Institute for
Fiscal Studies

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

Algiers, October 2017

Self-control problems

- A large theoretical literature posits that people suffer from self-control problems

  - predicts that people over-consume some tempting goods relative to what their long-run self would choose

  - possibly causally linked to poverty (Bernheim, Ray and Yeltekin, 2015; Mani, Mullainathan, Shafir and Zhao, 2013; Haushofer and Fehr, 2014)

  - and seemingly worse in the young (Ameriks, Caplin, Leahy and Tyler, 2007; Bucciol, 2012)

- Provides rationale for public policy that

  - makes current consumption of tempting goods more costly

  - provides or facilitates the use of commitment devices

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2017
Richard H. Thaler

Richard H. Thaler - Facts

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Richard H. Thaler

Born: 1945, East Orange, NJ, USA

Affiliation at the time of the award: University of Chicago, Chicago, IL, USA

Prize motivation: "for his contributions to behavioural economics"

Prize share: 1/1

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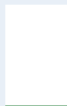MLA style: "Richard H. Thaler - Facts". *Nobelprize.org*. Nobel Media AB 2014. Web. 25 Oct 20

2017
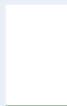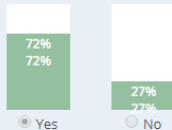**Nobel Laureates**

2017 ECONOMIC SCIENCES PRIZE QUESTION

Do you have difficulties keeping your New Year's resolutions?

○ Yes   ○ No

Nobel Prize Lessons

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2017
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2017 Nobel Laureates

2017 ECONOMIC SCIENCES PRIZE QUESTION

Do you have difficulties keeping your New Year's resolutions?

72%
72%

27%
27%

○ Yes   ○ No

Answers: 2563

Nobel Prize Lessons

Self-control problems in food purchases

- ▶ Temptation in food purchases is a commonly used example in theoretical papers

  - ▶ motivated by concern over increasing prevalence of obesity and diet-related disease such as diabetes, some cancers, heart disease, ...

- ▶ The experimental literature has found evidence of behavioural effects in decisions over food

- ▶ Large diet industry provides anecdotal evidence of self-control problems

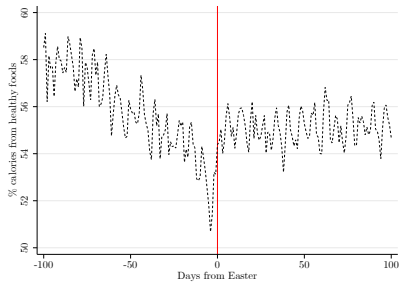- ▶ But there is little direct evidence of the existence and size of self-control problems from observational data
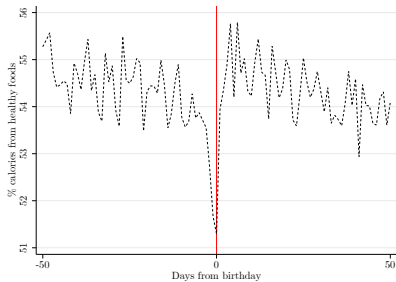
Google searches for "Diet"
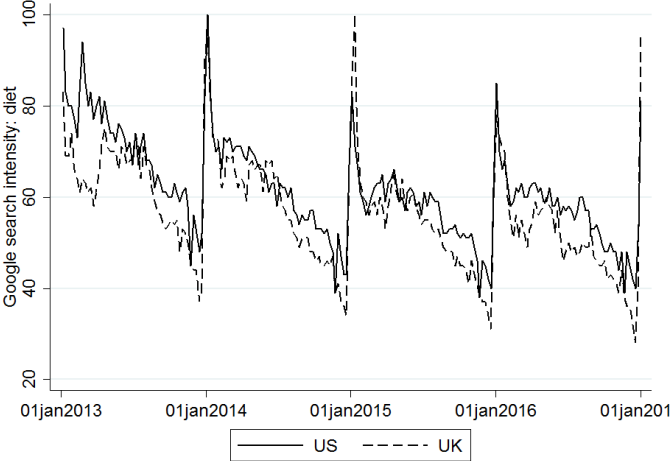
Share of calories in grocery basket from healthy food
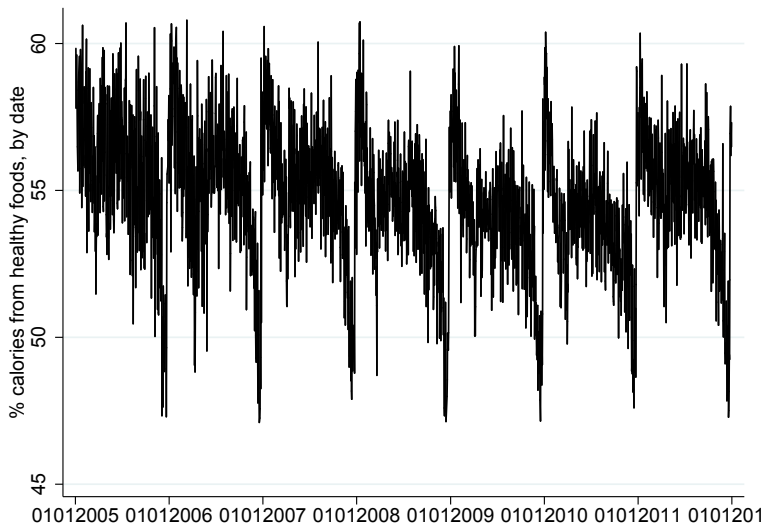
(a) Easter

(b) Birthdays

Empirical challenge in studying self-control

- Preference heterogeneity is likely to be an important driver of both:
    - cross-sectional variation in choice behaviour
    - differences in how people respond to changes in their economic environment (i.e. price and income)

- The challenge is to separate evidence that is indicative of self-control problems from this preference heterogeneity
    - develop an empirically tractable approach that
        - encompasses standard economic models of consumer choice (prices and income), in addition to psychological factors related to temptation and self-control
        - allows us to quantify the extent of individual's self-control problems
    - apply to longitudinal data on individuals' grocery purchases
        - long time dimension help to allow for rich preference heterogeneity

Heterogeneity

(a) mean healthy share
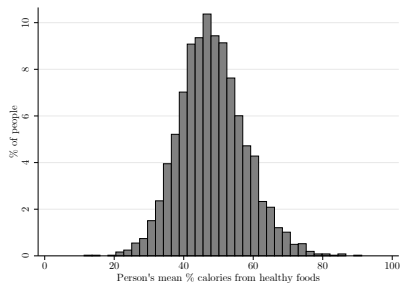
(b) within person variation
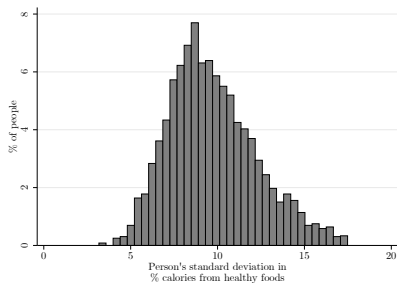
Two-selves model

- We model food purchase behaviour as a compromise between two-selves each with stable preferences over separate food and drink baskets

    - healthy self – preferences over fruit, vegetable, wholegrains

    - unhealthy self – preferences over soft drinks, crisps, confectionery

- Allocation of products between selves is endogenous and individual specific

- Multi-selves models have a long history in the theoretical literature

    - Strotz, 1955; Peleg and Yaari, 1973; Gul and Pesendorger, 2001, 2004; Kalai, Rubinstein and Spiegler, 2002; Fudenberg and Levine, 2006; Manzini and Mariotti, 2007, 2015, 2016; de Clippel and Eliaz, 2012, Ambrus and Rozen, 2015

Two-selves model

- ▶ Broadly this multi-selves literature models choice as

    - ▶ two stage process
        - ▶ first self (healthy self) chooses a menu from a set of available menus
        - ▶ second self (visceral self) chooses from that menu

    - ▶ sophisticated consumers
        - ▶ healthy self anticipates the choice of the visceral self, and chooses accordingly (either through intrisic self-control, or by using commitment devices), sub-game perfect equilibrium

    - ▶ naive consumer
        - ▶ assumes preferences in the second stage are the same as in the first, makes dynamically inconsistent choices

- ▶ Our definition of self-control is closely related to this literature

    - ▶ an increase in the influence of the visceral (short-run) self in decision making indicates a failure to exert self-control

Two-selves model

- ▶ Many food and drinks products

    - ▶ a set are healthy (h) and a set are unhealthy (l), available at prices $(\mathbf{p}_t^h, \mathbf{p}_t^l)$

    - ▶ each period, t, individual i chooses a vector of quantities, $(\mathbf{q}_i^h, \mathbf{q}_i^l)$

- ▶ An individual is characterized by a healthy and an unhealthy self, each with (different) rational preferences

    - ▶ the two selves enter into a bargaining process that is different for every individual and may not be stable over time

    - ▶ heterogeneity in preferences (and other characteristics, such as metabolism, and lifestyle choices, such as levels of exercise) mean individuals differ in weight to the healthy self

    - ▶ a resolute individual is one whose bargaining process is stable over time

    - ▶ an individual with self-control problems will, from time to time, be tempted by their unhealthy self, and so experiences greater fluctuations in the bargaining process

Collective approach to choice behaviour

- ▶ We borrow from the collective household economics literature

    - ▶ the two selves enter into a bargaining process that results in a Pareto optimal outcome

    - ▶ to study choice we are agnostic about the specific interaction between the selves (to study welfare we need to introduce more structure)

- ▶ We make use of the sharing rule concept used to quantify the bargaining power of individuals in collective models

    - ▶ Chiappori, 1988, 1992; Browning and Chiappori, 1998; Chiappori and Ekeland, 2009; Dunbar, Lewbel and Pendakur, 2013; Browning, Chiappori and Lewbel, 2013

    - ▶ Chiappori (1988) shows that the sharing rule is compatible with assumption that both selves choose Pareto efficient allocations, so the sharing rule is a direct indication of the bargaining power of the selves

Two-selves model

- Individual i in t chooses a vector of healthy and unhealthy products, $(\mathbf{q}_i^h, \mathbf{q}_i^l)$ to solve:

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

  subject to

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

  where $u^{ih}\left(.\right), u^{il}\left(.\right)$ are stable well-behaved utility functions

- μ_{it}, the Pareto weight that represents the bargaining weight of the healthy self in i's optimisation problem in t

  - under assumption of bargaining between two selves, μ_{it} generally depends on $\mathbf{p}_t^h$, $\mathbf{p}_t^l$, x_{it} and non-standard factors z_{it}

  - $\mu_{it} = \mu_i \in]0, 1[$ corresponds to standard rational choice model with strong separability between healthy and unhealthy products; we will show this model fits the data less well

Two-selves model

▶ An important feature of our model is that it incorporates elements of non-standard decision making, without abandoning the assumption of rational choice behaviour altogether

▶ Provides a useful way to quantify the influence of both selves

  ▶ the Pareto weight, μ_{it}, is monotonically related to the observed healthy self expenditure share $\eta_{it} = x_{it}^h/(x_{it}^h + x_{it}^l)$

 $$\eta_{it} = \eta_i(\mathbf{p}_t^h, \mathbf{p}_t^l, x_{it}, z_{it})$$

Revealed preference methods

- We evaluate the empirical fit of the two-selves model using revealed preference tools

    - Samuelson, 1938; Afriat, 1967; Varian, 1982; Cherchye, De Rock and Vermeulen, 2007, 2011

    - for given data the Afriat Inequalities define a utility level U_t^{ij} and a marginal utility of income λ_t^{ij} (associated with the observed budget x_{it}^j for each observed bundle $\mathbf{q}_{it}^j$)

        - the Afriat Inequalities are linear in the unknowns U_t^{ij} and λ_t^{ij}
        - we can use standard linear programming techniques to verify rationalisability of self j's behaviour for a given individual i

    - checking behavioural consistency with the two-selves model requires verifying the Afriat Condition for each self separately

        - 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

▸ Afriat Inequalities

Data

- Kantar Worldpanel

    - 3,645 individuals
    - observe all grocery purchases for at least 24 months
    - observe quantities and prices (and demographics, etc.)

- Data is at the transaction level

    - approximately 600,000 barcodes (UPCs)
    - over 100,000 distinct products (by brand)
    - we aggregate to 85 products (milk, bananas, fresh fish, biscuits,...)
    - we use the Nutritional Profiling Score to rank products in terms of healthiness
        - aggregates individual nutrients into single index
        - is what is used by UK regulators
    - we need to allocate products to healthy or unhealthy basket, for each indivudual we choose the cut off that fits the data best

Endogenous cutoffs between healthy and less healthy foods
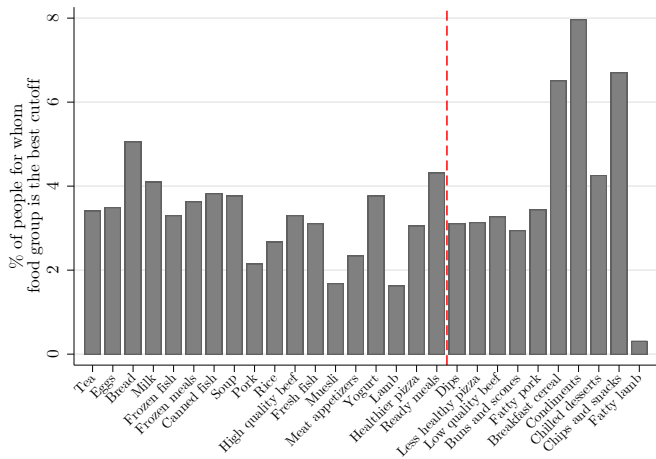
Fit of the two-selves model

- A natural alternative to the two-selves model is a single-self model, in which an individual has a single stable utility function defined over all 85 goods

  - the pass rate of the two-selves model is about twice as high as the pass rate of the single-self model

  - the distribution of the Afriat index for the two-selves model stochastically dominates that for the single-self model

- Almost 20% of individuals have observed purchase behaviour that is exactly rationalisable by the two-selves model

  - for the remaining individuals a small perturbations (1% on average) of the budget ensures purchase behaviour is rationalised by the two-selves model

Distribution of Afriat indices
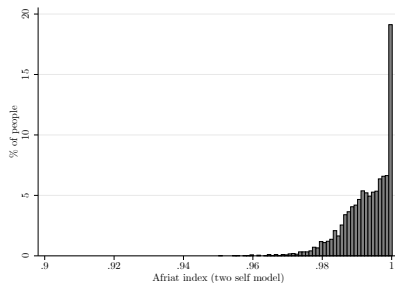
(a) Two-selves model   (b) Single-self model
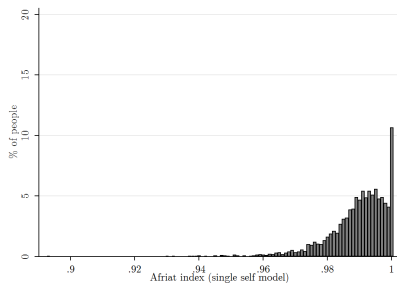
Recovering the sharing rule

▶ The two-selves model gives a structural interpretation to the share of spending on healthy food via the sharing rule:

$$\eta_{it} = \eta_i(\mathbf{p}^h_{rt}, \mathbf{p}^l_{rt}, x_{it}, z_{it})$$

- ▶ consumer-specific nonparametric function of 85 prices, income and z_{it}

- ▶ to implement empirically we need restrictions

  - ▶ unobservable is one dimensional and separable: $\eta_{it} = g_i(\mathbf{p}^h_{rt}, \mathbf{p}^l_{rt}, x_{it}) + z_{it}$

  - ▶ we can split $z_{it} =$ into a set of quarterly effects, τ_{it}, and a consumer-specific component, ϵ_{it}

  - ▶ 85 prices can be approximated by two price indices: one for healthy foods, Π^h_{irt}, and one for unhealthy foods, Π^l_{irt}:

    $$\eta_{it} = g_i(\Pi^h_{irt}, \Pi^l_{irt}, x_{it}) + z_{it}.$$

  - ▶ g_i can be approximated by individual specific log linear function

Recovering the sharing rule

We approximate the sharing rule with

$$\eta_{it} = g_i(\Pi_{irt}^h, \Pi_{irt}^l, x_{it}) + z_{it}$$

$$= \alpha_i + \beta_i \ln\left(\frac{\Pi_{irt}^h}{\Pi_{irt}^l}\right) + \gamma_i \left(\widetilde{\ln x_{it}}\right) + \lambda_i \left(\widetilde{\ln x_{it}}\right)^2 + \tau_{it} + \epsilon_{it}.$$

where $\widetilde{\ln x_{it}}$: log of real food expenditure; ensures the sharing rule is homogeneous of degree zero in prices and expenditure

Estimates from the sharing rule

- estimates imply own-price elasticities for healthy food
  - median: -0.57
  - 25th percentile: -0.73
  - 75th percentile: -0.39

- income elasticies
  - healthy foods with respect to total food expenditure
    - median: 1.06
    - for around 20% of individuals the coefficient on total food expenditure is positive implying healthy food is a luxury
    - for 3% of individuals is negative implying healthy food is a necessity
    - for the remaining 75% is equal to 1

The mean sharing rule, $\widehat{\alpha}_i$
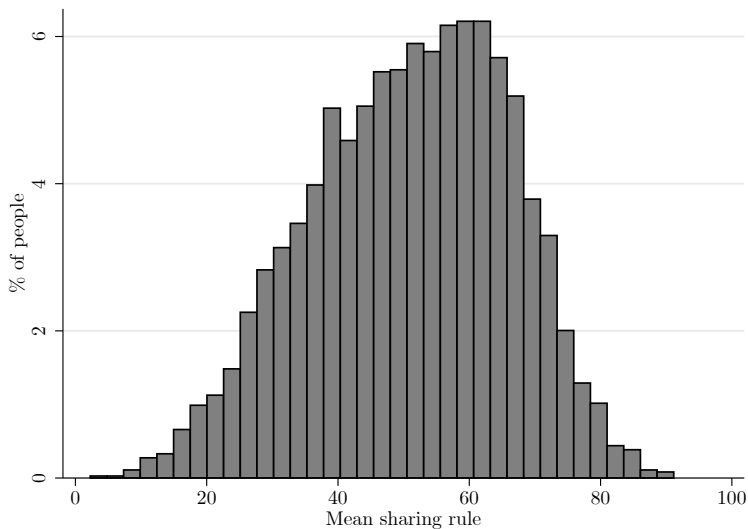
Variation in mean sharing rule, $\widehat{\alpha}_i$

(a) Age
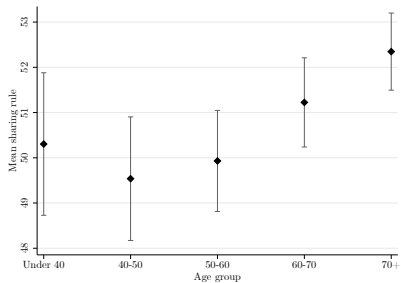
(b) Total food budget
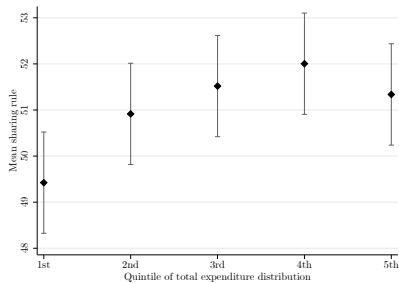
Variation in the mean sharing rule over months
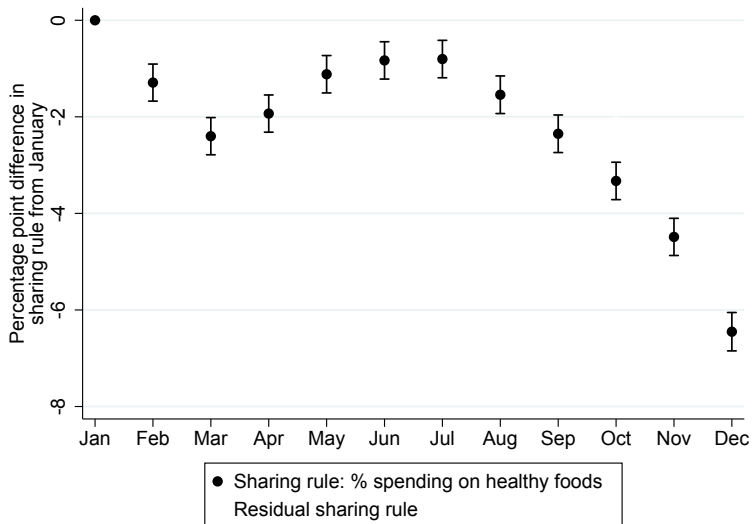
Variation in the mean sharing rule over months
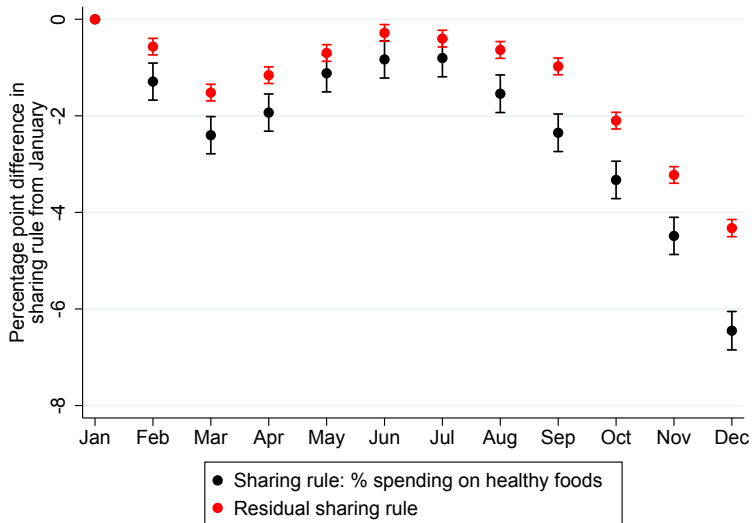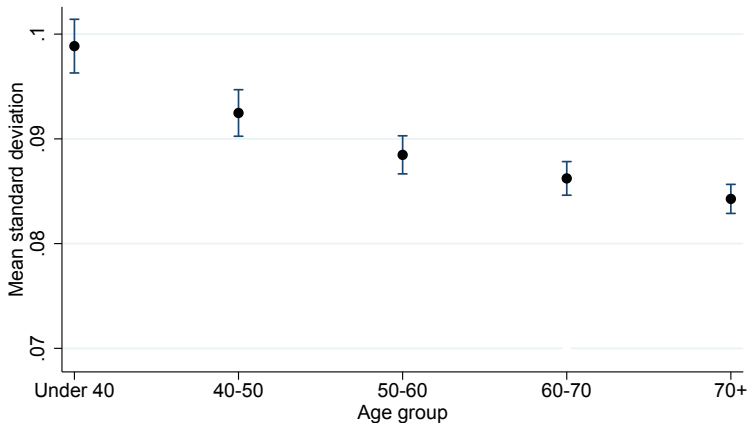
Deviations from mean sharing rule, $sd(\epsilon_{it})$
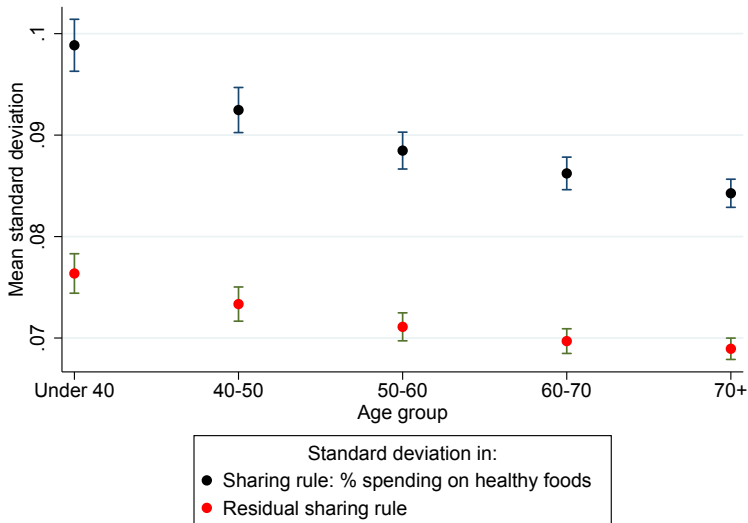
Deviations from mean sharing rule, $sd(\epsilon_{it})$

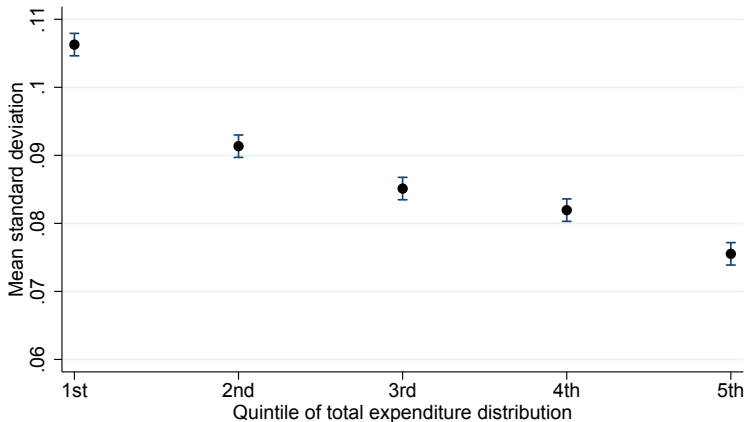# Deviations from mean sharing rule, $sd(\epsilon_{it})$
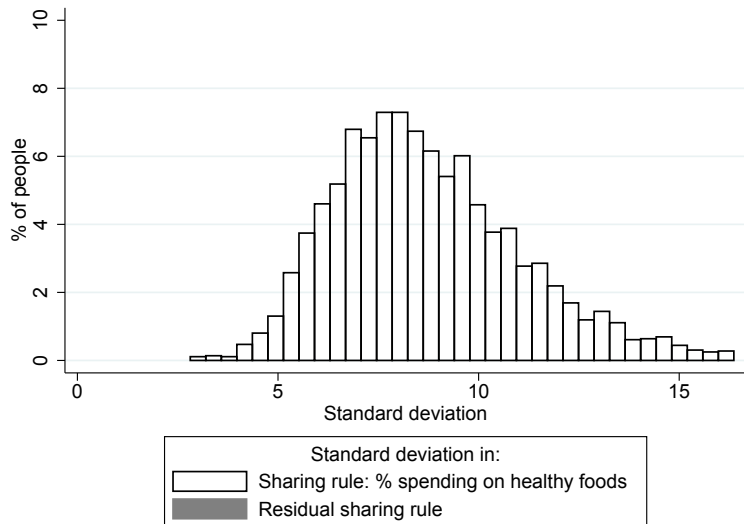
Deviations from mean sharing rule, $sd(\epsilon_{it})$
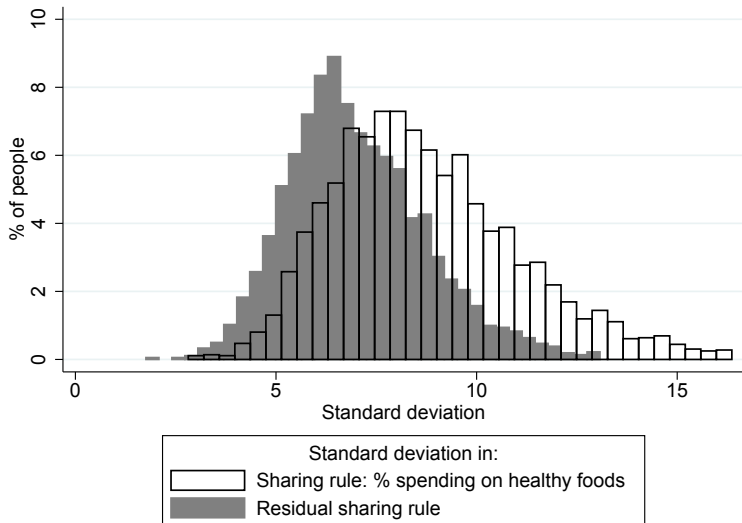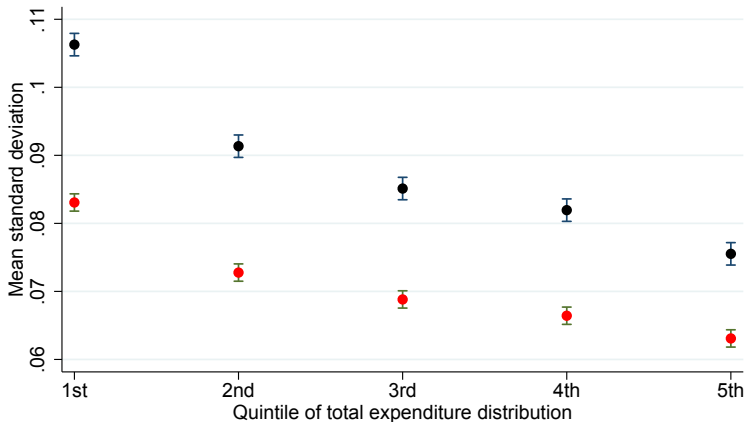
Deviations from mean sharing rule, $sd(\epsilon_{it})$

Standard deviation in:
- Sharing rule: % spending on healthy foods
- Residual sharing rule
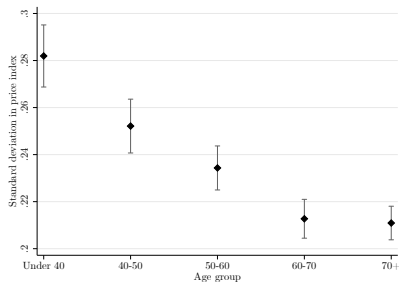
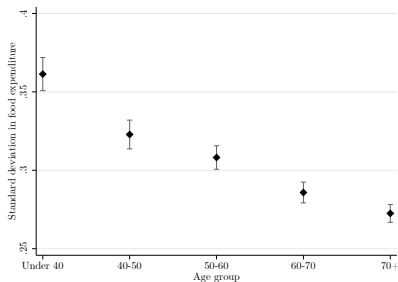# Deviations from mean sharing rule, $sd(\epsilon_{it})$

Variation in prices and food spending, by age

young individuals face more variation in their economic environment (prices and budgets) and adjust their food purchasing behaviour more strongly in response to these changes
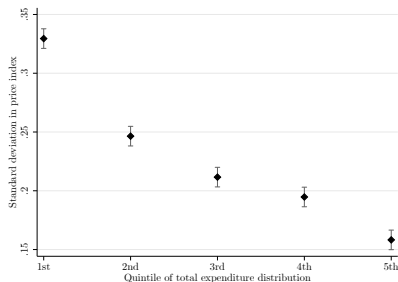

(a) variability of price
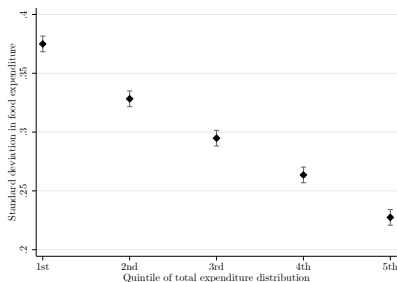
(b) variability of food budget

Variation in prices and food spending, by total expenditure

poorer individuals face more variation in their economic environment
(prices and budgets) and adjust their food purchasing behaviour more
strongly in response to these changes

(a) variability of prices   (b) variability of food budget

Summary

- Within-person variation in diet quality is important, and similar in magnitude to between person variation

- The two-selves model fits the data well, and provides a structural interpretation of the data, allows us to quantify variation in the sharing rule

- the sharing rule varies between and within people

    - lower income and younger individuals suffer more from self-control problems than higher income and older people

    - but failure to account for responses to changing prices and food budgets leads to an overestimate of the age and income gradient in self-control

    - low income and young individuals tend both to face more variation in their economic environment (prices and budgets) and to adjust their food purchasing behaviour more strongly in response to these changes

Further work

- Useful framework in which to evaluate what factors influence (lack of) self-control

    - advertising

    - commitment devices

    - other factors...

Further work

- By placing more structure on the form of demand we can use to study the impacts of policy and other counterfactual situations on welfare

    - purchasing for immediate vs. future consumption

    - identification based on comparing behaviour of same individual when making purchases with different consumption horizons

    - preliminary estimates suggest

        - on-the-go purchases associated with sugar temptation

        - effect is increasing in consumer BMI

On-the-go associated with more sugary soft drinks
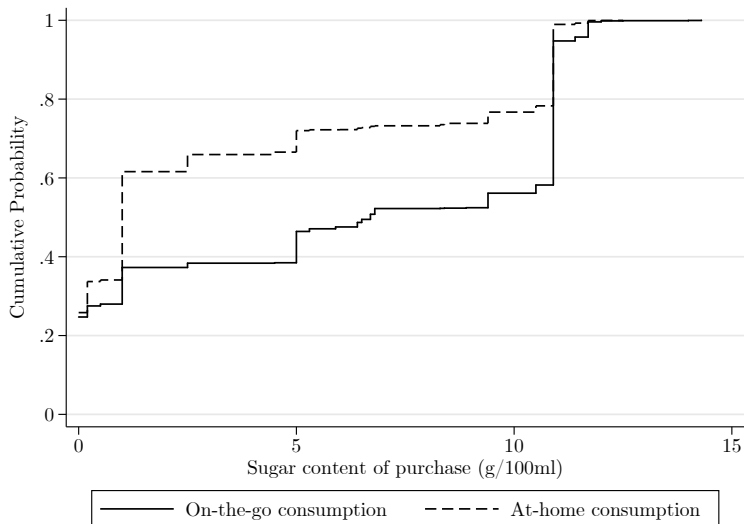
Thank you for your attention

Afriat Inequalities

Data, $S^{ij} = \{(\mathbf{p}_t^j; \mathbf{q}_{it}^j), t = 1, ..., T\}$ (where $j = h, l$), are rationalizable if they satisfy the Afriat Condition:

Definition

Let $S^{ij} = \{(\mathbf{p}_t^j; \mathbf{q}_{it}^j), t = 1, ..., T\}$ be a set of observations of self j, where $j = h, l$. The set S^{ij} satisfies the *Afriat Condition* if there exist numbers $U_t^{ij}, \lambda_t^{ij} \in \mathbb{R}_{++}$ that meet, for all observations s and t, the *Afriat Inequalities*:

$$U_s^{ij} - U_t^{ij} \leq \lambda_t^{ij} \mathbf{p}_t^{j\prime}(\mathbf{q}_{is}^j - \mathbf{q}_{it}^j).$$