
Shopping around?

How consumers adjust to economic shocks

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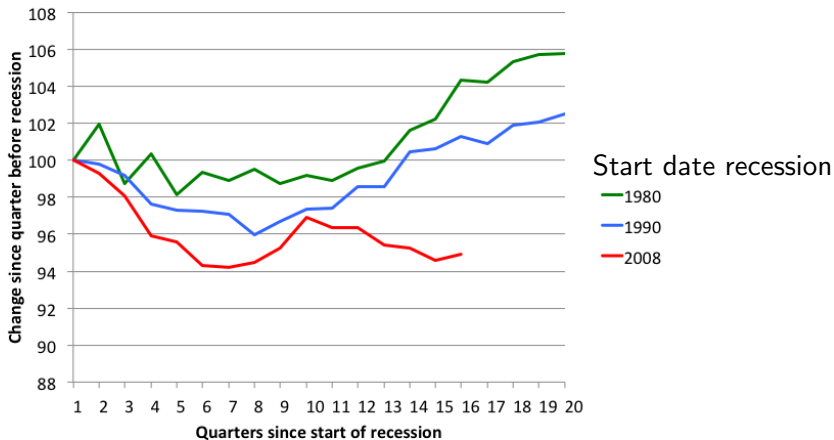
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Motivation

- The Great Recession (2008-2009)
 - increased unemployment, reduction in real incomes, shocks to asset prices
 - household real expenditure on food fell substantially
 - in the US, UK, Italy, (and others?)
- Is this a cause for concern?
 - policy/media concern about “food poverty” (UK) and “food insecurity” (US)
 - but relative prices of foods and time changed; households might e.g. substitute time for expenditure
- General interest in how economic downturns affect health

Fall in non-durable expenditure (UK)

food accounts for most of the difference across recessions



Source: Crossley, Low and O'Dea (2011) "Household consumption through recent recessions" IFS Working Papers , W11/18

Food prices

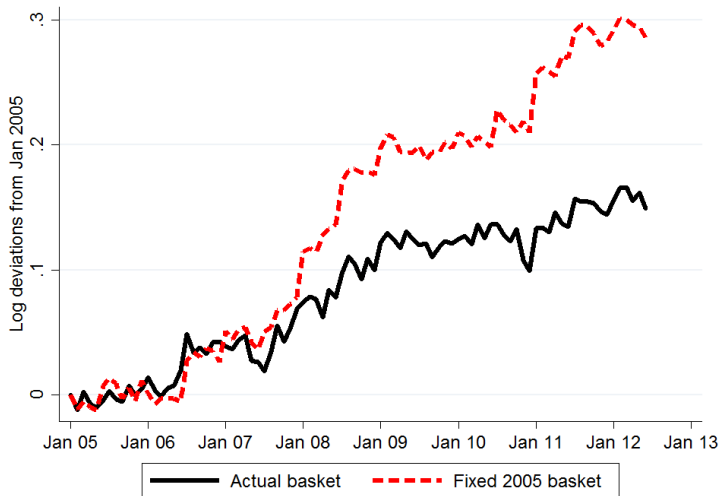
- The Great Recession was contemporaneous with large changes in food prices
 - world commodity prices rose
 - in the UK depreciation of sterling led to increase in price of imported goods
 - big changes in relative food prices
 - Meat, poultry, eggs, dairy, cereals became relatively more expensive
 - Prepared foods relatively less expensive

How did households adjust?

- Over Great Recession (2008-2010) households experienced changes in
 - real incomes
 - opportunity cost of time
 - relative prices of different foods
- In response to these changes households can:
 - reduce the quantity of food they buy
 - shift towards cheaper food (lower nutritional quality?)
 - substitute time for expenditure
- If the relative price of time fell, consumers may engage in greater search or home production
 - these mechanisms reduce price paid without necessarily changing nutritional composition of shopping basket
 - and suggests that consumption is smoother than implied by expenditure

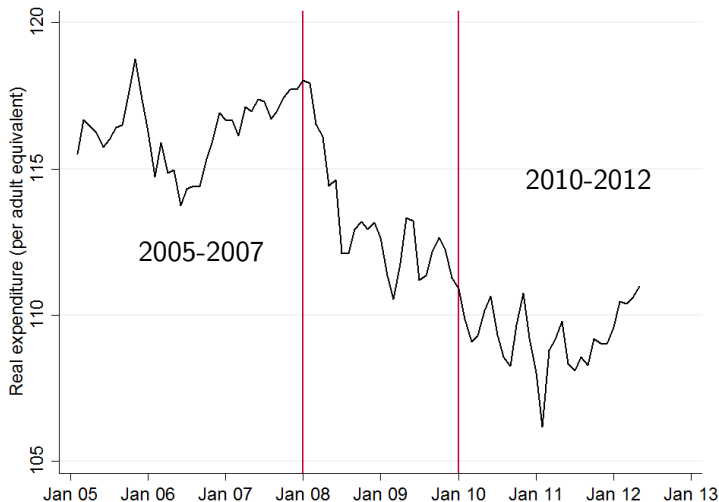
There was substitution towards cheaper calories

Price of "the average" UK grocery basket



To simplify the empirics we focus on two time periods

Real expenditure on the average UK grocery basket



How did households adjust?

- Outline a model of consumer behaviour in the grocery market:
 - consumers can adjust behaviour along a number of margins
 - reduce quantity
 - reduce quality and other characteristics
 - spend more time searching for a cheaper price
- Allows us to study the relative importance of different margins of adjustment

A model of grocery shopping

- $v(C, \mathbf{z})$: household utility from shopping basket
 - C : total calories
 - \mathbf{z} : a vector of calorie characteristics
- $P = P(e, C, \mathbf{z}; \phi)$: price paid per calorie
 - e : shopping effort
 - C : total calories
 - \mathbf{z} : characteristics
 - \mathbf{z}' : cooking time is a characteristic
 - ϕ : unobserved characteristics
- preferences over grocery basket are weakly separable from other arguments in household's utility function

A model of grocery shopping

- Household chooses shopping effort, total calories and characteristics of grocery basket to minimise costs:

$$\min_{e, C, \mathbf{z}} P(e, C, \mathbf{z}; \phi)C + \omega(e + \mathbf{z}')$$

$$s.t. \quad v(C, \mathbf{z}) = \bar{v}$$

- ω : opportunity cost of time

A model of grocery shopping

First order conditions

- shopping effort

$$-\frac{\partial P}{\partial e} C = \omega$$

- total calories

$$\left(P + \frac{\partial P}{\partial C} C \right) = \lambda \frac{\partial v}{\partial C}$$

- characteristics:

$$\frac{\partial P}{\partial z_k} C = \lambda \frac{\partial v}{\partial z_k}$$

$$\left(\frac{\partial P}{\partial z'} C + \omega \right) = \lambda \frac{\partial v}{\partial z'}$$

- the marginal rate of substitution between calories and characteristic k :

$$\frac{\partial v / \partial z_k}{\partial v / \partial C} = \frac{\frac{\partial P}{\partial z_k} C}{\left(P + \frac{\partial P}{\partial C} C \right)}$$

Empirical functional form

- We approximate the price function with a log-log functional form:

$$\ln P_{ht} = \alpha \ln \mathbf{e}_{ht} + \beta \ln \mathbf{z}_{ht} + \gamma \ln C_{ht} + \tau_t + \eta_h + \epsilon_{ht},$$

- h : household, t : month
- \mathbf{e}_{ht} , \mathbf{z}_{ht} : vectors of choice variables
- C_{ht} : total calories purchased
- τ_t : common time (year-month) effects
- η_h : household effects

Data - Kantar World Panel

- all grocery purchases of a representative panel of British households, 2005-2012
 - purchases recorded at bar code (UPC) level
 - recorded using handheld scanner in home
 - exact price and quantity
 - nutritional and other product and store characteristics
 - demographic characteristics of households
 - over 28,000 households
 - over 1.2 million grocery baskets (household-year-month)
 - panel data
 - allows us to control for permanent differences across households
- grocery basket is food at home

Calories from food out and food at home

Food out from Expenditure and Food Survey (EFS)

- food out is 36-37% of expenditure but 12-13% of calories
- food out also falls

Real expenditure £per month	Food at home	Food out
2005-2007	121.02	70.45
2010-2012	114.00	63.76
% change	-5.8	-9.5
Calories per day		
2005-2007	2505	381
2010-2012	2478	342
% change	-1.1	-10.3

All figures per person (adult equivalent)

Data - price per calorie and total calories

- $\ln P_{ht} = \alpha \ln \mathbf{e}_{ht} + \beta \ln \mathbf{z}_{ht} + \gamma \ln C_{ht} + \tau_t + \eta_h + \epsilon_{ht}$
 - h: household, t: month
- P_{ht} : per calorie price of households grocery basket
 - $P_{ht} = \sum_{isd \in t} P_{isd} W_{hisd}$
 - i: product (barcode), s: store, d: day
 - $P_{isd} = \frac{p_{isd}}{c_{id}}$
 - $W_{hisd} = \frac{c_{id} b_{hisd}}{\sum_{isd \in t} c_{id} b_{hisd}}$
 - b_{hisd} : number of purchases
- C_{ht} : total calories purchased in shopping basket
 - $C_{ht} = \sum_{isd \in t} c_{id} b_{hisd}$

Determinants of price per calorie

- Shopping effort (e_{ht})
 - number trips
 - number chains visited
 - shop at discounter (Aldi, Lidl, ...)
 - bought on sale
 - (distance travelled)
- Characteristics (z_{ht})
 - generic (non-branded) products
 - large pack sizes
 - nutrients
 - protein, saturated fat, unsaturated fat, sugar, other carbs, fiber, salt
 - food groups
 - fruit, vegetables, grains, dairy, cheese and fats, poultry and fish, red meat, drinks, prepared sweet, prepared savoury, alcohol

Identification

- we require that realisations of right hand side variables are uncorrelated with error:

$$\mathbb{E}(\epsilon_{ht} | \mathbf{e}_h, \mathbf{C}_h, \mathbf{z}_h, \eta_h) = 0, \quad t = 1, \dots, T.$$

- our identification strategy
 - rely on *differential within household* variation, this will control for many issues of potential concern
- there may be household-time varying omitted variables or measurement error that is correlated with the error term

Identification

- total calories C_{ht} appears on the right-hand side and as the denominator of the dependent variable
 - measurement error \Rightarrow inconsistent parameter estimates
 - our data allow us to measure C_{ht} well
 - we instrument total calories with household's total caloric needs
- we require individual product prices (p_{isd}) uncorrelated with choice variables (e_{ht}, C_{ht}, z_{ht})
 - common time effects
 - regional variation in prices
 - omitted choice variables

Identification

- total calories C_{ht} appears on the right-hand side and as the denominator of the dependent variable
- we require individual product prices (p_{isd}) uncorrelated with choice variables ($\mathbf{e}_{ht}, C_{ht}, \mathbf{z}_{ht}$)
 - common time effects
 - deal with general inflation and aggregate market conditions
 - regional variation in prices (e.g. supermarkets may set higher prices in wealthy areas)
 - omitted choice variables

Identification

- total calories C_{ht} appears on the right-hand side and as the denominator of the dependent variable
- we require individual product prices (p_{isd}) uncorrelated with choice variables ($\mathbf{e}_{ht}, C_{ht}, \mathbf{z}_{ht}$)
 - common time effects
 - regional variation in prices (e.g. supermarkets may set higher prices in wealthy areas)
 - if cross sectional differences fixed over time then absorbed by household fixed effects
 - a problem would arise if firms changed over time the extent to which they price discriminate between different groups of households in a way that was correlated with within household changes in choices
 - omitted choice variables

Identification

- total calories C_{ht} appears on the right-hand side and as the denominator of the dependent variable
- we require individual product prices (p_{isd}) uncorrelated with choice variables ($\mathbf{e}_{ht}, C_{ht}, \mathbf{z}_{ht}$)
 - common time effects
 - regional variation in prices
 - omitted choice variables
 - problem if household transaction weights (w_{hisd}) vary in ways correlated with ($\mathbf{e}_{ht}, C_{ht}, \mathbf{z}_{ht}$)
 - time and household fixed effects \Rightarrow problem arises only if vary over time differentially across households
 - e.g. productivity differences in shopping technologies across households (some households better at search) and household effects don't fully account for this

Coefficient estimates - preliminary

dep var $\ln(P_{ht})$	(1)	(2)	(3)		(1) cont.	(2) cont.	(3) cont.
Ntrips	-0.0107 (0.0006)	0.0833 (0.0006)	0.0619 (0.0021)	Fruit	2.393 (0.0107)	1.433 (0.0088)	1.489 (0.0103)
Nstores	0.0430 (0.0006)	0.00379 (0.0005)	0.00532 (0.0006)	Veg	0.496 (0.0072)	0.441 (0.0058)	0.441 (0.0058)
Discounter	0.0486 (0.0025)	-0.0458 (0.0023)	-0.0362 (0.0025)	Dairy	-0.292 (0.0092)	-0.00313 (0.0072)	0.0196 (0.0076)
Sale	-0.471 (0.0029)	-0.128 (0.0024)	-0.144 (0.0028)	CheeseFats	-0.299 (0.0098)	0.124 (0.0075)	0.0952 (0.0079)
Generic	-0.996 (0.0031)	-0.406 (0.0030)	-0.422 (0.0034)	RedMeat	-0.275 (0.0098)	0.282 (0.0075)	0.233 (0.0088)
Large pack	-0.372 (0.0033)	-0.115 (0.0025)	-0.130 (0.0029)	PoultryFish	-0.848 (0.0134)	-0.373 (0.0100)	-0.463 (0.0132)
C_{ht}	-0.0466 (0.0005)	-0.147 (0.0007)	-0.100 (0.0044)	Drinks	1.128 (0.0132)	0.856 (0.0105)	0.865 (0.0106)
Sugar	0.521 (0.0117)	0.244 (0.0087)	0.240 (0.0087)	PrepSweet	0.140 (0.0071)	0.187 (0.0055)	0.166 (0.0058)
Sat Fat	1.973 (0.0138)	0.838 (0.0109)	0.877 (0.0116)	PrepSavoury	0.721 (0.0067)	0.849 (0.0054)	0.851 (0.00543)
Unsat Fat	0.700 (0.0136)	-0.0124 (0.0101)	-0.0128 (0.0102)	Alcohol	2.816 (0.0083)	2.535 (0.0078)	2.516 (0.0080)
Protein	5.315 (0.0196)	3.548 (0.0152)	3.733 (0.0232)				
Fibre	0.0132 (0.0011)	-0.0372 (0.0009)	-0.0431 (0.0011)				
Salt	-0.0284 (0.0006)	-0.00749 (0.0004)	-0.00840 (0.0004)				
				Time effects	Yes	Yes	Yes
				HH effects	No	Yes	Yes
				IV	No	No	Yes

Standard errors in parentheses; 1,166,936 observations on 28,111 households 2005-2012.

Determinants of change in price paid per calorie

- change in behaviour from 2005-2007 to 2010-2012
 - led to a -2.69 log point change
- evaluate price per calorie in absence of switching
$$\ln \bar{P}_h = \hat{\alpha} \ln \bar{\mathbf{e}}_h + \hat{\beta} \ln \bar{\mathbf{z}}_h + \hat{\gamma} \ln \bar{C}_h + \hat{\tau}_t + \hat{\eta}_h$$
 - where $(\bar{\mathbf{e}}, \bar{\mathbf{z}}, \bar{C})$ are means over 2005-2007
- What contribution of different factors
 - $\hat{\alpha} \ln \Delta \mathbf{e}_h, \hat{\beta} \ln \Delta \mathbf{z}_h, \hat{\gamma} \ln \Delta C_h$

	Contribution
Shopping effort	-1.06
Non-nutrient characteristics	-0.12
Nutrient characteristics	-1.26
Food groups	-0.25
Total	-2.69

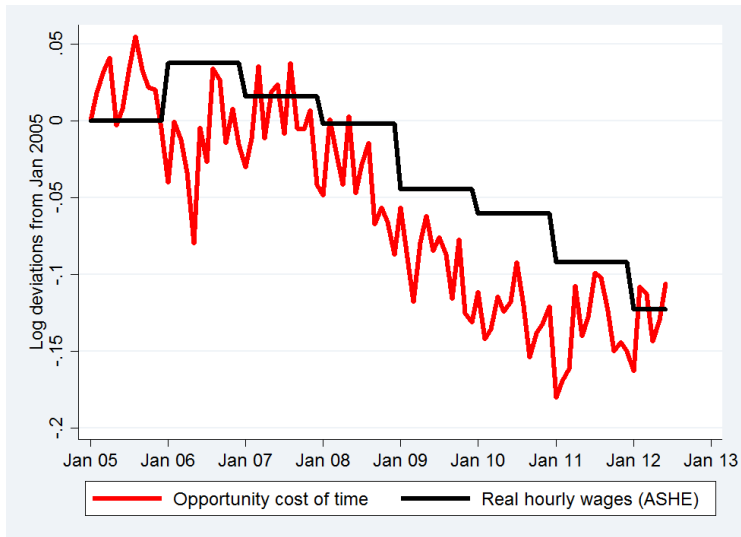
Shopping effort

- an important determinant of the -2.69 log point reduction in price per calorie was an increase in goods purchased on sale

	$\hat{\alpha}$		$\hat{\alpha}\Delta\ln(e_h)$
	Affect on $\ln(P_h)$	% change behaviour	Contribution
Shopping trips	0.06	0.3%	-0.04
Chains visited	0.01	3.9%	0.02
Discounter	-0.04	14.9%	-0.05
Sales	-0.14	36.4%	-0.99
Total			-1.06

Opportunity cost of time

implied by the first order condition and estimates



Nutrients

	Coefficient	% change	Contribution
Protein	3.73	-1.7%	-0.85
Saturated fat	0.88	-1.9%	-0.20
Unsaturated fat	-0.01	0.7%	-0.00
Sugar	0.24	0.0%	0.00
Fibre	-0.04	6.4%	-0.27
Salt	-0.01	-1.4%	0.06
Total			-1.26

Heterogeneity

- households with children versus adult only and pensioners
- rich versus poor households

	Households with children youngest child is:		Adult	Pensioner
	Pre-school	School age		
Real expenditure £per month				
2005-2007	92.16	90.43	118.40	133.08
2010-2012	79.90	81.94	112.23	125.03
% change	-13.3	-9.4	-5.2	-6.1
Calories per day				
2005-2007	2197	2235	2586	2901
2010-2012	2085	2162	2583	2853
% change	-5.1	-3.3	-0.1	-1.7
Real price per calorie (£per 1000kcal)				
2005-2007	1.41	1.35	1.55	1.54
2010-2012	1.29	1.27	1.47	1.48
% change	-6.9	-3.0	-2.6	-2.5
Observations	53,569	84,427	193,031	183,601
Households	2741	5014	7346	5897

All figures per person (adult equivalent)

	High	Middle	Low
Real expenditure £per month			
2005-2007	117.86	116.37	114.46
2010-2012	111.87	108.42	107.51
% change	-5.1	-6.8	-6.1
Calories per day			
2005-2007	2411	2568	2735
2010-2012	2419	2531	2668
% change	0.3	-1.5	-2.5
Real price per calorie (£per 1000kcal)			
2005-2007	1.65	1.52	1.40
2010-2012	1.55	1.43	1.35
% change	-5.9	-5.4	-3.7
Observations			
Households			

All figures per person (adult equivalent)

Determinants of change in price paid per calorie

	High	Middle	Low
Shopping effort	-0.98	-1.10	-1.02
Non-nutrients	-0.72	0.27	-0.25
	-1.70	-0.75	-1.35
Nutrients	-1.57	-0.99	-1.30
Food groups	-0.14	-0.15	-0.38
	-1.71	-1.14	-1.68
Total	-3.41	-1.89	-3.03

Nutrients

- Protein
 - all households reduced, those with young children and richest by most
- Vegetable purchases reduced
 - by all income/education groups, households with children and pensioners by most
- Non-sugar carbohydrates
 - all households increased, households with children, pensioners and poorest by most
- Drinks and alcohol
 - reduced by all households, households with children by most (except alcohol for richer households increased)
- Saturated fats
 - all households decreased, households with children and poorest by most

