Exploring the Returns to Scale in Food Preparation (Baking Penny Buns at Home)

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Abstract: We show that as household size increases, households substitute away from prepared foods and towards ingredients. They also devote more time to food preparation. These observations (1) are consistent with a simple model with home production, returns to scale in the time input to food preparation, and varieties of food that differ in the required time input; (2) support the idea that returns to scale in home production are an important source of returns to scale in consumption; and (3), mean that across household sizes, household market expenditures on food are not proportional to food consumption quantities. The latter may provide a partial explanation for a puzzle raised by Deaton and Paxson.

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Executive Summary

Understanding the nature and magnitude of returns to scale in household consumption is important for a large number of questions in applied economics. These include: How should social benefits vary with household size? What is the appropriate amount of life insurance for each member of a couple? How can we compare the incidence of poverty across groups that live in households of different sizes?

While returns to scale in household consumption are most often associated with public goods (such as housing), home production could be an important additional source of returns to scale. In this note we explore this idea by focusing on a particular example: food preparation. We begin by developing a simple model with home production, returns to scale in the time input to food preparation, and varieties of food that differ in the required time input.

Our empirical strategy employs very detailed food expenditure data, as well as data from time-use diaries. We show that as household size increases, households substitute away from prepared foods and towards ingredients. They also devote more time to food preparation.

These observations are consistent with our model and support the idea that returns to scale in home production are an important source of returns to scale in consumption. As household size increases, the returns to scale mean that food preparation becomes cheaper. Our results also imply that across household sizes, market expenditures on food are not proportional to food consumption quantities. The latter may provide a partial explanation for a puzzle raised by Deaton and Paxson.

1. Introduction

The idea that "two can live more cheaply than one" (Deaton, 1997) is not controversial. However, understanding the nature and magnitude of returns to scale in household consumption is important for large number of questions in applied economics. These include: How should social benefits vary with household size? What is the appropriate amount of life insurance for each member of a couple? How can we compare the incidence of poverty across groups that live in households of different sizes?

Returns to scale in consumption are often associated with public goods within the household (housing being an obvious example.) However, since Becker (1965), economists have understood that many goods may be purchased not for direct consumption, but rather for combination with time in the home production of the goods and services that are ultimately consumed. It is plausible that home production is an important source of returns to scale in household consumption. In this note we explore this idea by focusing on a particular example: food preparation. If there are important returns to scale in home production (in addition to public goods such as housing), then documenting those will be important for the types of questions outlined above.

In addition, our analysis is closely related to an important puzzle in understanding returns to scale in household consumption posed by Deaton and Paxson (1998). They suggest that, holding per capita resources constant, returns to scale (in at least some goods) imply that larger households are better off, and so should consume more of personal goods such as food. However, they document in a range of data sets that larger households have lower per capita food expenditures (holding per capita resources constant). Gan and Vernon (2003) suggest that returns to scale in food consumption – particularly in food preparation – may resolve this puzzle. However, Deaton and Paxson (2003) emphasize that returns to scale in food preparation strengthen rather than resolve their puzzle.

The latter assertion is true of models in which "food" is a single commodity, or at least homogeneous with respect to preparation time. In contrast, if food is a composite of goods that differ in their preparation times, returns to scale in food preparation are a potential explanation of the Deaton-Paxson Puzzle. Deaton and Paxson recognize this possibility in their original paper, but do not consider it a likely explanation (Deaton and Paxson, 1998, pg. 922). The slightly richer model that we present in this note retains the Barten – type demographic effects of Deaton and Paxson's analysis but adds explicit home production (of food) and two types of food (which differ in their preparation times). Thus it serves to illustrate the case in which returns to scale in food preparation might explain the Deaton and Paxson Puzzle, and to contrasts with the case in which food is homogeneous with respect to time costs.

The second contribution of this note is to examine some of the predictions of our richer model using detailed data from detailed food expenditure diaries and from detailed time use diaries. We find evidence supporting key predictions of our model. There do seem to be returns to scale in food preparation, and these lead to substantial substitutions across types of food as household size increases.

With respect to the Deaton-Paxson puzzle, we find that a version of the puzzle remains. However, we argue that the type of test for returns to scale that Deaton and Paxson propose may be difficult to implement (at least for developed countries) because of substitutions *within* broad food categories.

The rest of this note is organized as follows. In the next section we review the puzzle posed by Deaton and Paxson, and the implications of adding home production to their model while maintaining the assumption that food is a homogeneous good. In Section 3, we contrast this analysis with a model with two types of food that differ in their preparation times. Section 4 presents our empirical analysis. Section 5 provides a concluding discussion.

2. The Deaton-Paxson Puzzle

2.1 The Basic Puzzle

Consider a household with *n* members (adults only) who enjoy two goods: a private good *f* (food) and a composite of other goods *x* which is subject to some scale economies. To focus on returns to scale, we follow Deaton and Paxson (1998) in assuming a unitary model of household preferences.[1] The household's problem is:

$$\max nu\left(\frac{f}{n}, \frac{x}{n^{\theta}}\right) \qquad 0<\theta<1$$

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

The expression n^{θ} captures returns to scale in the (composite) good x. When $n=1$, $n^{\theta}=1^{\theta}=1$; when $n=2$, $n^{\theta}=2^{\theta}<2$, and so on.[2] The p_i are market prices and y is household income (or total expenditure).

Note that the budget constraint can be rewritten in terms of individual consumption, per capita income, and *shadow* prices:

$$p_f * f * + p_x * x* = y*,$$

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[1] For an analysis combing returns to scale with a collective model of household preferences see Browning, Chiappori and Lewbel (2003).

[2] Deaton and Paxson (1998) (and Gan and Vernon, 2003) assume a more general form for the returns to scale ($\frac{x}{\phi(n)}$). Note however that we restrict our empirical analysis to singles and couples. With just two household sizes, a simple technology is completely general (even a linear technology would do).

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

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

The key insight of Barten-type models (Barten, 1964) is that demographics have price-like effects. Here, as household size increases, the price of the private good (food) is unaffected,[3] but the resource cost (shadow price) of the good subject to returns to scale (x^*) falls: $\frac{\partial p_x{}^*}{\partial n} < 0$. This will have both income and substitution effects, as follows:

	f*		***x****
IE	↑		↑
SE	↓	**(but small?)**	↑
TE	↑	**(?)**	↑
Data:	**observed**		**not observed**

As n increases, x^* (individual consumption of x) should unambiguously rise. However, note that x^* is not observed by the econometrician, as it depends on the returns to scale parameter θ . In contrast, individual food consumption, f^*, is observed (as it depends only on total food and household size.) The income and substitution effects for food have opposite sign, but Deaton and Paxson posit that since there are few substitutes for food, the income effect should dominate.[4] Thus, holding resources (income or total outlay) per capita constant, larger households should have higher per capita consumption of food and, given common market prices, higher per capita food expenditures.

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[3] Gorman (1976) famously wrote "When you have a wife and baby, a penny bun costs three pence."

[4] Deaton and Paxson note that this is particularly likely to be true in developing countries, and include such countries in their empirical analysis. Of course, for the case of no substitution effect, the utility function must be Leontief: $n^* \min\left[\frac{f}{n}, \frac{x}{n^\theta}\right]$.

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

2.2 Food Preparation with Homogeneous Time Costs

Beside food, Deaton and Paxson also examine household expenditures on some other private goods. They find that "the coefficients on household size are generally positive for clothing and entertainment"[5], which implies that food has different characters from other private goods. Gan and Vernon (2003) suggest that returns to scale in food consumption would help resolve the puzzle and 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) respond that returns to scale in food consumption could certainly help to explain the puzzle but note that returns to scale in the time required for food preparation actually deepen, rather than resolve, the puzzle. To see why, consider the following simple extension to the model, adding home production (of food):

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

$$\begin{aligned} s.t.: \quad & \frac{f}{n} = \min[\frac{t}{n^{\gamma}}, \frac{i}{n}] \\ & w(\frac{T}{n} - \frac{l}{n} - \frac{t}{n}) = p_x \frac{x}{n} + p_i \frac{i}{n} \\ & 0 < \theta < 1, \quad 0 < \gamma < 1 \end{aligned}$$

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[5] Deaton and Paxson find mixed results for alcohol and tobacco. These are goods for which it is quite plausible to assume that preferences change with household size (particularly co-habitation). Using data from the Canada Family Expenditure Survey 1992 and 1996, we find a positive but insignificant effect of household size (among singles and couples, and as always holding per capita income constant) for clothing, and a negative effect for alcohol and tobacco (significant only for the former).

where i is quantity of ingredients purchased, t is time spent on food preparation, and l is leisure time. The production function implies:

$$t = \frac{i}{n^{1-\gamma}}$$

and:

$$f = i$$

so that the problem can be rewritten:

$$\max nu(\frac{i}{n}, \frac{x}{n^{\theta}}, \frac{l}{n})$$

$$s.t.: \quad w\frac{T}{n} = p_x \frac{x}{n} + p_i \frac{i}{n} + w\frac{l}{n} + w\frac{i}{n}(\frac{1}{n^{1-\gamma}}).$$

As before the budget constraint rewritten in terms of individual consumption, per capita income (now full income), and shadow prices:

$$wT^* = p_x^* x^* + wl^* + p_i^* i^*,$$

where

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

and

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

Now the shadow prices (full costs) of both food and other goods (x^*) fall with household size, leading to larger income effects. Moreover, the direction of substitution effects, if any, depend on the relative size of the returns to scale parameters θ and γ, and could favour food. As household size increases (holding resources per capita constant), per capita food consumption – and hence per capita quantities of ingredients purchased – should increase. As Deaton and Paxson note, budget data record *market* expenditures on ingredients (food). That is, they record $p_i i$, not the full cost, $p_i^* i$. However, this is actually useful because (assuming common market prices) market expenditures are proportional to quantities, so per capita market expenditures should rise with household size (holding per capita resources constant). Thus the Deaton-Paxson puzzle remains – and is deepened because income effects should be greater here than in the simpler model.

3. Food Preparation with Heterogeneous Time Costs

Models in which foods differ in their time cost have quite different implications. The simplest model that illustrates this point assumes 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. Alternatively, ingredients i can be purchased and combined with time to produce regular food, r. We assume the same home production technology is as in the model of the previous section. We do not assume that prepared food and home cooking are perfect substitutes. Thus in this model the household's problem is:

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

$$\begin{aligned} s.t.: \quad & \frac{w(T-l-t)}{n} = p_c \frac{c}{n} + p_i \frac{i}{n} + p_x \frac{x}{n} \\ & \frac{f}{n} = f\left(\frac{r}{n}, \frac{c}{n}\right) \\ & \frac{r}{n} = \min\left[\frac{t}{n^{\gamma}}, \frac{i}{n}\right] \end{aligned}$$

The production function implies $t = \dfrac{i}{n^{1-\gamma}}$ 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 Deaton and Paxon 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****
IE	↑	↑
SE	↓	↑
TE	**?**	↑

There are three key predictions. First, as household size increases there should be a substitution from ready-to-eat or prepared foods towards ingredients. This is important because it means that, 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. Another way to think about this point is that in this model, the "market price" of food (which in this model is a weighted average) is not constant across household sizes, because households of different size purchase different food baskets. Thus broad expenditure patterns across household sizes are not necessarily informative about quantity patterns.

The second key prediction is that in this model, 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.

Finally, we can use the production condition $\left(t = \frac{i}{n^{1-\gamma}}\right)$ to eliminate ingredients rather than preparation time. This leads to an unambiguous prediction that $t^* = \frac{t}{n^{\gamma}}$ should rise with household size. Of course, 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. However, note that 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).[6] We now turn to an empirical examination of the predictions of our model.

[6] Of course, this also means lower per capita time expenditures would not necessarily contradict the model, as this observation could be consistent with increasing effective time per person.

4. Empirical Evidence

To investigate the empirical relevance of the model described in the previous section, we employ two cross-sectional data sources. The first is the 1992 and 1996 Canadian Food Expenditure Survey (FOODEX), a detailed two week diary of household food expenditures, which distinguishes several hundred types of food purchased from stores. We have divided those types of foods into `ingredients' (foods requiring substantial preparation) and prepared or "ready-to-eat" foods.[7] The second data set is the detailed time use diaries that are part of the 1996 Canadian General Social Survey (GSS), and in particular the information on time spent on food preparation in that data.

In our empirical analysis we focus on singles and couples (without children), and further restrict the sample to individuals aged 25-55 and working full time (ie., both members of a couple must satisfy these criteria for the household to be included). Our FOODEX sample contains 1188 singles and 945 couple households. The GSS sample includes 1196 singles and 1163 couple households.

We focus on fully employed singles and couples because we believe it gives the cleanest focus on returns to scale. Moreover, as explained below, the limitations of our data make it convenient to focus on households with small labour supply elasticities. A downside of this choice is that when they compare households of size 1 and 2 only, Deaton and Paxson do not find their puzzle in all the countries they consider.[8] However, we will demonstrate below that the Deaton - Paxson puzzle is evident in our sample.

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[7] Prepared foods include cooked meats; canned meats, stews and soups; frozen precooked fish; canned pasta products; baked beans; pre-cooked meat or poultry pies; pre-cooked frozen dinners; other pre-cooked food preparations.
[8] See Table 2 of Deaton and Paxson (1998).

In both data sets there are slightly more men than women among singles. In all our calculations, we use weights to undo this discrepancy (so that there is no difference in "average" gender between the couples and singles.)[9]

We examine the expenditure patterns in the FOODEX data with both nonparametric and parametric (OLS) regressions. The former relate shares and ratios of expenditures to income per capita. The latter in addition condition on the age, gender and education of the household head, as well as seasonal and regional dummies. We condition on total market income, rather than full income (as our extended model with home production would suggest is appropriate), because neither data set contains information on wages.[10] The assumption that maps our theory into our empirical work is that for these samples (young, childless, singles and couples, working full time) labour supply elasticities are very small (so that we can treat market income as essentially exogenous.) We believe that for this sample, this is a reasonable assumption.

We begin by examining food shares by per capita income for singles and couples. Nonparametric regression estimates are presented in Figure 1 and parametric regression estimates in the first column of Table 1. Figure 1 shows that every level of per capita income, couples have lower food budget shares, and hence lower food expenditure (holding per capita income constant, a lower share implies lower expenditure.) The confidence intervals displayed in Figure 1 indicate that the differences are not statistically significant. However, with a parametric specification, the estimated shares of couples are not only lower but the difference from singles is

[9] In practice, this correction makes no difference to our results.
[10] Deaton and Paxson (1998) condition on per capita expenditure, and then instrument this quantity with cash income, which is assumed to be exogenous.

statistically significant (the coefficient on the couple dummy in Column 1 of Table 1). Thus the Deaton and Paxson puzzle is apparent in our data.

We now turn to an analysis of prepared foods and ingredients. Figure 2 displays the estimated nonparametric curves for the ratio of prepared foods to ingredients. Holding per capita resources constant, food expenditures of couple households are significantly shifted towards ingredients (and away from prepared foods). Confidence intervals suggest the difference between the two curves is also statistically significant at most income levels. A parametric regression analysis reveals the same pattern (Column 2 of Table 1), and the difference between couples and singles is statistically significant. These are the substitution patterns within food predicted by our extended model.

In addition to prepared food purchased for consumption at home, we also examine expenditures on take-out fast-food. Take-out fast-food can be considered food at home with little preparation time (perhaps even less than the prepared foods purchased in stores).[11] Figure 3, and column 3 of Table 1, illustrate that, holding per capita resources constant, food expenditures of couple households are significantly shifted away from fast-food and towards ingredients, which is again consistent with our first prediction.

These types of substitutions suggest substantial returns to scale in food preparation. They also mean that food at home is not a homogeneous commodity, and that across household sizes, expenditures may not be proportional to household sizes. If larger households are substituting towards foods that are cheaper on the market but require greater time inputs, then market expenditures could fall, while quantities do not fall, or even rise.

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[11] In contrast, meals eaten in restaurants may comprise a bundle of different services, including entertainment.

Some evidence on this is provided in Table 2, which focuses on meat purchase in particular. The FOODEX data collects both expenditures and quantities, so that we can examine quantities directly. We can also calculate unit values, which are expenditure divided by quantity – similar to a price.[12]

The bottom panel of Table 2 shows that, for both singles and couples, the average unit value ($ per kg) of prepared meat is higher than for unprepared meat (an ingredient) – by about 25%. These differences are both economically and statistically significant. The top panel of Table 2 shows the consequence of these differences in average unit values. The difference in per capita expenditures on meat between singles and couples is larger than the difference in per capita quantities, and the latter difference is not statistically significant at traditional levels of significance. Note, however, that the per capita quantity of meat does not rise with household size, a point we return to below.

Another key prediction of our extended model is that per capita quantities of the most time intensive good – in our case ingredients – should rise with household size (holding per capita income constant). This is because of both the income and substitution effects of the changes in shadow prices brought about by increasing household size. Assuming that market prices are constant, this means that, at a given level of per capita resources, couple households should spend a larger share of their budget on ingredients. This is not what we observe in our data. Figure 4 and column 4 of Table 3 show that, if anything, couples spend a lower share of their budget on ingredients. Thus a version of the Deaton and Paxson puzzle remains.

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[12] Unit values are not quite a price, because variation in unit values can reflect, for example, variation in quality. See Deaton (1997) for further discussion.

Of course, this observation can be explained by the same argument that we have applied to total food expenditures. `Ingredients' in turn are a composite good comprising many types of food with different preparation times, and substitutions between them mean that market expenditures on ingredients are not proportional to quantities. Larger families may pay a lower `average' price because of such compositional effects. However, it is difficult to provide affirmative evidence of this hypothesis (largely because it is not clear what further dis-aggregation of food expenditures would be most appropriate). One suggestive piece of evidence can be found in the bottom panel of Table 2. The average observed unit value of unprepared meat is lower for couples than for singles, and this difference is statistically significant. This means that expenditures are not necessarily proportional to quantities (across household sizes) even at this level of dis-aggregation.

Our extended model can be solved for the time input rather than ingredients, and gives the unambiguous prediction that *effective* time per person on food preparation should rise with household size. A potential empirical problem is that *effective* time is not observed (as it depends on the returns to scale parameter). Nevertheless, Table 1 summarizes food preparation times from the 1998 GSS Time Use Survey.[13] The key point is that couples spend more time *per person* on food preparation than singles (32 min vs. 26 min per person for daily meal preparation, i.e. the household food preparation time of couples is more than double the food preparation time of singles). As noted above, if per capita time rises moving from singles to couples, then *effective* time must also rise. Thus the time use data are consistent with the predictions of our model, and suggest significant returns to scale in food preparation.

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[13] Unfortunately, the GSS time use survey only reports household income in categories, precluding the possibility of conditioning on per capita income as we did in the food data.

5. Discussion

In this note we have explored the intuitive idea that returns to scale in home production are an important source of returns to scale in consumption. We focused on food preparation. Substantial returns to scale in home production would have implications for a number of applied economic questions. Returns to scale in food preparation in particular would challenge the common view that food can be considered a "private good." The model we present in this note also illustrates how such returns to scale can provide a solution to an important puzzle posed Deaton and Paxson (1998). As Deaton and Paxson have suggested, this requires that foods are heterogeneous with respect to time costs (as they are in our model). In models such as ours, substitution between foods that differ in preparation times and market prices means that market expenditures are not proportional to quantities. Thus there can be a compositional effect: larger families may consume larger quantities of food while spending less (in the market) because their food basket is shifted towards ingredients that have lower market prices (but require greater time inputs.)

We have examined several types of types of evidence to determine whether households behave in this way. On the positive side, it there seems to be good evidence for returns to scale in food preparation and heterogeneity within food with respect to time costs.

First, using detailed food expenditure data we show that larger households' food baskets are significantly shifted away from prepared and ready-to-eat foods and towards foods requiring preparation time (`ingredients'). Second, we provide evidence from time use data that *per capita* food preparation time is significantly greater for working couples than for working singles.

However, we are ultimately left with a version of the original Deaton and Paxson puzzle. In our extended model with two kinds of foods, market expenditures on the more time intensive type of food should increase with household size, holding per capita resources constant. That is, in our richer model (with heterogeneous preparation times), Deaton and Paxson's original assertion that returns to scale in time costs deepen their puzzle applies to the most time intensive food. However, in our data, market expenditures on `ingredients' do not increase with household size (holding per capita resources constant).

Of course, this observation can be explained by the same argument that we have applied to total food expenditures: `Ingredients' in turn are a composite good comprising many types of food with different preparation times, and substitutions between them mean that market expenditures on ingredients are not proportional to quantities. Larger families may pay a lower `average' price because of such compositional effects. If such substitution patterns are important at finer levels of dis-aggregation, the Deaton and Paxson's strategy for testing for returns to scale may be very difficult to implement.

With respect to the Deaton-Paxson puzzle, an extremely important caveat to our analysis is that the kinds of substitution patterns we have identified (between prepared foods and ingredients, or more generally, between foods with different preparation times) may well be much less important in developing countries, or among those living at subsistence levels. Evidence from developing countries was an important part of Deaton and Paxson's original empirical analysis.

We would also emphasize that our analysis in no way revives "Engel's second law" (or "Engel's assertion"), or the methods of determining equivalence scales that are based upon it. This assertion states that households of different size with the same food (market) expenditure share have the same welfare level. The problems with this assertion have been well described by Deaton (1997) and by Deaton and Paxson (2003). Our demonstration that differences in budget shares across households of different sizes are not proportional to differences in food quantities makes the Engel method seem even more arbitrary.

More generally, our results suggest that the identification strategies (in the estimation of collective household models, for example) that rest on food being a "private good" may be problematic. Across households of different sizes, the total quantity of food consumed is not proportional to observed (market) expenditures.

Finally, we think our analysis suggests that a full understanding of returns to scale in household consumption will require modeling that includes two features. The first is home production (such as the time costs of food preparation). In this respect our analysis echoes a number of recent papers that propose home production as the resolution of consumption puzzles (for example, Apps and Rees, 2001, and Aguiar and Hurst, 2004). The second is careful consideration of the characteristics of the many goods that households purchase (such as differences in the time inputs they require). The kinds of substitution patterns we have documented suggest that working with highly aggregated expenditure categories (such as `food') may mask important ways in which returns to scale operate, or indeed, the ways in which households optimize.

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Tables and Figures

Table 1: Food 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

Notes:

1. Based on a pooled sample of 1188 singles and 945 childless couples from the 1992 and 1996 Canadian Food Expenditure Surveys. All members are aged 25-55 and working full time. In all calculations the data are weighted to equalize the proportion of each gender amongst singles.
2. Additional regressions controls include age, sex, education of the household head, as well as season and region dummies. Including quadratic term of logistic per capita income has little impact on the coefficient of couple dummy. Full results are available from the authors

Table 2: Meat Purchases

		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]	

Notes:

1. Based on a pooled sample of 1188 singles and 945 childless couples from the 1992 and 1996 Canadian Food Expenditure Surveys. All members are aged 25-55 and working full time. The data are weighted to equalize the proportion of each gender amongst singles.

Footnote f or text: not a function of outliers. Test of equality of median is rejected with t statistics of 4.7 and 8.9 for singles and couples.

Table 3: *Per capita* time spent on food preparation

	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.

Figure 1. Nonparametric curves and confidence intervals
food at home budget share

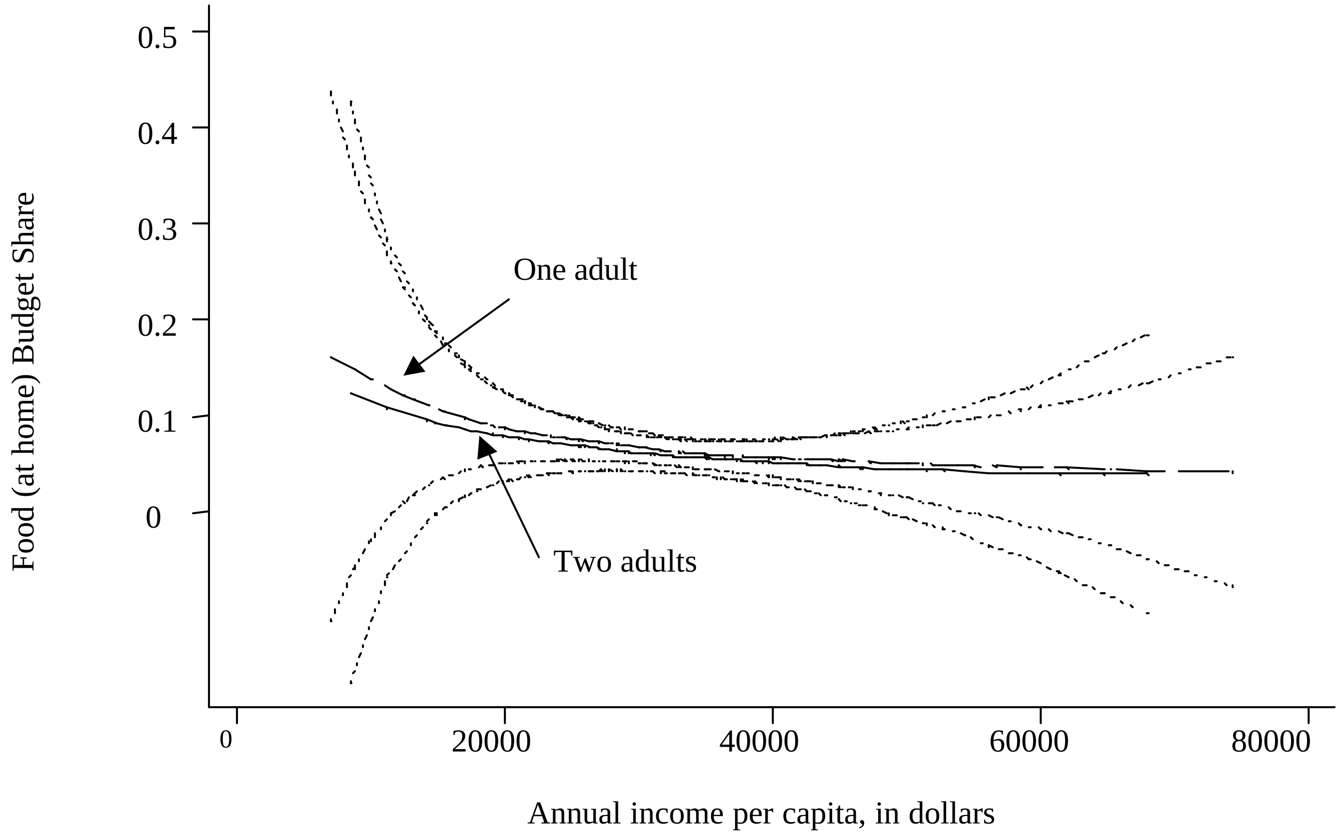

Figure 2. Nonparametric curves and confidence intervals,
expenditure ratio of prepared food to ingredients

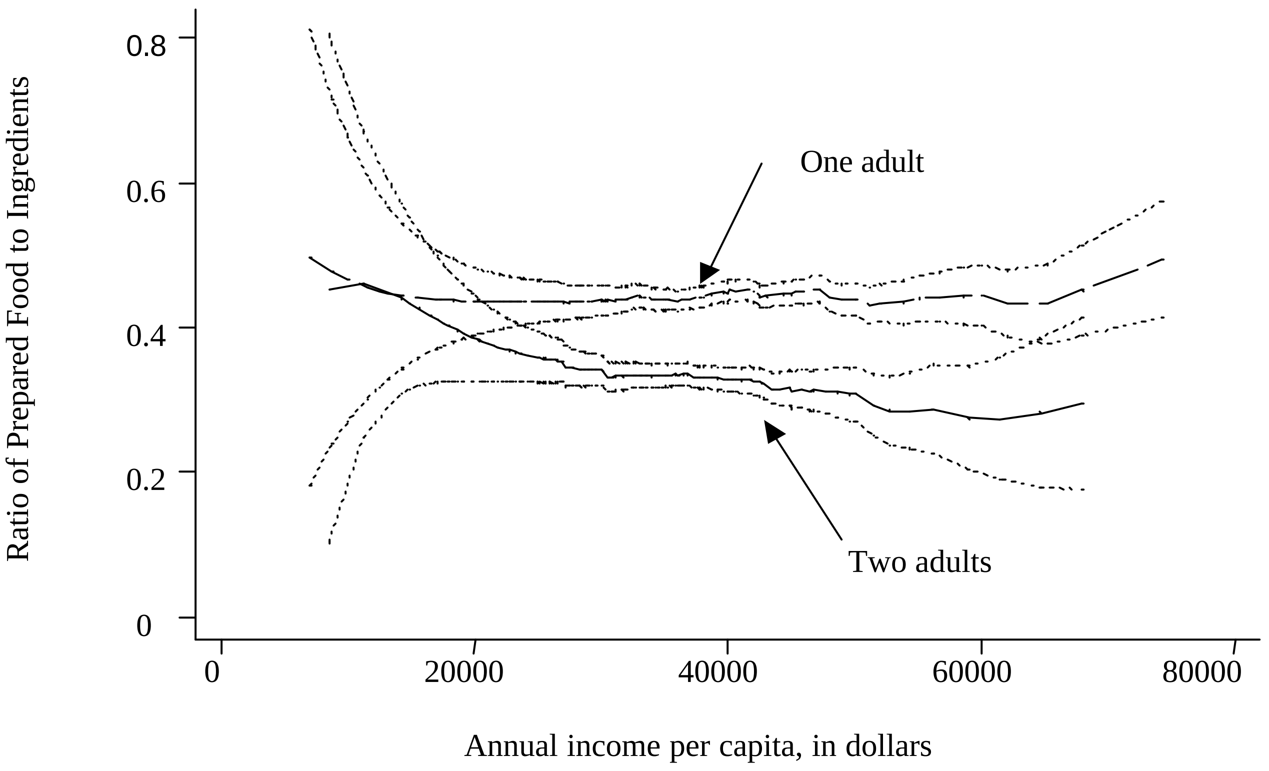

Figure 3. Nonparametric curves and confidence intervals, expenditure ratio of take-out food to ingredients

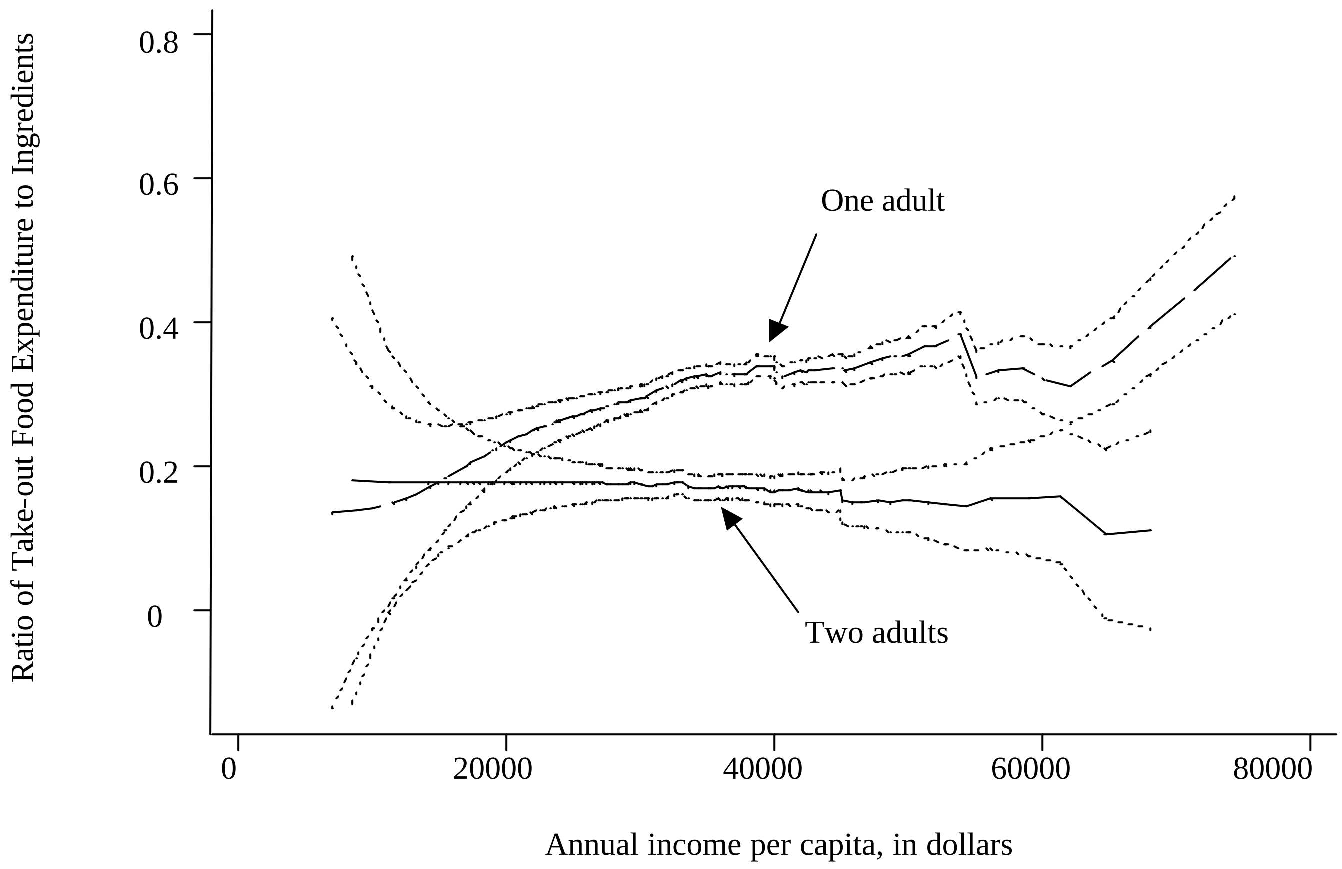

Figure 4. Nonparametric curves and confidence intervals,
Ingredients budget share