healthy self
- ▶ Our definition of temptation is closely related to this literature
 - ▶ an increase in the influence of the unhealthy (short-run) self in decision making indicates succumbing to temptation (a lack of self-control)
 - ▶ importantly, we measure temptation as within consumer deviations in choices over time, allowing for heterogeneity in preferences

Self-control

- ▶ The two selves engage in a bargaining game with each other with bargaining power that can change over time
- ▶ Self-control implies the bargaining power of the two selves is stable through time
 - ▶ self-control can arise either from an intrinsic psychological trait or from external commitment devices
- ▶ Lack of self-control implies that the bargaining power of the unhealthy self will sometimes become stronger, the individual succumbs to temptation, with a deterioration of diet quality
 - ▶ from time to time, for example New Year, Valentines Day or a major birthday, the individual makes a resolution to have a more healthy diet, translates into (temporarily) higher bargaining power of the healthy self

Collective models

- ▶ We make use of the sharing rule concept, which is often used to quantify the bargaining power of individuals in collective models
 - ▶ popular in the household economics literature (Chiappori (1988, 1992), Browning and Chiappori (1998), Chiappori and Ekeland (2009), Dunbar et al. (2013) and Browning et al. (2013))
- ▶ We consider an individual with a healthy and an unhealthy self characterized by (different) rational preferences and they enter into a bargaining process that results in a Pareto optimal outcome
 - ▶ the sharing rule describes the variation in an individual's food basket over time due to variation in the bargaining weight between the healthy and unhealthy selves
 - ▶ we are agnostic about the specific interaction between the selves, meaning that our approach encompasses most of the multiple-selves models in the theoretical literature

Revealed preference methods

- ▶ We first check whether the theoretical implications of our two-selves model are satisfied for our data
 - ▶ make use of revealed preference methods in the tradition of Samuelson (1938), Afriat (1967) and Varian (1982) and methods developed to apply these to collective choice behaviour (Cherchye, De Rock and Vermeulen (2007, 2011) and Cherchye, De Rock, Lewbel and Vermeulen (2015)
 - ▶ these allow us to evaluate the empirical fit of our two-selves model without the need to make assumptions about the parametric specification of demand
 - ▶ and to fully account for variation in preferences across individuals
- ▶ We then recover the sharing rule by estimating a flexible reduced form demand equation

Application to food choices

- ▶ We study decisions over food purchases and the nutritional characteristics of individual's food basket
 - ▶ this is an area where the literature has emphasised that some consumers may suffer from self-control problems (Downs et al. (2009), O'Donoghue and Rabin (2000), Gul and Pesendorfer (2001))
 - ▶ and where it has potentially important welfare consequences (Finkelstein et al. (2013), Cawley (2000), Bhattacharya and Sood (2011))
- ▶ Considerable attention on the empirical variation in diet quality across individuals and impact on rising obesity and diet-related disease
 - ▶ Cutler et al. (2003), Cutler and Lleras-Muney (2010), Finkelstein and Zuckerman (2008), Baum and Ruhm (2009), Bleich et al. (2008)
- ▶ Much less attention has been paid to the empirical variation in diet quality within person over time

Data

- ▶ One important reason for a lack of research studying variation in diet quality within person over time has been a lack of suitable data
- ▶ We exploit longitudinal data on grocery purchases (Kantar Worldpanel)
 - ▶ 3,645 single individuals in UK over 2005–2011
 - ▶ all grocery purchases brought into the home
 - ▶ at least 24 months of data on each individual
 - ▶ transaction level, include price, nutrient information
 - ▶ we aggregate 100,000s of food products into 85 food items
 - ▶ we aggregate to the month level
 - ▶ price for a food item is a price index of products within that group

Measuring diet quality

- ▶ We are interested in the diet quality of an individual's grocery basket
 - ▶ diet quality is a complicated object
 - ▶ it relates to the appropriate balance of different nutrients
- ▶ We use the nutrient profiling score (NPS)
 - ▶ converts the multidimensional nutrient profile of a food product into a single dimensional score, which indexes its nutritional quality
 - ▶ healthy products have low score, pulses and vegetables have scores around -10
 - ▶ unhealthy products like chocolates and biscuits have scores over 20
 - ▶ used by the UK Food Standard Agency (FSA), and the UK advertising regulator Ofcom to determine the healthiness of a product
 - ▶ the FSA and Ofcom consider scores below 4 “healthy”

Data structure

- ▶ individuals $i \in \{1, \dots, I\}$
- ▶ consumption bundles contain healthy and unhealthy foods and drinks
 - ▶ H_i , healthy items such as fruits, vegetables and whole grains
 - ▶ L_i , unhealthy foods such as sugary drinks, crisps and confectionary
 - ▶ the i subscripts reflect the fact that individuals may have different views on the nutritional quality of specific food items
- ▶ We observe T grocery baskets purchased by each individual i
 - ▶ \mathbf{q}_{it}^h quantities of the healthy food items
 - ▶ \mathbf{q}_{it}^l quantities of the less healthy food items
 - ▶ \mathbf{p}_t^h and \mathbf{p}_t^l market prices
 - ▶ $x_{it} = x_{it}^h + x_{it}^l = \mathbf{q}_{it}^h \mathbf{p}_t^h + \mathbf{q}_{it}^l \mathbf{p}_t^l$, individual's total food budget

Two-selves model of demand

- ▶ healthy self consumes only \mathbf{q}_{it}^h , with well-behaved utility $u^{ih}(\mathbf{q}_i^h)$
- ▶ unhealthy self consumes only \mathbf{q}_{it}^l , with well-behaved utility $u^{il}(\mathbf{q}_i^l)$
- ▶ Pareto efficiency implies that observed food purchase behaviour $(\mathbf{q}_{it}^h, \mathbf{q}_{it}^l)$ can be represented as the solution to:

$$\max_{\mathbf{q}_i^h, \mathbf{q}_i^l} \mu_{it} u^{ih}(\mathbf{q}_i^h) + (1 - \mu_{it}) u^{il}(\mathbf{q}_i^l)$$

subject to

$$\mathbf{p}_t^h \mathbf{q}_i^h + \mathbf{p}_t^l \mathbf{q}_i^l \leq x_{it}$$

- ▶ μ_{it} represents the bargaining weight of the healthy self
- ▶ it will depend on food prices $(\mathbf{p}_t^h, \mathbf{p}_t^l)$ and total food expenditures x_{it}

The bargaining weight and sharing rule

- ▶ The bargaining weight also potentially depends on other \mathbf{z}_{it} that affect the bargaining weight but not preferences or the budget constraint
 - ▶ allows us to capture behavioural aspects without leaving behind the assumption of rational choice behaviour altogether
- ▶ We quantify the influence of both selves using the sharing rule (Chiappori, 1988 and Chiappori and Ekeland, 2009)
 - ▶ the sharing rule distributes the total food budget x_{it} of individual i between the healthy and unhealthy selves
 - ▶ in our setting there is a one-to-one relation between the bargaining weight and the sharing rule
 - ▶ we can empirically recover the sharing rule and study the effects of prices, total food expenditures and factors that enter \mathbf{z}_{it}

Revealed preference test

- ▶ We check behavioural consistency with the two-selves model
 - ▶ requires verifying for each self separately that there exist a utility level and marginal utility of income that are consistent with the data (i.e. that the data satisfy the Afriat Conditions)
 - ▶ use standard linear programming techniques to verify rationalisability of self j 's behaviour
- ▶ If the two selves pass this check, then we conclude that the individual behaves in terms of two selves maximising their stable rational preferences subject to their budget constraints
 - ▶ fully non-parametric test, does not depend on any functional form assumptions
 - ▶ can be obtained and applied to each individual separately, so avoids homogeneity assumptions across individuals

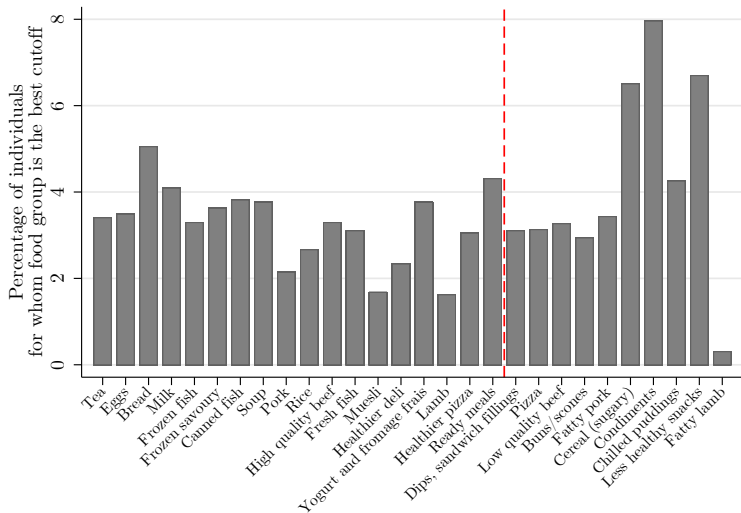
Goodness of fit

- ▶ The Afriat Condition provides an exact test of stable rational preferences
 - ▶ either the data satisfy the condition or they do not
- ▶ It is interesting to measure how close the observed behaviour is to exact rationalisability in the case where the Afriat Condition is violated
 - ▶ we use a two-selves, weighted version of the Afriat Index
 - ▶ a widely used measure to assess the goodness-of-fit of the rationalisability condition in revealed preference applications

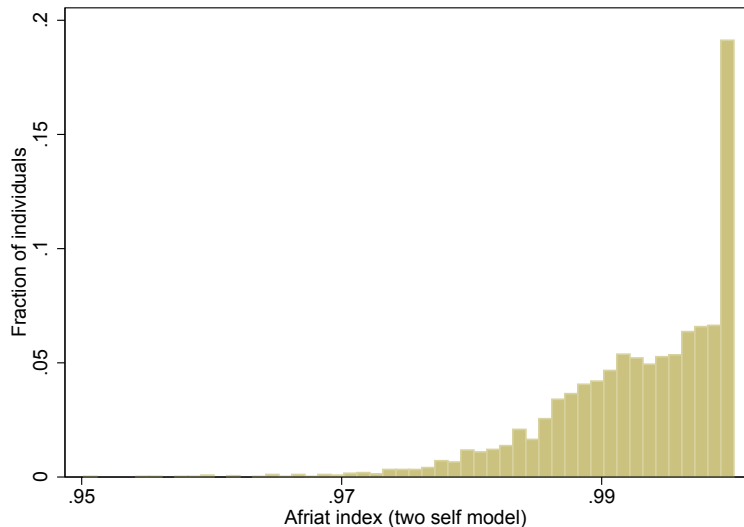
What is a healthy product?

- ▶ People might differ in terms of what is and what is perceived to be “healthy” and “unhealthy”, we classify foods into 3 categories
- ▶ definitely healthy
 - ▶ 34 food items with Nutritional Profile Score less than 0
- ▶ definitely unhealthy
 - ▶ 24 food items with Nutritional Profile Score greater than 10
- ▶ maybe healthy, maybe unhealthy
 - ▶ 27 food items with Nutritional Profile Score between 0 and 10
 - ▶ for each individual we empirically identify the cutoff within these 27
 - ▶ we compute the Afriat Index evaluated at each possible cut off and choose the classification that corresponds to the highest index value
 - ▶ this allows an additional degree of heterogeneity in individuals' definition and perceptions of what are healthy and unhealthy food

Estimated cutoff between healthy and unhealthy foods



Afriat indices for two-selves model



Power and fit

- ▶ The two-selves model fits better than a single-self model
 - ▶ pass rate is about twice as high with the two-selves model
 - ▶ the Afriat index is higher in around two-thirds of cases
- ▶ A two-selves model with fixed bargaining weights has a zero pass rate and Afriat indices that are everywhere substantially lower than with the time varying bargaining weights
- ▶ We also conduct a test of power
 - ▶ based on Becker (1962), measuring the probability of rejecting the rationalisability condition for a randomly drawn consumption bundles, and show that power is high

Recovering the sharing rule

- ▶ The sharing rule is a monotonic transform of the bargaining weight μ_{it} in our context
 - ▶ the two-selves model gives a structural interpretation to the share of spending on healthy food
- ▶ We recover the empirical counterpart
 - ▶ we partition the vector z into observable and unobserved components,

$$\eta_{it} = g_i(\mathbf{p}_t, x_{it}, z'_{it}, \epsilon_{it})$$

where η_{it} , \mathbf{p}_t , x_{it} and z'_{it} are observed and ϵ_{it} is a scalar unobservable

- ▶ Challenges in estimating g_i
 - ▶ it is a consumer specific non-parametric function with arguments that include 85 prices, expenditure, other covariates and a potentially non-separable unobservable ϵ_{it}

Recovering the sharing rule

- ▶ We assume
 - ▶ the unobservable is separable,

$$\eta_{it} = g_i(\mathbf{p}_t, x_{it}, z'_{it}) + \epsilon_{it}$$

- ▶ the price vector can be approximated by two price indices, one for healthy foods, and one for unhealthy foods,

$$\eta_{it} = g_i(\Pi_{it}^h, \Pi_{it}^l, x_{it}, z'_{it}) + \epsilon_{it}$$

- ▶ and approximate $g_i(\cdot)$ by,

$$\eta_{it} = \alpha_i + \beta_i \ln \left(\frac{\Pi_{it}^h}{\Pi_{it}^l} \right) + \gamma_i \left(\widetilde{\ln x_{it}} \right) + \lambda_i \left(\widetilde{\ln x_{it}} \right)^2 + \delta_i z'_{it} + \epsilon_{it}$$

where $\widetilde{\ln x_{it}}$ is real food expenditure

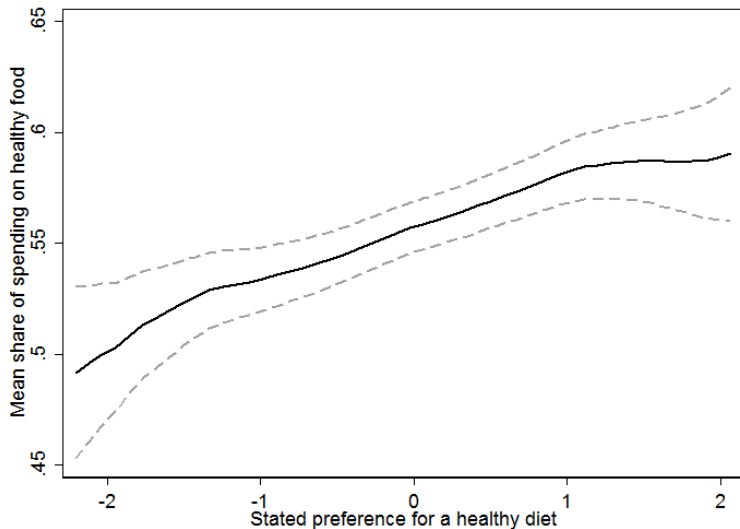
Recovering the sharing rule

- ▶ We estimate

$$\eta_{it} = \alpha_i + \beta_i \ln \left(\frac{\pi_{it}^h}{\pi_{it}^l} \right) + \gamma_i \left(\widetilde{\ln x_{it}} \right) + \lambda_i \left(\widetilde{\ln x_{it}} \right)^2 + \delta_i z'_{it} + \epsilon_{it}$$

- ▶ instrument for potential endogeneity of expenditure and prices
- ▶ We are primarily interested in the estimates of α_i and ϵ_{it}
 - ▶ α_i captures i 's mean preference for healthy over unhealthy foods
 - ▶ ϵ_{it} measures an individual's deviation from their mean sharing rule
 - ▶ the variation of these deviations, e.g. $\sigma_i = \mathbf{sd}(\epsilon_{it})$, is a measure of the extent to which an individual suffers from a lack of self-control

The mean sharing rule, $\hat{\alpha}_i$, increases with stated preferences for a healthy diet

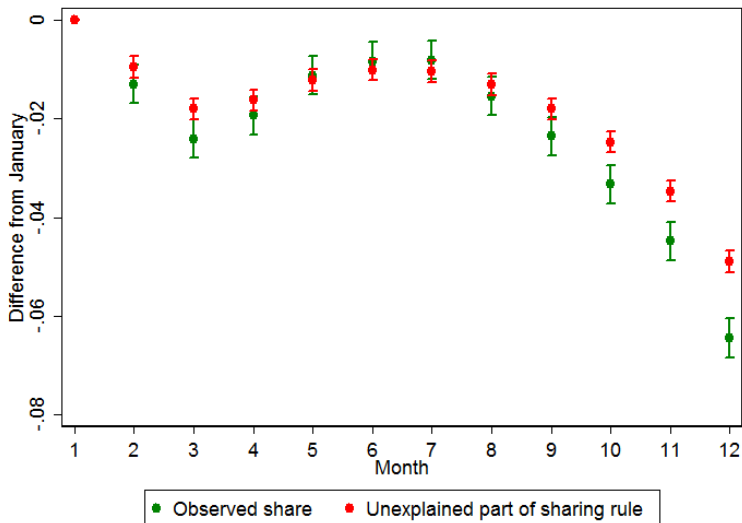


The mean sharing rule, $\hat{\alpha}_i$, varies with demographics

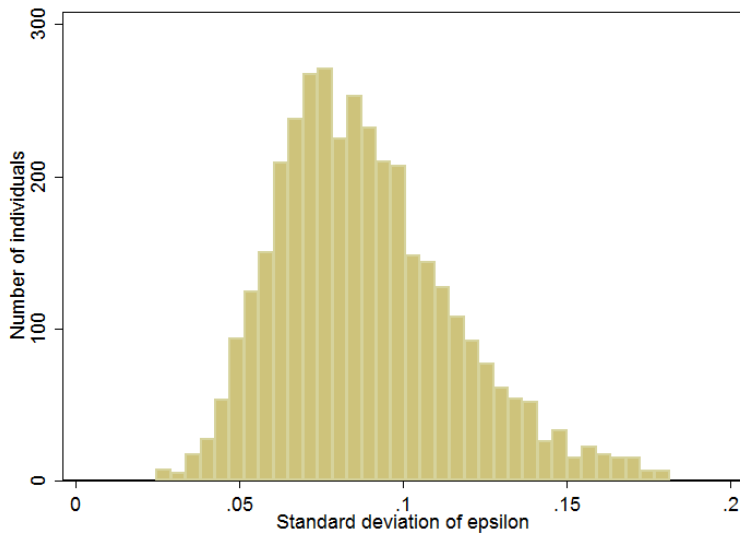
| | percentage point difference in share of spending on healthy food (mean approx 55%) |
|--|--|
| Female - male | 1.9 |
| Age over 65 - Age less than 40 | 0 |
| High skilled - Low skilled | 3.0 |
| Full time work - Not working | 2.3 |
| Non-smoker - smoker | 4.0 |
| Above median - Below median food expenditure | 1.5 |

All statistically significant at the 5% level, most at the 1% level.

Variation over the year, $\hat{\epsilon}_{it}$

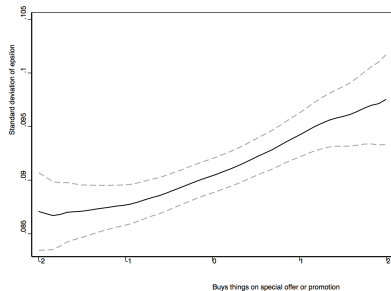


Variation across individuals in self-control, $sd(\hat{\epsilon}_{it})$

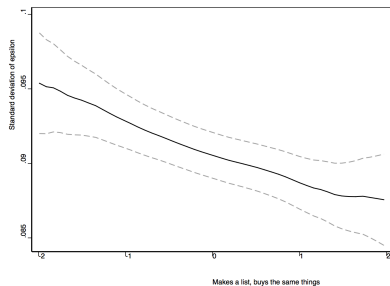


Variation across individuals in self-control, $sd(\hat{\epsilon}_{it})$

(a) Buys things on offer or promotion



(b) Buys same things, uses shopping list



Variation across individuals in self-control, $sd(\hat{\epsilon}_{it})$

difference in $sd(\hat{\epsilon}_{it})$
(mean approx 9.0)

Statistically significant at the 5% level

Age less than 40 - Age over 65 1.2

Below median - Above median food expenditure 1.9

Not statistically significant, even at the 10% level

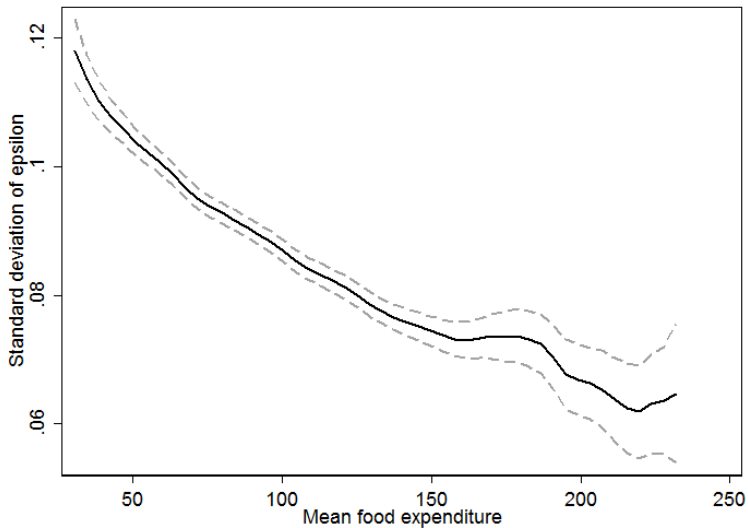
Female - male

High skilled - Low skilled

Full time work - Not working

Non-smoker - smoker

Variation across individuals in self-control, $sd(\hat{\epsilon}_{it})$



Summary and final comments

- ▶ There is important variation in the nutritional quality of food choices
 - ▶ across individuals **and within individuals over time**
 - ▶ temptation and a lack of self-control are important
- ▶ The two-selves model seems to fit the data well and gives economic structure to the interpretation of this variation
- ▶ We present an approach to quantifying the extent of self-control
 - ▶ allows us to compare the extent of self-control problems across individuals and over time
 - ▶ younger and poorer people suffer more from a lack of self-control
 - ▶ while mean preferences for healthy foods are correlated with a range of demographics – gender, skill level, work status, smoker – these are seemingly not related the extent of temptation and a lack of self-control