Exploring the Returns to Scale in Food Preparation

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Introduction: Two Can Live More Cheaply Than One

- But how much more cheaply?
- Returns to scale in consumption – households consume some “public” or shared goods.
- Related (but different) idea: some individuals (children) have fewer needs.
- These are important policy questions (setting benefits, insurance needs, measuring poverty and inequality.)

Background (1): the Deaton-Paxson Puzzle

- An old insight due to Barten is that differences in household composition can have "price-like" effects.

- Suppose households care about each members consumption of food ($\frac{f}{n}$) and consumption of a good that is partially shared ($\frac{x}{n^{\theta}}, 0 < \theta < 1$).

- The households budget constraint is:

$$p_f \frac{f}{n} + p_x \frac{x}{n} = \frac{y}{n}$$

- In terms of consumptions (not expenditures) this is:

$$p_f{}^* f^* + p_x{}^* x^* = y^*,$$

$$y^* = \frac{y}{n},\ f^* = \frac{f}{n},\ x^* = \frac{x}{n^{\theta}},$$

$$p_f{}^* = p_f, \quad p_x{}^* = \frac{p_x}{n^{1-\theta}}.$$

- As household size increases the effective price of public goods falls.

- Holding per capita income constant, the price changes has income and substitution effects.

- Since there are few substitutes for food, the income effect should dominate.

- Thus larger households should have higher per capita consumption of food and, given common market prices, higher per capita food expenditures.

	f**	***x*****
Income Effect	↑	↑
Substitution Effect	↓ **(but small?)**	↑
Total Effect	↑ **(?)**	↑
Data:	**observed**	**not observed**

- Deaton and Paxson (1998) examine expenditure data from a range of countries and find the opposite result: larger households have lower per capita food expenditures holding per capita income constant.
- They consider and reject a number of possible explanations for this puzzle.

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Background (2): Food Preparation with Homogeneous Time Costs

- DP98 also find that "the coefficients on household size are generally positive for clothing and entertainment" – food is different.

- Gan and Vernon (2003) suggest that returns to scale in food consumption would help resolve the puzzle. They speculate that returns to scale in the time cost of food preparation might be the source of returns to scale in food consumption.

- Deaton and Paxson (2003) counter that returns to scale in the time required for food preparation actually deepen, rather than resolve, the puzzle.

- Why? Now the shadow prices (*full costs*) of both goods fall with household size, leading to larger income effects. Moreover, the direction of substitution effects, if any, depends on the relative size of the returns to scale, and could favour food.

- Our point: models in which foods differ in their time cost have quite different implications. (DP98 mention, but dismiss this possibility.)

- We offer:

    - A simple model to illustrate this point,

    - Empirical evidence which supports this point.

Food Preparation with Heterogeneous Time Costs

- Suppose that there are just two kinds of food, with the most extreme heterogeneity in time costs of preparation.
- Prepared or "cooked" food, c, is purchased "ready-to-eat" and requires no preparation time.
- Ingredients i can be purchased and combined with time to produce regular food, r.
- Assume a Leontief home production technology.

$$\max nu\left(\frac{f}{n},\frac{x}{n^{\theta}},\frac{l}{n}\right)$$

$$s.t.: \quad \frac{w(T-l-t)}{n} = p_c\frac{c}{n} + p_i\frac{i}{n} + p_x\frac{x}{n}$$

$$\frac{f}{n} = f\left(\frac{r}{n},\frac{c}{n}\right)$$

$$\frac{r}{n} = \min\left[\frac{t}{n^{\gamma}},\frac{i}{n}\right]$$

The production function implies $t = \frac{i}{n^{1-\gamma}}$ and $r = i$. Thus the problem can be written:

$$\max nu(f(c^*, i^*), x^*, l^*)$$
$$s.t.: wT^* = p_x^* x^* + wl^* + p_i^* i^* + p_c c^*$$

where

$$c^* = \frac{c}{n}, \quad i^* = \frac{i}{n}, \quad l^* = \frac{l}{n}, \quad x^* = \frac{x}{n^{\theta}},$$

and

$$p_i^* = p_i + \frac{w}{n^{1-\gamma}}, \quad p_x^* = \frac{p_x}{n^{1-\theta}}.$$

- When household size increases, the shadow prices of ingredients (regular food), $i^*(=r^*)$, and other goods, x^*, fall.

- We follow DP98 in assuming that substitution effects between food and other goods are negligible (so the change in p_x^* affects food purchases only through income effects).

- The income and substitution effects on food purchased can be summarized as follows:

	c^*	i^*
Income Effect	↑	↑
Substitution Effect	↓	↑
Total Effect	**?**	↑
Data:	**observed**	**observed**

Three key predictions:

1. **As household size increases there should be a substitution from ready-to-eat or prepared foods towards ingredients**

- Across household size, (per capita) market expenditures on all foods are not proportional to (per capita) food quantities.
- Market expenditures (per capita) are:

$$p_c \frac{c}{n} + p_i \frac{i}{n}$$

- If $p_i < p_c$ (as seems reasonable) then substitution from c to i could lead market expenditures to fall, even if per capita quantities of food were constant or rising. Thus this kind of compositional effect could explain the Deaton-Paxson puzzle.

2. **Per capita quantities of the most time intensive food should rise with household size (holding per capita resources constant).**

- This is because of both income and substitution effects.

- This prediction is in some sense the analogue of the prediction that Deaton and Paxson examine in their original (1998) paper.

3. Effective time spent on food preparation , $t^* = \frac{t}{n^{\gamma}}$**, should rise with household size.**

- t^* is not observed in the data because (except for singles) it depends on the return of scale parameter γ. Only t (or $\frac{t}{n}$) is observed.
- If returns to scale are operating ($0 < \gamma < 1$) and per capita time ($\frac{t}{n}$) rises with household size, then *effective* time per capita ($t^* = \frac{t}{n^{\gamma}}$) must rise with household size because $\frac{t}{n^{\gamma}} > \frac{t}{n}$ when $n \geq 2$.
- Thus the observation that per capita time spent on food preparation rises with household size would support the model (and suggest quite large returns to scale)

Empirical Evidence - Data

- 1992 and 1996 Canadian Food Expenditure Survey (FOODEX), a detailed two-week diary of household food expenditures.
    - We have divided foods into ‘ingredients’ (foods requiring substantial preparation) and prepared or “ready-to-eat” foods.
- Time use diaries that are part of the 1998 Canadian General Social Survey (GSS).

Empirical Evidence – Samples

- Singles and couples (without children).
- Aged 25-55 and working full time (inelastic labour supply).
- FOODEX sample contains 1188 singles and 945 couple households.
- The GSS sample includes 1196 singles and 1163 couple households.
- Singles reweighted by gender.

Fig. 1: Food (at home) budget share

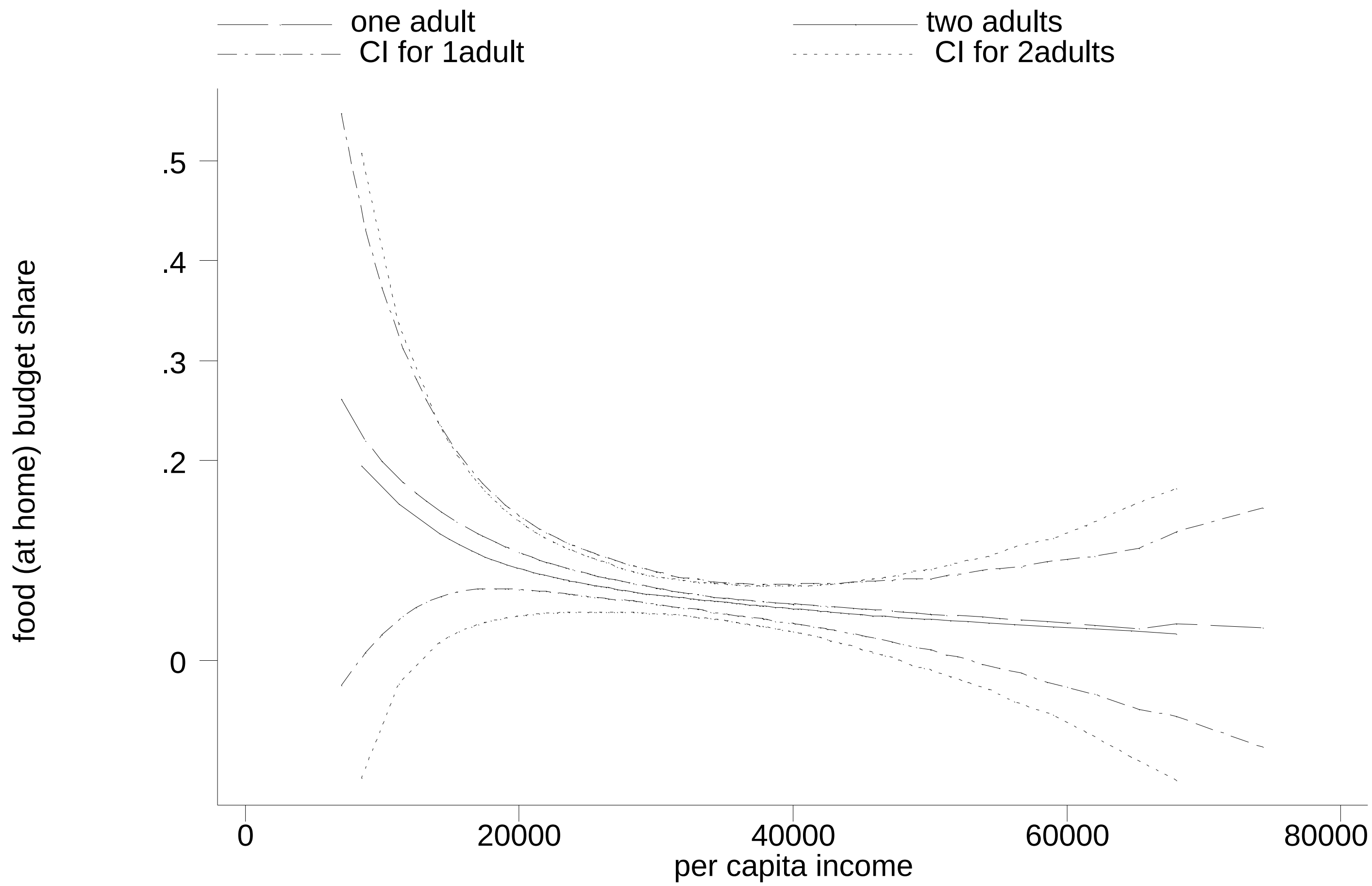


Table 1: Regression Coefficients in Food Share Regressions

	Food (purchased from store) budget share	Ratio of prepared food to ingredients	Ratio of take-out fast-food to ingredients	Ingredients budget share
	Regression Coefficients x100, [t-statistics in square parentheses]			
Couple Dummy	-1.03 [-3.80]	-10.04 [-3.99]	-10.91 [-3.34]	-0.67 [-2.91]
ln (per capita income)	-8.94 [-6.11]	-1.10 [-0.38]	8.39 [2.60]	-7.21 [-6.22]
R^2	0.31	0.029	0.025	0.29

Fig. 2: Ratio of Prepared Food to Ingredients

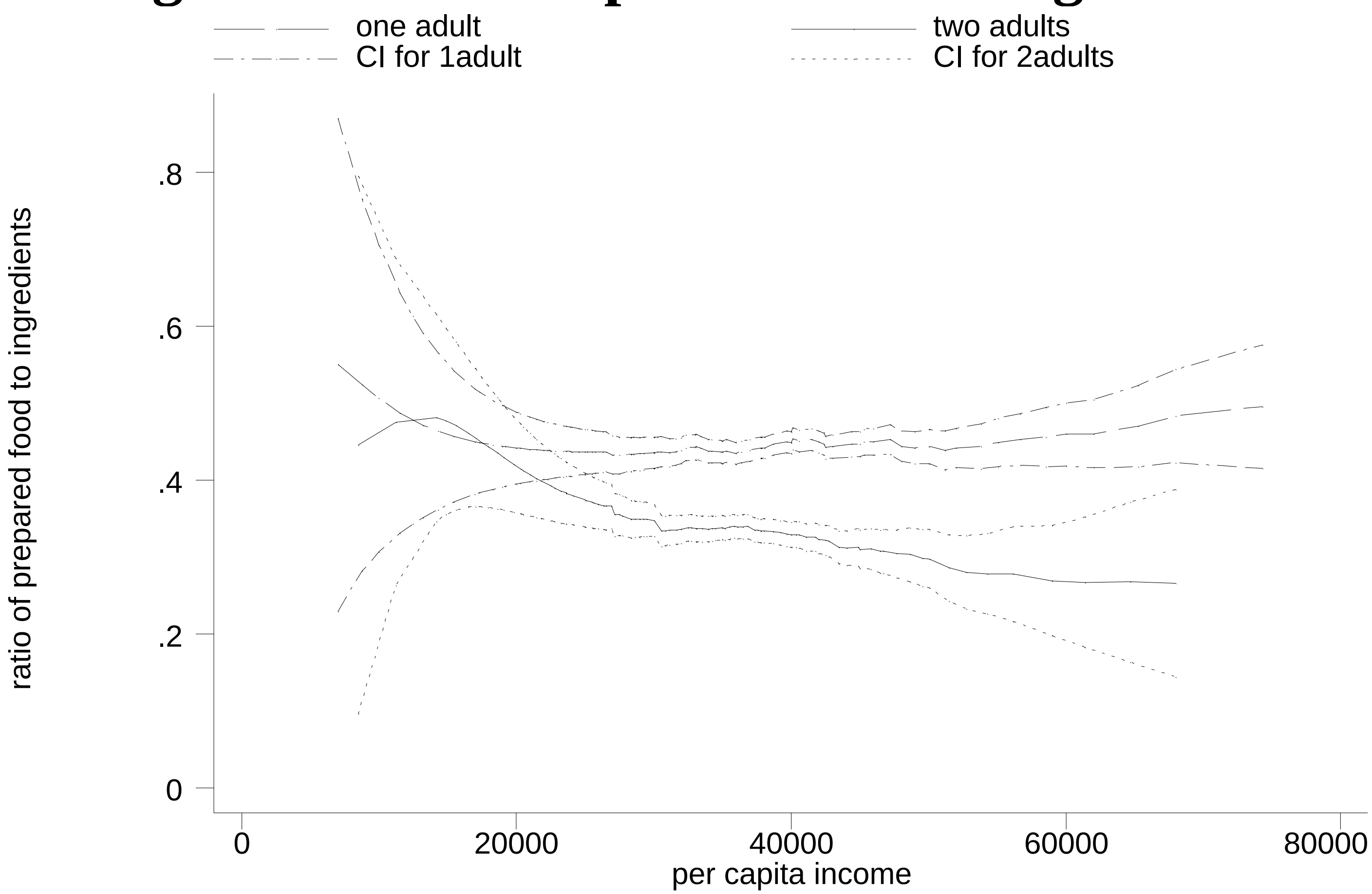


Fig. 3: Ratio of fast-food to Ingredients

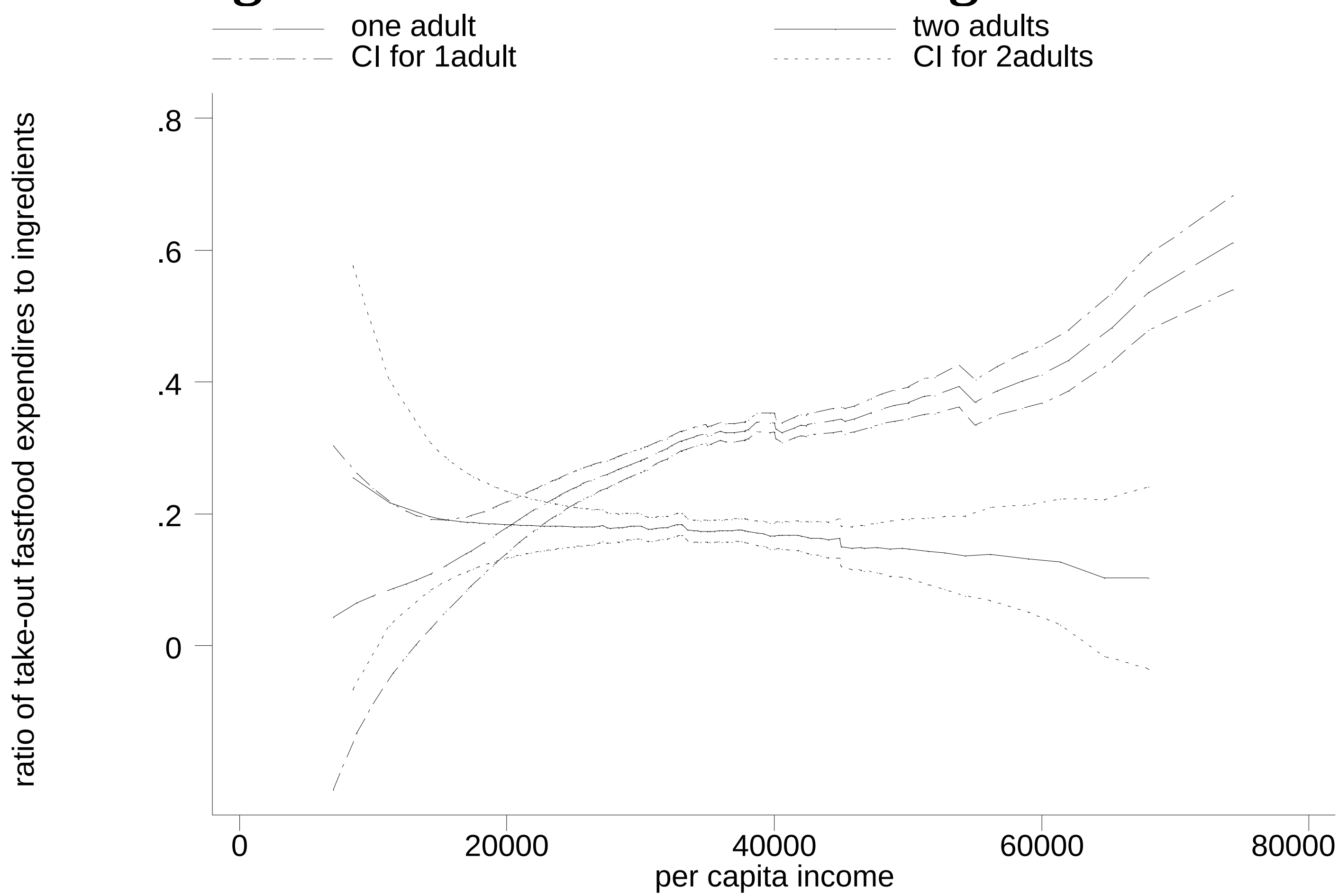


Fig. 4: Budget Share of Ingredients

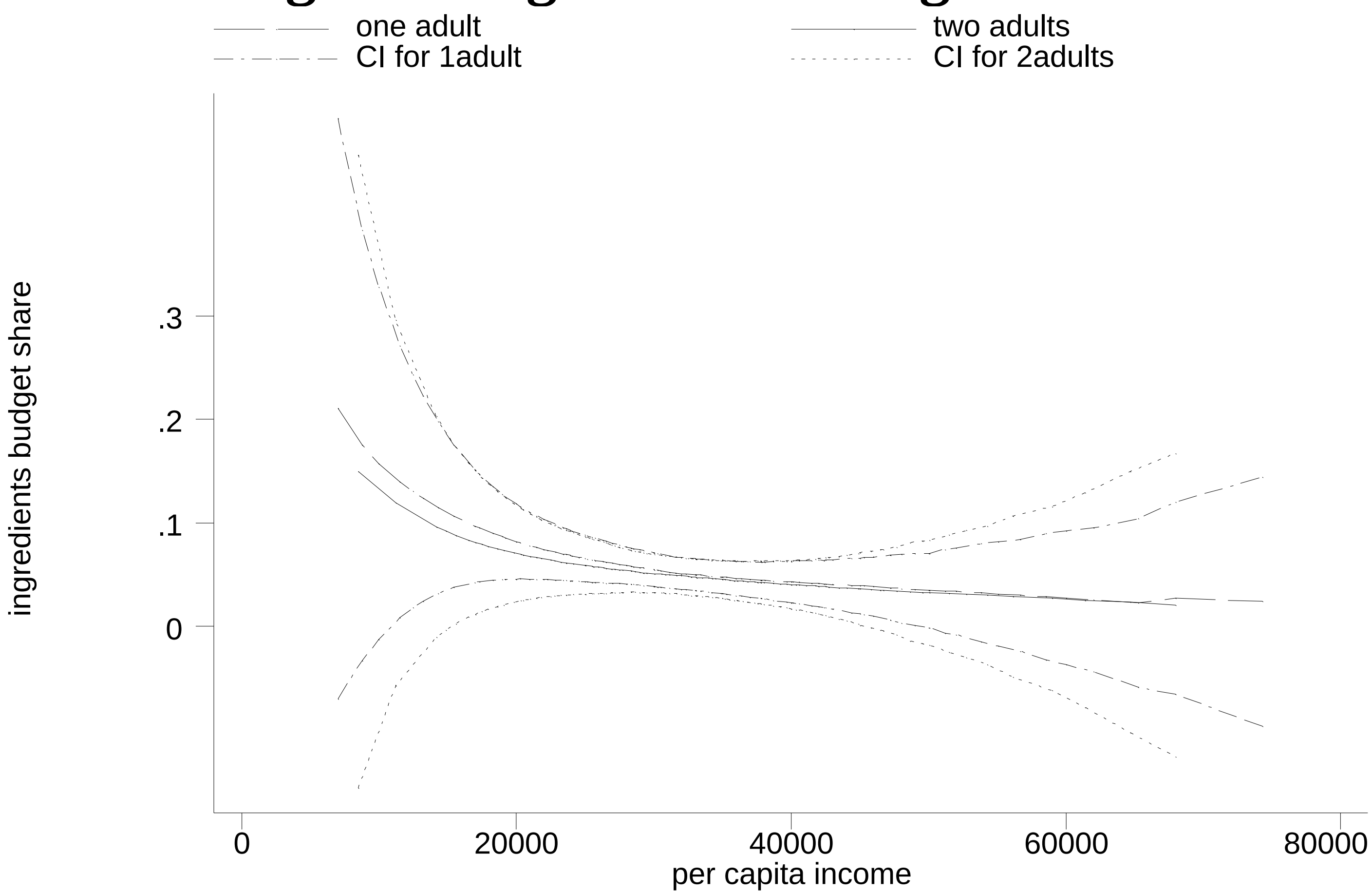


Table 2: Meat Expenditures, Quantities and Unit values, Weekly

		Singles	Couples	t-test of equality
Mean Weekly Purchases (standard errors in parentheses)				
Unprepared	*$ per capita*	9.2 (0.34)	8.5 (0.30)	[-1.66]
	kgs per capita	1.7 (0.07)	1.7 (0.08)	[-0.02]
Prepared	*$ per capita*	3.6 (0.13)	2.7 (0.11)	[-4.92]
	kgs per capita	0.5 (0.02)	0.4 (0.02)	[-5.50]
	share in total meat ($)	0.36 (0.01)	0.30 (0.01)	[-4.09]
	share in total meat (kgs)	0.35 (0.01)	0.28 (0.01)	[-4.63]
Total meat	*$ per capita*	12.8 (0.36)	11.2 (0.33)	[-3.26]
	kgs per capita	2.2 (0.07)	2.0 (0.08)	[-1.42]
Mean Unit Values ($/kg, standard errors in parentheses)				
Unprepared		6.6 (0.10)	6.3 (0.09)	[-2.01
Prepared		8.1 (0.16)	8.3 (0.15)	[0.84]
t-test of equality		[7.9]	[11.0]	

Table 3: *Per Capita* Time Spent on Food Preparation (minutes)

	Single household	Couple household	
	Means, minutes per day (Standard errors are in parentheses)		t-test of equality
Food Preparation and cleanup	40.7 (1.49)	47.6 (2.29)	[3.02]
Food Preparation (shopping plus meal preparation)	35.6 (1.32)	39.9 (2.00)	[2.15]
Meal preparation	26.4 (1.03)	32.0 (2.68)	[3.16]
Grocery shopping	9.1 (0.75)	8.0 (0.93)	[-0.93]

Notes:

1. Based on a sample of 861 singles and 550 childless couples from the 1996 Canadian General Social Survey. All members are aged 25-55 and working full time. The data are weighted to equalize the proportion of each gender amongst singles.

Conclusions

- Good evidence for returns to scale in food preparation and heterogeneity within food with respect to time costs.
  - o Detailed food expenditure data reveals that larger households' food baskets are significantly shifted away from prepared and ready-to-eat foods and towards foods requiring preparation time (`ingredients').
  - o Evidence from time use data that *per capita* food preparation time is greater for working couples than for working singles.
- However, we are ultimately left with a version of the original DP98 puzzle: expenditures on ingredients fall with household size.

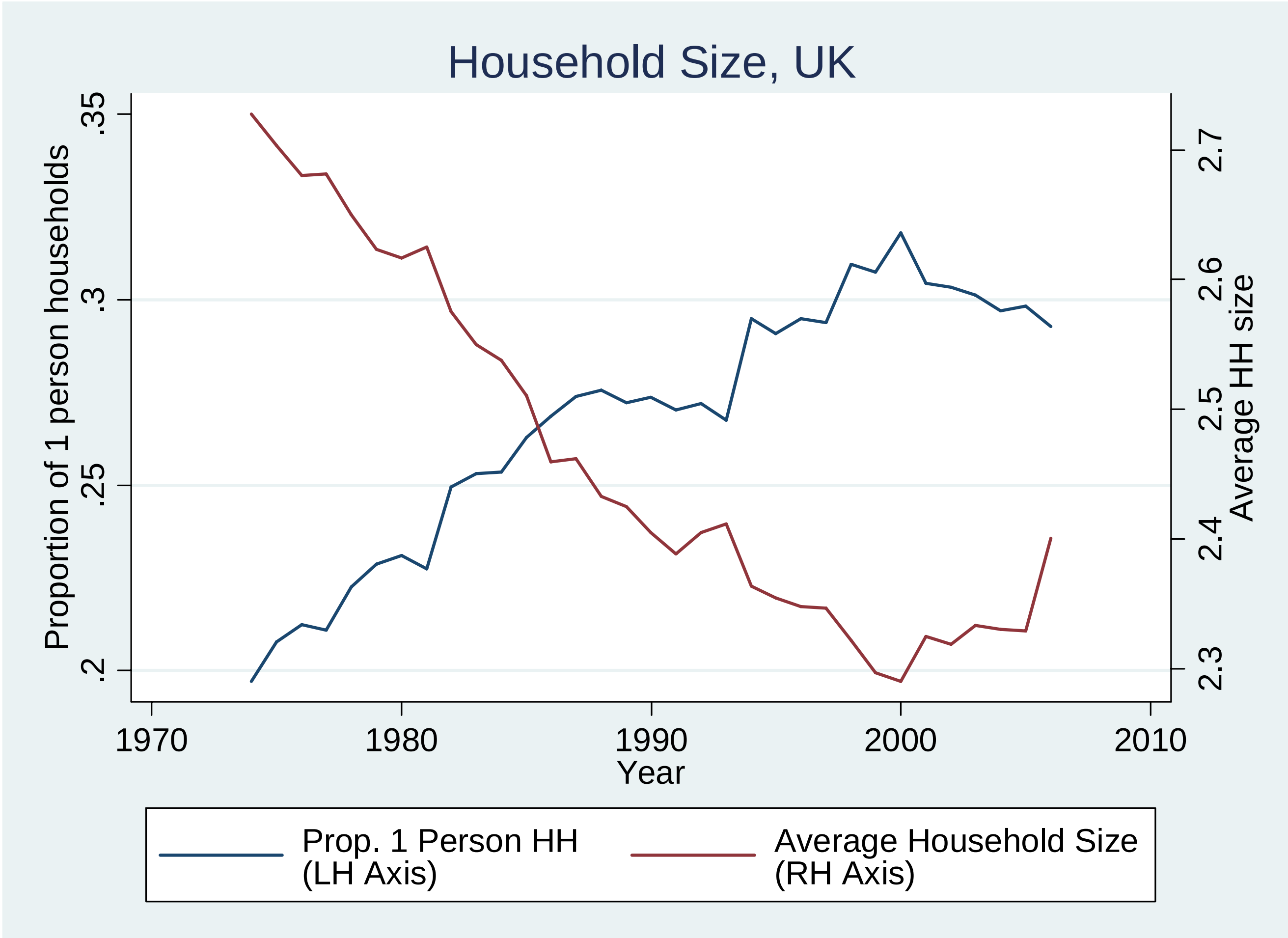
- One implication is that identification based on the idea that food is a private good is suspect.
- Another way to think about it: expenditure measures consumption with error, and the measurement error is correlated with household size.

What Does Any of This Have to Do With Health?

- Demographics $\Rightarrow$Relative Prices $\Rightarrow$Diet / Nutrition $\Rightarrow$Health Outcomes?
- Technology explanation for Trends to Obesity (Cutler, Glaeser and Shapiro, 2003).
    - Innovations in packing, freezing and preserving food have led to a shift from household preparation to mass preparation of foods. This has lowered the time price of food.
- Wage changes also affect the time price of food. Some debate in the literature about role of Female LFP in obesity (Butler, Glaeser and Shapiro, 2003, say at most 10% of the growth).

- Here: changes in household size alter the relative price of prepared foods. If prepared foods are of lower dietary quality (more salt, more fat, etc) can this affect health?

- Note that there are significant trends in household size; with substantial returns to scale in food preparation, these translate into substantial relative price changes (between prepared foods and ingredients)


Household Size, UK
Proportion of 1 person households
.2
.25
.3
.35
Average HH size
2.3
2.4
2.5
2.6
2.7
1970
1980
1990
2000
2010
Year
Prop. 1 Person HH (LH Axis)
Average Household Size (RH Axis)

Cutler, D.M., E.L. Glaeser and J.M. Shapiro, (2003), “Why Have Americans Become More Obese?” *Journal of Economic Perspectives*, 17(3):93-118.